love every drop
anglianwater

Revised Draft WRMP24
Technical Document

Demand forecast

August 2023

Demand Forecast

Business in the Community Awards **Winner 2017**

Financial Times **Climate Leaders 2022**

The Queen's Awards for Enterprise: **Sustainable Development 2020**

Utility Week Awards 2021 Winner **Utility of the Year**

1 WRMP24 Introduction

1.1 About our company

1.1.1 Anglian Water is the largest water and wastewater company in England and Wales geographically, covering 20% of the land area.

1.1.2 We operate in the East of England, the driest region in the UK, receiving two-thirds of the national average rainfall each year; that's approximately 600mm.

1.1.3 Our region has over 3,300km of rivers and is home to the UK's only wetland national park, the Norfolk Broads.

1.1.4 Between 2011 and 2021, our region experienced the highest population increase in England. Despite this, we are still putting less water into our network than in 1989.

1.2 Planning for the long term

1.2.1 Our company Purpose is "to bring environmental and social prosperity to the region we serve through our commitment to Love Every Drop". This purpose is at the heart of our business, having been enshrined in our Articles of Association in 2019.

1.2.2 Central to delivering this purpose is planning for the long term; one of the strategic planning frameworks we use to achieve this is the Water Resources Management Plan (WRMP), which details how we will ensure resilient water supplies to our customers over the next 25 years.

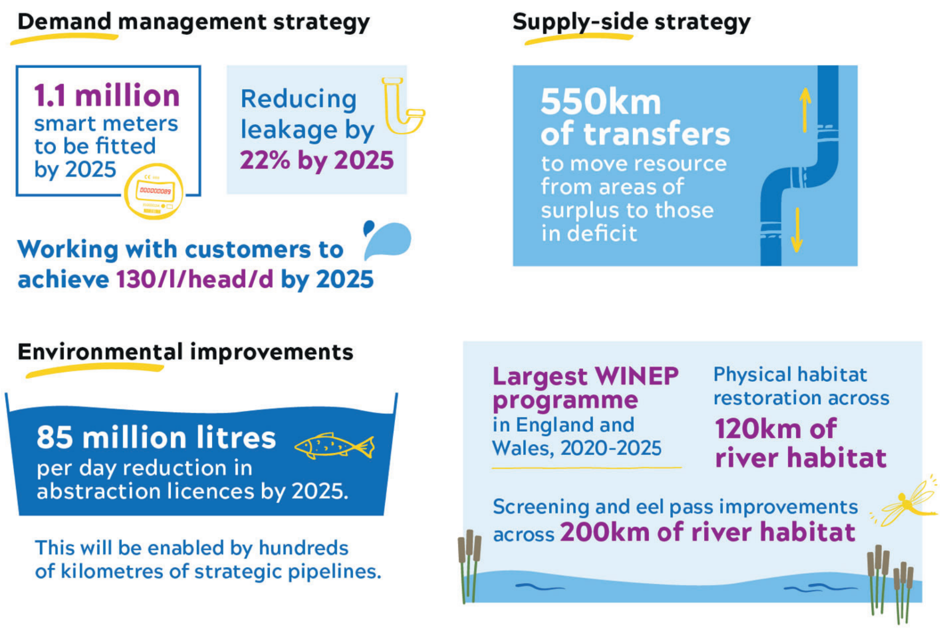
1.2.3 A WRMP looks for low regret investments [1] for our region, giving flexibility to adapt to future challenges and opportunities such as technological advances, climate change, demand variations, and abstraction reductions.

1.3 What is a Water Resources Management Plan?

1.3.1 We produce a WRMP every five years. It is a statutory document that sets out how a sustainable and secure supply of clean drinking water will be maintained for our customers. Crucially it takes a long-term view over 25 years, allowing us to plan an affordable, sustainable pathway that provides benefit to our customers, society and the environment.

1.3.2 Our previous WRMP, WRMP19, had an ambitious twin track strategy, combining an industry leading smart meter roll out and leakage ambition with a strategic pipeline across our region, bringing water from areas of surplus to areas of deficit. An overview of WRMP19 can be seen in (Figure 1).

Figure 1 Our WRMP19 twin track approach



1 Investments that are likely to deliver outcomes efficiently under a wide range of plausible scenarios

1.3.3 This WRMP focusses on the period 2025 to 2050, and is known as WRMP24. We have developed it by following the Water Resources Planning Guideline (WRPG)[2], as well as other relevant guidance, in order to meet statutory requirements. This has ensured our WRMP24:

- Provides a sustainable and secure supply of clean drinking water for our customers.
- Demonstrates a long-term vision for reducing the amount of water taken from the environment, and shows how we will protect and improve it.
- Is affordable.
- Maintains flexibility by being able to respond to new challenges.
- Complies with its legal duties.
- Incorporates national and regional planning.
- Provides best value for the region and its customers.

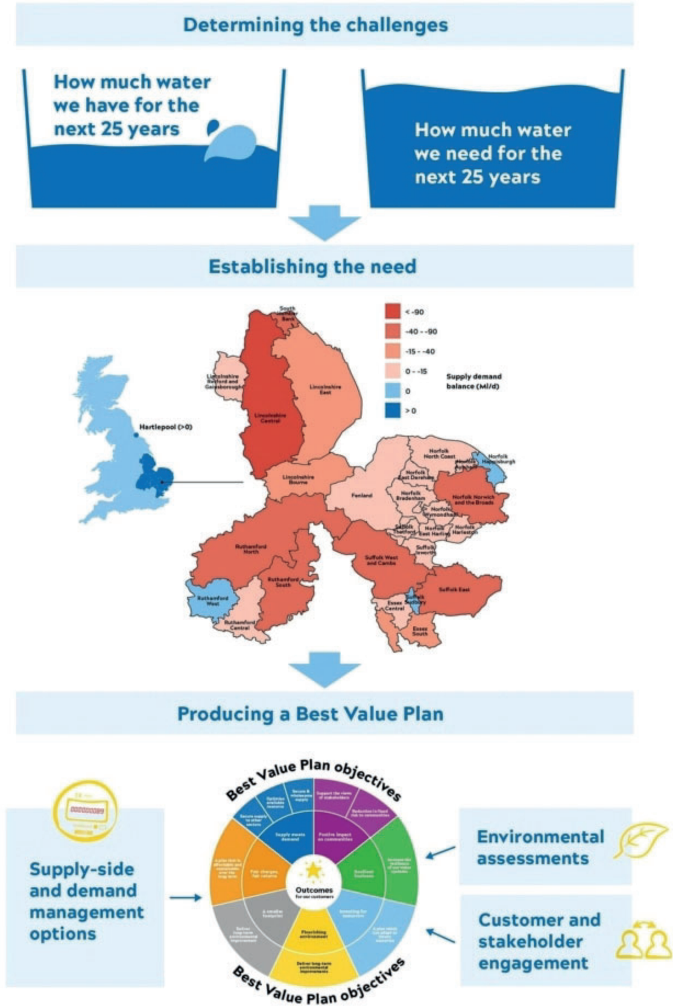
1.4 Developing our WRMP

1.4.1 Our WRMP24 has been progressed following processes detailed in the WRPG, as shown (Figure 2).

1.4.2 We start by determining the extent of the challenges we face between 2025 and 2050. We achieve this by developing forecasts to establish the amount of water available to use (supply forecast) and the amount of water needed (demand forecast) in our region. When these forecasts are combined, a baseline supply-demand balance is created. This tells us whether we have a surplus of water or a deficit, establishing our water needs for the planning period.

1.4.3 An appraisal for both demand management options and supply-side options is undertaken, starting with an unconstrained list of possible options which progresses through various assessments until a final constrained list is determined.

Figure 2 Figure 2 A high level overview of our WRMP24 planning process



2 https://www.gov.uk/government/publications/water-resources-planning-guideline/water-resources-planning-guideline

1.4.4 Demand management options aim to reduce the amount of water being used by our customers and lost in our water network. Examples of these options include smart metering and the promotion of water efficiency measures, such as reducing shower times. Supply-side options are also developed; these provide additional water to supply to customers. Examples of these options include new raw water storage reservoirs or water reuse treatment works.

1.4.5 We environmentally assess both demand management and supply-side options so we can understand their potential environmental impacts and what could be put in place to mitigate them; in some cases we exclude options from further consideration.

1.4.6 The next step is for the water savings associated with the chosen demand management options to be added into our baseline supply-demand balance to determine if our region's water needs are met. If the demand management options savings do not solve the need, supply-side options are added into the modelling process. This is undertaken in our Economics of Balancing Supply and Demand (EBSD) model which conducts numerous modelling runs, creating a range of plans that meet our objectives. These plans are also environmentally assessed.

1.4.7 We develop a best value plan from these different model runsand environmental assessments, encompassing the views of our customers and stakeholders who have been consulted throughout the plan's development.

1.5 Best Value Plan

1.5.1 To ensure we developed the right solution for our region's water needs, we have focussed on 'best value'. To us, best value is looking beyond cost and seeking to deliver a benefit to customers and society, as well as the environment, whilst listening and acting on the views of our customers and stakeholders.

1.5.2 These views, from our customers and stakeholders, have helped build our best value framework, shown in (Figure 3) which has been used as the basis for our decision making.

Figure 3 Best Value Plan

1.6 Our revised draft Water Resources Management Plan

1.6.1 Our best value plan, the revised draft WRMP24, has been produced following a public consultation on our draft WRMP24. This consultation ran from December 2022 to March 2023. Taking into account consultation feedback and our revised forecasts, we have:

- Increased our leakage ambition from 24% to 38%
- Included projected non-household demand for the South Humber Bank, in north Lincolnshire
- Developed non-household demand management options
- Recognised further opportunities to utilise the existing resource we have, and
- Removed abstractions from the supply forecast that are likely to be closed due to Habitats Regulations

1.6.2 Our core supply side strategy - featuring two new reservoirs, interconnectors and water reuse - remains the same as our draft. We have provided further information demonstrating that this is a low regret plan which will underpin the environmental, economic and social resilience of our region, whilst retaining flexibility to adapt in the longer term.

1.7 Strategic context of the revised draft WRMP24

1.7.1 Our revised draft WRMP24 aligns with our Purpose,as well as internal and external strategic plans and initiatives. We have worked collaboratively with internal and external stakeholders, regulators and other water abstractors to achieve this.

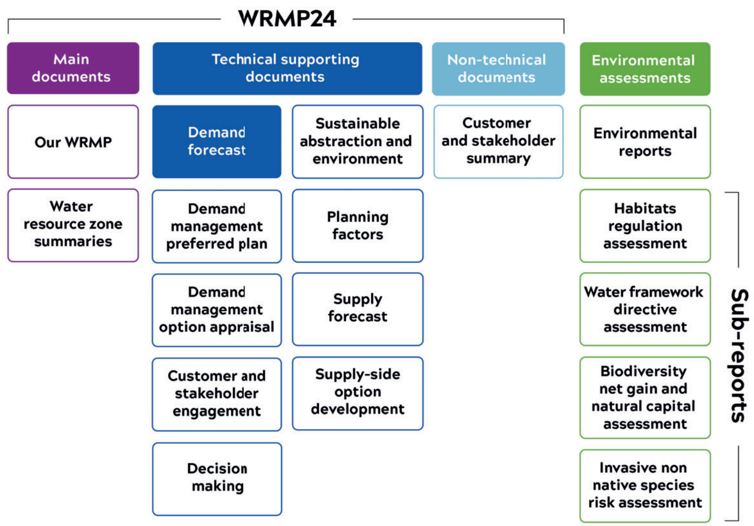
1.7.2 These interactions are highlighted throughout our revised draft WRMP24 submission, showing the importance of collaborative planning. For instance, Regional Plans led by Water Resources East (WRE) and Water Resources North (WReN) have been significant in shaping our investment priorities and requirements, with WRE demonstrating the valve of the strategic regional options (SROs) at the regional, multi-sectoral level.

1.7.3 This revised draft WRMP24 will help to shape our company investment strategy for the next Price Review submission (PR24), as well as our Long Term Delivery Strategy. We have also maintained close links with the Drainage Wastewater Management Plan and our Drought Plan.

1.8 Guide to our revised draft WRMP24 submission

1.8.1 Our submission comprises a non-technical customer and stakeholder summary, our main report and nine technical supporting documents, shown in (Figure 4) below. These technical documents are supported by a suite of independent environmental assessments. Water resource zone summaries will also be available, as well as associated tables on request.

Figure 4 Our revised draft WRMP24 reports



1.8.2 This report is concerned with the development of the Revised draft WRMP24 Demand forecast technical supporting document.

1.8.3 This is the WRMP24 Demand management preferred plan technical supporting document. The main changes in this document between draft and revised draft are:

- Updated population and property forecasts (revised to January 2023).
- Updated base-line data to align with the 2021/22 water balance (from 2019/20): date nearer to the WRMP24 start year.
- Updated smart meter installation profiles to include 'Accelerated Infrastructure Delivery' (AID) program.
- Revised assessment of smart meter savings based upon additional smart meter data from the full roll-out.
- Revised inclusion of factors that influence demand (Covid19 and Government led interventions).
- Increased leakage reduction program (achieving a 38% from the national framework baseline 2017/18), including mains replacement.
- Inclusion of assessed non-household demand management options (and demand reductions)
- Revised non-household demand forecast (to account for increased growth).
- Inclusion of an assessment of demand requirements for Hydrogen and carbon capture projects (South Humber bank).
- Revised costs based upon updated information, in alignment with the PR24 process.
- Updated base-line and final plan demand forecasts based upon the above.
- Improved detail regarding the 'Demand management monitoring framework'.

1.8.4 The smart meter roll-out and water efficiency options have not been changed from the Draft WRMP24.

1.9 Next steps

1.9.1 Our Statement of Response and revised draft WRMP24 documents are available to view atanglianwater.co.uk/wrmp

2 Executive Summary

2.1 The WRMP 2024 demand forecast, demand management strategy and preferred plan

2.1.1 Whilst considering the future for water demand in the Anglian Water region, we have been mindful of our role in achieving the wider ambitions for water efficiency and demand reduction, as detailed in 'Environmental Improvement Plan (EIP) 2023 (April 2023) Goal 3: Clean and plentiful water' (Defra, 2023).

2.1.2 We have recognised the specific targets for reductions in leakage and customer consumption (PCC) and have tailored our ambitious plan to contribute to these reductions (noting that this must be viewed in the context of each water company's current position and that modelling must be robust and defensible).

2.1.3 This report will detail the demand management planning process and the, strategic out-comes will be detailed in the 'Demand management option preferred plan: WRMP24 Technical Report'.

2.1.4 As a part of our revised draft WRMP24 plan, we have developed our demand forecast, based upon;

- updated (for 2023) property and population projections (including potential strategic growth in our region),
- redefined demand management portfolios (including more detailed analysis based upon smart meter data) and
- updated assessments of other influences on demand.

2.1.5 The demand forecast process has required the re-evaluation of demand management options based upon their feasibility in addressing increasing demand from a growing population. (See the ***'Demand Management Preferred Plan Technical Report'***).

2.1.6 Demand management options have been developed for;

- metering (based around the full implementation of AMI smart metering),
- leakage reduction, and
- household water efficiency measures (linked with the smart meter roll-out)

2.1.7 These options have been combined into portfolios; targeting savings from attitudinal and behavioural change, water efficiency and leakage (both household losses and those associated with our distribution network).

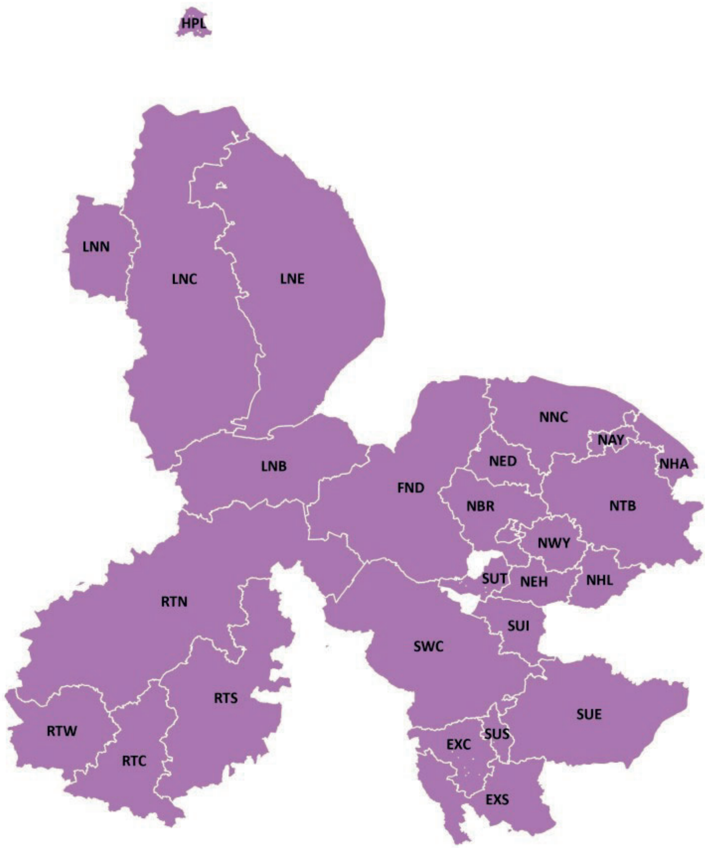
2.1.8 Those options deemed to be most cost effective in advancing water efficiency have been quantified and the savings have been applied to the appropriate demand segments (measured/unmeasured consumption, customer supply pipe leakage, plumbing and distribution losses) to produce Dry Year Annual Average (DYAA) and Critical Period (CP) base-line and final plan forecasts (including the demand management option savings). These forecasts have been produced for each water resource zone in the Anglian water region (including Hartlepool). This has allowed the creation of a future forecast for demand to be derived, based upon our understanding of population and property growth, with and without demand management options.

2.2 WRMP 2024 Water Resource Zones

2.2.1 The Anglian Water Resource Zones have been re-evaluated for WRMP24, producing the geography, as shown. This reassessment has been based upon our revised draft WRMP24 Water Resource Zone (WRZ) integrity analysis, reviewing security of supply and resource zone interconnectivity.

2.2.2 The Revised draft WRMP24 Demand forecast, Demand management option analysis and cost benefit analysis (CBA) have been modelled at the Sub-WRZ, Planning Zone level, in order to allow forecasts to be produced for WRMP24 and Water Resources East (WRE) purposes, noting that WRE has a different resource zone geography. See the figure below (Figure 5):

Figure 5 WRMP 2024 Water Resource Zones (WRZs)



2.3 Key Demand Forecast Outcomes

In this section we will summarize the outcomes of our base-line (BL) forecast and preferred final plan (FP) for the revised draft WRMP24 including:

- Our preferred population and property forecast.
- Demand (Distribution Input) outcomes for both base-line and final plan forecasts.
- Per capita consumption with (FP) and without (BL) demand management options.
- Leakage and metering trajectories for our **preferred final** plan.

2.3.1 Growth Scenarios for Anglian Water have been developed by our external demographic consultant, Edge Analytics, who have also developed a number of strategic growth scenarios (reflective of the OxCam Arc strategic Oxford-Cambridge growth corridor) based upon an uplift in local housing, for relevant local authorities (whilst also accounting for Local Authority plans).

2.3.2 For our revised draft WRMP24, we have taken a pragmatic approach, including a conservative version of this strategic growth, in order to minimize future risk from unexpected population growth in our region (Our OxCam1b scenario). This reflects the fact that the current Government position has been revised with regard to the potential for OxCam strategic plan development. However, despite significant uncertainty, growth in this part of our region around Cambridge still appears to be a strategic priority.

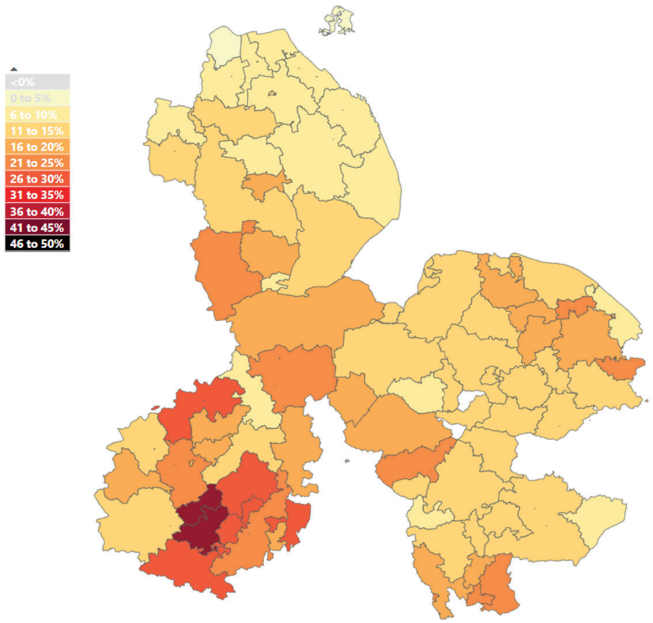
2.3.3 Consequently, the chosen scenario maintains near term Local Authority planned growth (higher than trend) beyond AMP7 (rather than returning to trend in the long term) in these known high growth areas. This would seem to be the most pragmatic approach, given recent growth in the areas covered by the arc, and the fact that the East of England has experienced the highest growth rates in the UK since the 2011 census (>8%). This forecast has been aligned with our WRE partners and is in accordance with WRMP24 Guidance. This and other key scenarios (used for sensitivity testing) have been updated for our revised draft WRMP24.

2.3.4 **Our preferred growth scenario has been chosen to reflect Local Authority planning projections with an additional long term uplift to account for potential regional strategic growth.**

- **Base-line Household Population - 4.987M (2024/25)**
- **Base-line Properties - 2.162M (2024/25 - excluding voids)**
- **Households are forecast to increase by 0.527M from 2.162M (2024/25) to 2.689M (2049/50), during the WRMP24 planning period,** increasing by 24%. This reflects LAUA planning projections and a low variant of strategic growth (Oxcam1b).

2.3.5 Percentage growth can be shown across the region, as shown in the figure below: ([Figure 6](#))

Figure 6 Population Growth - % change from 2025-2050 (PZ detail)



- **Note there is an additional allowance for non-household population.** The consumption for this is accounted for in the Non-Household forecast.

The demand forecast also includes the societal influence of Covid19 and the potential for Government led interventions (white good labelling and mandatory standards) to reduce consumption.

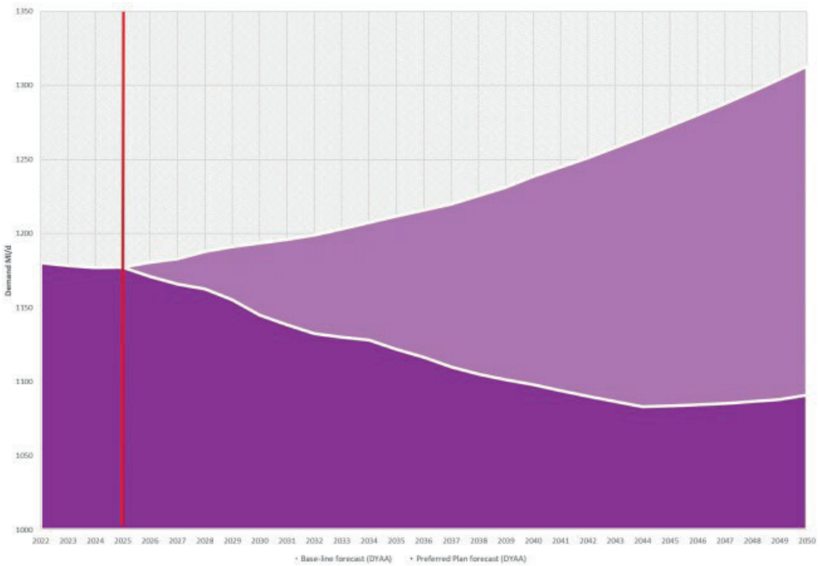
For the revised draft WRMP24 we have produced:

- **A dry year annual average (DYAA) base-line (BL) demand forecast (excluding DMOs)**
  - Demand is expected to increase from 1177.1 Ml/d in 2024/25 to 1312.7 Ml/d in 2049/50 in the base-line (BL) scenario (an increase of 135.6 Ml/d). This includes our current smart meter strategy (1.1M meters) and strategic growth. Note that no allowance for 'Government led interventions' is included in the baseline forecast (as stated in the WRPG: *'Your baseline should not include any relevant government interventions (i.e., mandatory water labelling) which should instead be reflected through options and through your final plan'*).[3]
- **A dry year annual average (DYAA) final plan (FP) demand forecast (including DMOs)**
  - For the preferred plan we see a steady decline in demand as demand management options take effect.
  - Note that for the revised draft WRMP24 government led interventions are included only in the final plan projection, causing a large deviation for the baseline and preferred plan forecasts (in line with Water Resource planning Guidance).
  - For the preferred plan (FP) scenario, we expect demand to be 1090.9 Ml/d in 2049/50 (significantly below the initial 2024/25 value of 1177.1 Ml/d). Note this scenario includes the impact of our complete smart meter rollout, leakage reduction, non-household water efficiency and government led interventions.

3 Environment Agency (March 2023), '*Water Resources Planning Guideline WRMP24*', p.42

2.3.6 Dry year annual average demand can be shown for the base-line, without demand management (light purple) in light purple and preferred plan forecast (dark purple) as below (Figure 7):

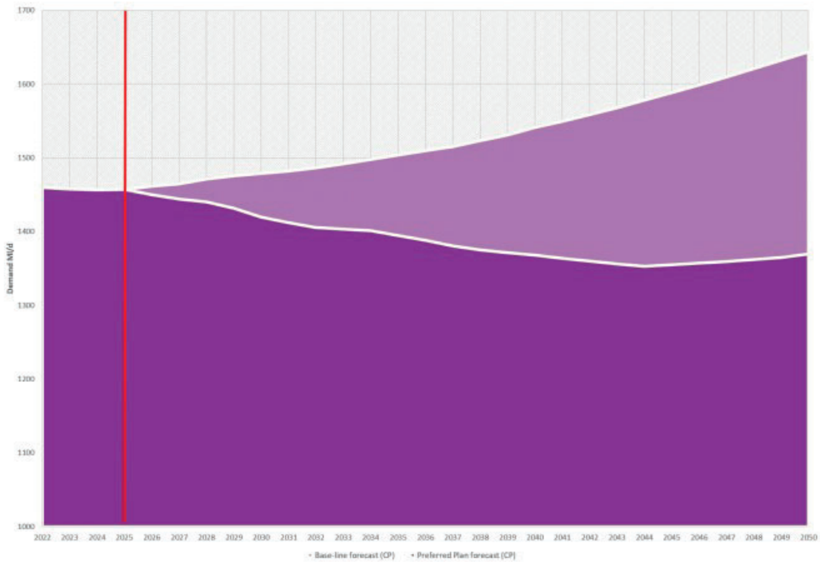
Figure 7 Base-line and Final preferred plan demand (DYAA)



- **A critical period (CP) base-line (BL) demand forecast (excluding DMOs)**
  - Demand is expected to increase from 1457.1 Ml/d in 2024/25 to 1643.8 Ml/d in 2049/50 (an increase of 186.7 Ml/d). This includes our current smart meter strategy (1.1M meters), strategic growth, leakage and non-household water efficiency, but excludes the allowance for 'Government led interventions'.
- **A critical period (CP) final plan (FP) demand forecast(including DMOs)**
  - For the preferred plan (FP) scenario, we expect demand to be 1369.6Ml/d in 2050. This includes our demand management program, and government led interventions.

2.3.7 Critical period demand can be shown for the base-line (light purple) and preferred plan (dark purple) forecasts as below (Figure 8):

Figure 8 Base-line and Final preferred plan demand (CP)

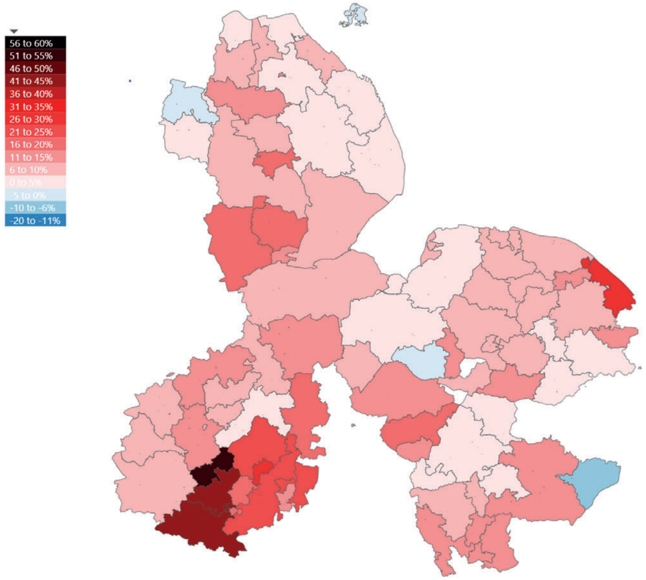


2.3.8 The relative (% increase) changes in demand can be shown geographically for the period 2024/25 to 2049/50, for both the base-line scenario and the preferred plan.

2.3.9 The preferred plan scenario can be seen to more than off-set demand growth due to increasing population, as we aim to maximise demand reductions with our preferred portfolio. This can be shown at Planning Zone (sub water resource zone) level as below (note growth in red, reduction in blue).

2.3.10 Base-line demand without additional demand management enhancement shows significant increases as shown below (Figure 9):

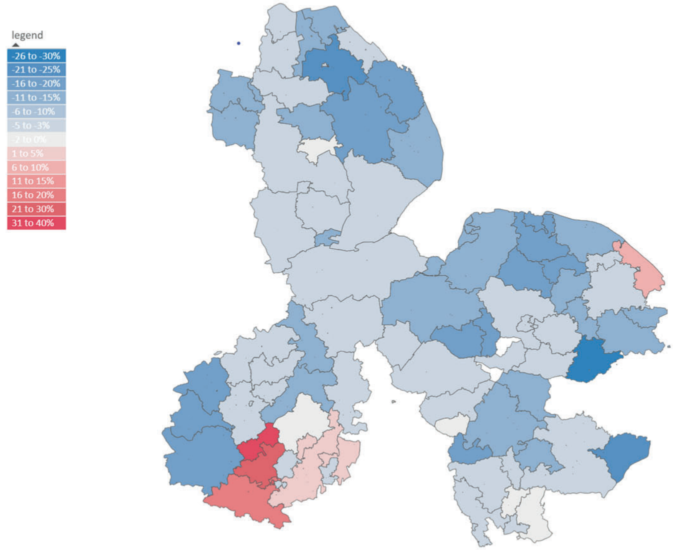
Figure 9 Base-line - DYAA - Percent change in demand 2025-2050 (PZ detail)



2.3.11 Significant growth is expected in the south of our region over the planning period, especially around the Milton Keynes, Newport Pagnell, Bedford region, along with the Braintree, Colchester area.

2.3.12 Final preferred plan demand growth is significantly mitigated by our preferred demand management portfolio (Figure 10).

Figure 10 Preferred Plan with DMOs - DYAA - Percent change in demand 2025-2050 (PZ detail)

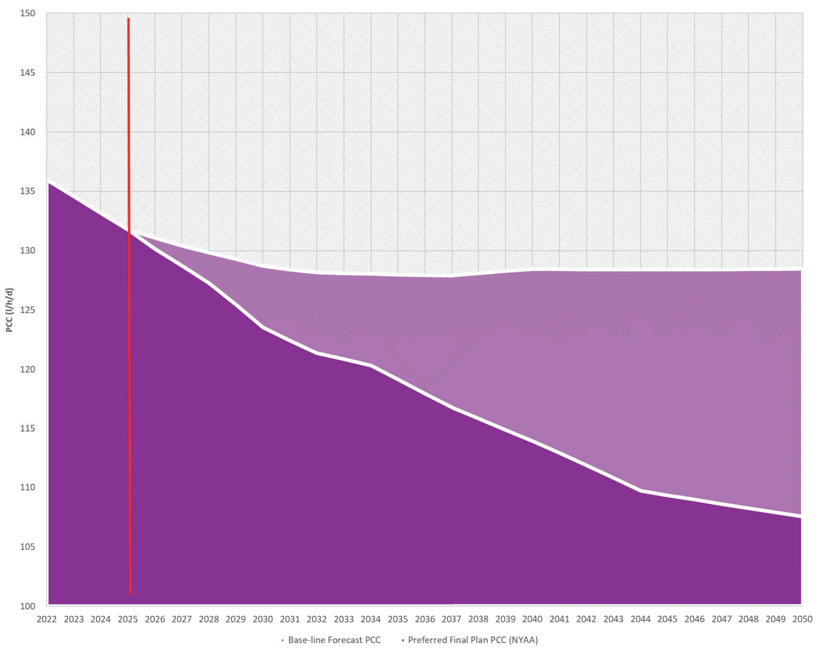


- **Our base-line (BL) forecast for per capita consumption** indicates that PCC should fall for both the DYAA base-line and preferred plan scenarios. For the DYAA base-line scenario it is expected that PCC will fall from a value of 134.4 l/h/d (2024/25) to 131.0 l/h/d by 2050. This decrease is attributed to the combined effects of smart meter savings (from the 1.1m smart meters installed in AMP7 (2020-2025)). Note there is no impact from 'Government led interventions'.
- **For our preferred plan (FP)** we expect DYAA PCC to decrease further from a value of 134.4 l/h/d (2024/25) to a value of 109.7 l/h/d by 2049/50 (note that the NYAA PCC value will be 107.6 l/h/d) in line with the National Framework target of 110 l/h/d. This additional decrease in PCC, will be driven by our full smart meter rollout and enhanced water efficiency options (linked with the opportunities arising from smart meters with respect to our water efficiency communications strategy). Note that the preferred plan includes the impact of 'government led

interventions' ('white good' / water utility labelling and mandatory standards)

2.3.13 Per capita consumption projections can be shown for both the base-line (light purple) and preferred plan (dark purple) as below (Figure 11):

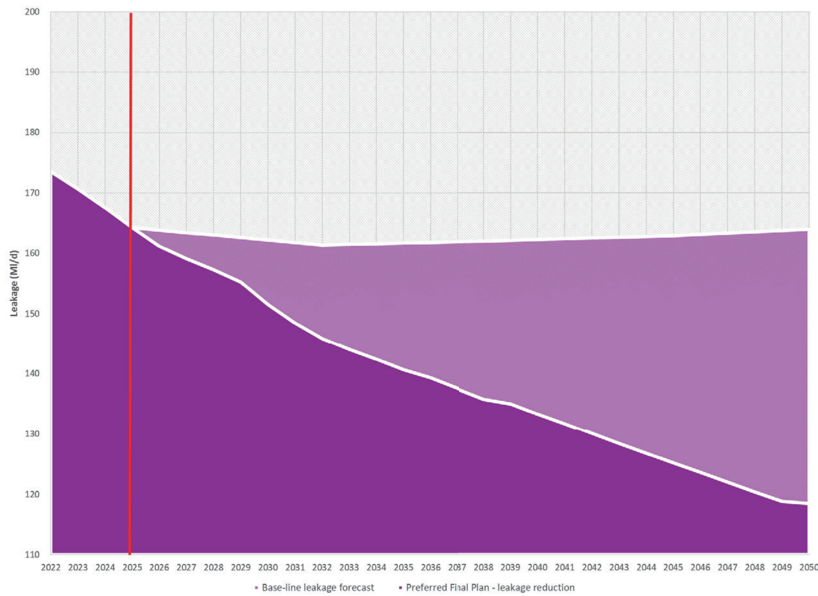
Figure 11 Per capita consumption, base-line and preferred plan



- **Leakage** is forecast to reduce to 164.2Ml/d by 2024/25, the base-year for the revised draft WRMP24; a reduction of 14.0% from our 2017/18 base-line (reflecting smart meter introduction and leakage measures). For our revised draft WRMP24 base-line forecast we are predicting leakage to be relatively static at 164.0 Ml/d by 2049/50 (noting increasing customer supply pipe leakage (cspl) due to property growth over the WRMP24 plan period (527K additional properties over the plan period)). The preferred plan includes additional mains replacement leakage reduction measures and the impact of our full rollout of smart meters (cspl reduction) leading to a leakage level of 118.5 Ml/d by 2049/50. This would reflect a 38% reduction in leakage from our 2017/18 leakage level.

2.3.14 Leakage forecasts can be shown for both the base-line (light purple) and preferred plan (dark purple) as shown below (Figure 12):

Figure 12 Leakage forecast, base-line and preferred plan



2.3.15 Note that in assessing our leakage targets we have been mindful of both the National Framework target (a 50% reduction in leakage nationally), our frontier position and the cost implications for our customers, given our frontier position with respect to leakage. The 38% reduction will only be achieved at significant cost to our customers, beyond AMP8 (2029/30), but is indicative of our ambition for long term leakage reduction. This is covered in more detail in our *Revised draft WRMP24Demand management preferred plan technical supporting document.*

3 Demand forecast overview

In this section we will:

- describe how we have derived a demand forecast for the dry year annual average, where demand is unrestricted, which includes adjustments for factors such as climate change, population growth, household size, property numbers, and current company demand management policy/activities.
- show how we have derived a demand forecast for the critical period, that accounts for the factors which we expect will drive demand during the critical period, such as seasonal changes or population growth.
- show how we have derived a demand forecast for the final plan dry year annual average, which includes adjustments to reflect solutions identified through our demand management options appraisal process.
- describe how we have derived a demand forecast for the final plan critical period, which includes adjustments to reflect solutions identified through our demand management options appraisal process.
- explain how demand forecasts have been arrived at and document any underlying assumptions, including how we have determined unrestricted demand.
- explain how we have reconciled current best estimates of demand with other parts of the water balance.

3.1 Overview

3.1.1 Our Revised draft WRMP24 submission comprises several reports. The main submission is supported by technical documents that explain our methodologies and provide the detailed results of our analysis.

3.1.2 This technical document describes our methodology for demand forecasting for the revised draft WRMP24, covering the following;

- Interpretation of the Guidance: The methodology demonstrates that we have understood the guidance.
- Adherence to the guidance: We have demonstrated how the methodologies adhere to the guidelines.
- Suitability of approaches: The assessment of the various components of demand matches the requisite level of sophistication suggested by the risk-based approach for a given Water Resource Zone (WRZ).

3.2 Background

3.2.1 Water companies have a statutory obligation to produce a Water Resources Management Plan (WRMP), which sets out how a company intends to maintain the balance between supply and demand for water over a minimum 25-year period, in this case from 2025 to 2050.

3.2.2 In the development of the WRMP24, companies must follow the Water Resource Planning Guideline ("Guidelines") and have regard to broader government policy objectives, as set out in Defra's Guiding Principles document and the National Framework. The WRMP24 has also been developed in co-ordination with other regional water companies and stakeholders as part of the Water Resources East (WRE) regional plan.

3.2.3 WRMPs should safeguard a secure and sustainable supply of water and focus on efficiently delivering the outcomes that customers want, whilst reflecting the value that society places on the environment.

3.2.4 The Environment Agency has updated the Water Resource Planning Guidance (WRPG) for WRMP24. In the current Guidance, they confirm that the WRMP24 must be closely aligned with the National Framework, Local Authority and Regional Plans (WRE) along with the Business Plan, Drought Plan, Drainage and Wastewater Management Plan and River basin management plans.

- *'National Framework (For companies wholly or mainly in England) - The National Framework sets out the challenge for water resources over the next generation. You are expected to work* *within and in regional groups to meet this challenge and work together to develop a cohesive set of plans that identify the best strategic options to meet the challenges we, as a country, face.*[4]

- *Regional plans - Your WRMP should reflect the relevant regional water resources plan. Regional plans are an expectation for companies in England and represent, at a national level, a fundamental change of approach for this round of planning.*[5]
- *Local Authority plans -Your planned property and population forecasts, and resulting supply, must not constrain planned growth. For companies supplying customers in England you should base your forecast population and property figures on local plans published by the local council or unitary authority.'*[6]

3.2.5 Additionally, the National Framework and the National Infrastructure Commission emphasize how important it is that demand should be understood, and that demand management should form a key strategy in both the regional WRE plan and the WRMP, engaging key participants, including wholesale Public Water Companies (PWCs), Retailers and other major water users. The National Framework emphasizes the need for all parties to work together collaboratively in developing the regional plan and national overview. Wide stakeholder engagement will ensure that the plans will be developed based upon shared understandings between multiple organizations and sectors.

3.2.6 Regional planning and Water Resources East (WRE) will form a key element of this planning process.

- *'Regional groups are critical to the development of integrated plans that include the right strategic solutions for the challenges facing the nation. Previously, water resource management plans have been developed by each water company from the bottom up.*
- *The previous round showed the limitations of this, as proposals for water transfers did not match and solutions were not sufficiently integrated. Developing plans at a regional scale, with strategic direction from the national framework, will help overcome this. We have set up a regional coordination group to make sure that the leads of the regional groups are speaking regularly and that the plans are joined up.*
- *Each regional group will produce a regional plan by September 2023. These plans will:*
  - *be integrated across water company and regional boundaries and include sectors beyond public water supply such as agriculture and industry*
  - *include a clear environmental destination and milestones for getting there*
  - *identify the right solutions, such as transfers and reservoirs, for their region and for the nation as a whole*
  - *directly feed into the next water company water resource management plans (WRMPs)'*[7]

3.2.7 Defra have also recently published their 'Environmental Improvement Plan (EIP) 2023 (April 2023) Goal 3 "Clean and plentiful water', stressing how demand management strategies must be integral to future plans for water resources. As they state:

- *To drive progress to close the gap, we have set a new legally binding target under the Environment Act 2021 to reduce the use of public water supply in England per head of population by 20% by 2038. To achieve this we will reduce household water use to 122 litres per person per day, reduce leakage by 37%, and reduce non-household (for example, businesses) water use by 9% by 31 March 2038. This is part of the trajectory to achieving 110 litres per person per day household water use, a 50% reduction in leakage and a 15% reduction in non-household water use by 2050.* [8]

3.2.8 During the development of our revised draft WRMP24, we have been mindful of these targets, whilst also building a robust scientific basis for our future forecasts.

4 Environment Agency (March 2023), *'Water Resources Planning Guideline WRMP24'*, p.13
5 Environment Agency (March 2023), *'Water Resources Planning Guideline WRMP24'*, p.15
6 Environment Agency (March 2023), *'Water Resources Planning Guideline WRMP24'*, p.69
7 Environment Agency (March 2020), *'Meeting our future water needs: a national framework for water resources', p.* 16
8 Defra (April 2023), *'Environmental Improvement Plan (EIP) 2023 Goal 3 Clean and plentiful water'*, p. 67

3.2.9 Whilst considering the future for water demand in the Anglian Water region, we have been mindful of our role in achieving the wider ambitions for water efficiency and demand reduction. We have recognised the specific targets for reductions in leakage and customer consumption (PCC) and have tailored our ambitious plan to contribute to these reductions (noting that this must be viewed in the context of each water company's current position and that modelling must be robust and defensible).

3.2.10 The latest forecasts of demographic change in the UK suggest that population and household growth will be a common characteristic of the Anglian Water region, over the next 25 years. A sustained period of new housing growth, ageing population profiles and a reducing average household size are expected to be key considerations for planners and policy makers. Strategic growth, such as the 'strategic corridor' proposals, might significantly impact housing growth and population and must also be considered whilst developing the plan.

3.2.11 As more people will be living in more homes, they will require more water and water recycling services, subsequently, the existing geographical disparities between the supply and demand for water is projected to become significantly more acute.

3.2.12 As stated in the Waterwise 'UK Water Efficiency Strategy to 2030';

- *'Without action to reduce water demand there is an increasing risk that future housing and business growth will be increasingly constrained by water availability. We are already starting to see this.'*[9]

3.3 Guidance

3.3.1 The EA/UKWIR provides detailed guidance with respect to the demand forecasting element of the Water Resources Management Plan:

- 'Final Water Resources Planning Guideline': EA, NRW, Defra and Ofwat (March 2023)
- 'Guiding principles for water resources planning': Defra (2021)
- 'Water Resources Long Term Planning Framework': Water UK (2016)
- 'Preparing for a drier future, England's Water Infrastructure Needs': National Infrastructure Commission (2018)
- 'Meeting our future water needs: a national framework for water resources': (March 2020)
- 'Collaborating to secure England's future water needs: Our initial water resource position statement': (March 2020)
- 'A leakage routemap to 2050': Water UK (2022)
- 'Agriculture, England; Environmental Protection England Water England; The Environmental Targets (Water) (England) Regulations': (2023)
- 'Our integrated plan for delivering clean and plentiful water': Defra (April 2023)
- 'Water 2050: A white paper': Water UK (2022)
- 'Population, household property and occupancy forecasting' - Guidance manual, supplementary report and worked example: UKWIR (2016)
- 'WRMP19 methods - Household consumption forecasting' - Guidance manual and supplementary report: UKWIR (2016)
- 'Peak water demand forecasting methodology': UKWIR (2006)
- 'WRMP19 methods - Risk based planning': UKWIR (2016)
- 'WRMP19 methods - Decision making process': UKWIR (2016)
- 'Integration of behavioural change into demand forecasting and water efficiency practices': UKWIR (2016)
- 'Customer behaviour and water use - A good practice manual and roadmap for household consumption forecasting': UKWIR (2012)
- 'Impact of climate change on water demand': UKWIR (2013)
- 'An improved methodology for assessing headroom': UKWIR (2002)

3.3.2 In developing the demand forecast for WRMP24, the EA recommends that the methodology balances simplicity and accuracy, and that more detailed analysis should be undertaken where there is vulnerability to growth within a given Water Resource Zone (WRZ).

9 *Waterwise (2023), 'UK Water Efficiency Strategy to 2030', p.11*

3.3.3 Given the significant growth and supply-side challenges expected across our region, we have reviewed our WRMP19 modelling processes, and enhanced our forecast modelling methods, applying the same sophisticated approach to all our WRZs. Furthermore, we have maintained alignments between our WRMP24, WRE and DWMP recycled water demand forecast modelling, in order to develop a coherent, set of demand forecasts, for all growth-related investment. We have also been keen to liaise with Local and Regional Planning Authorities to ensure that forecasts properly reflect Local Plans. This paper will concentrate on the requirements of the WRMP24, as opposed to WRE, or the DWMP24 (Drainage and Wastewater Management Plan).

3.3.4 Due to the complexity of, and pressures on water resources in the East of England, a scenario led approach has provided much greater clarity in understanding future uncertainties and planning options. These scenarios have been integral to the Water Resources East (WRE) planning process, as well as the revised draft WRMP24.

4 Forecast Processes

4.1 Forecast scope

4.1.1 Building upon our WRMP19 plan, we have improved all aspects of the forecasting methodology and framework for WRMP24, such that multi-variant scenario modelling of future demand might be more easily facilitated. The revised draft WRMP24 demand forecast model has fully integrated the consumption forecast (household and non-household), leakage forecast and demand management option (DMO) intervention forecasts into a single unified system; where all the relevant interdependencies (leakage, smart metering, etc.), have been accounted for.

4.1.2 The revised demand forecast system has been designed to fulfil the following objectives:

- Report in a spatially flexible manner (for different spatial projections).
- Generate multiple scenarios, reflecting differing growth projections, demand options and assumptions. This has given greater clarity to our understanding of future uncertainties, forecast sensitivities and demand management options.
- Include population and property variants based upon ONS trend projections, historic completion data, local authority growth plans and strategic growth initiatives (such as the OxCam Arc).
- Produce long term scenario variants (to 2100) for integration into the WRE regional planning process (Water Resources East).
- Enable the production of variant scenarios for growth, leakage and demand management for full Cost benefit Analysis (CBA) and for Economics of Balancing Supply and Demand testing (EBSD).
- Produce an aligned basis for demand forecasts for water and waste-water for relevant geographies (Water Resource Zones, (WRZs), Planning Zones (PZs) and water recycling catchment areas (WRCs)).
- Produce demand forecasts for the required minimum 25-year planning period (80 year for CBA and WRE).
- Reflect all factors and influences on consumption, for the plan period, to produce base-line and final plan DYAA and CP scenarios.
- Fully integrate and align demand management option impacts including household leakage, metering, water efficiency and non-household interventions.
- Allow further segmentation to be built into the modelling to reflect smart meter data, demographics and customer attitudes and behaviours.
- Include forecasts for non-household growth based upon historic regression, future econometric forecasting and non-household sector segmentation.
- Include factors for climate change and uncertainty (Target Headroom).
- Allow for the assessment of carbon impacts associated with demand management options.
- Produce the base-line forecast (BL) and preferred demand management options for the final plan scenario (FP)
- Meet all statutory requirements and follow industry 'best practice'.
- Allow for additional demand forecast factors including Covid19 impacts and the impact of Government led interventions (White good labelling and mandatory design standards).

4.1.3 For the revised draft WRMP24 purpose the demand model has produced:

4.1.1 'Base-line dry year annual average' forecast (BL - DYAA):

4.1.4 The base-line demand forecast has been adjusted to account for:

- population changes,
- changes in household size (occupancy for both measured and unmeasured customers),
- changes in property numbers,

- base-line impacts on water efficiency, consumption and leakage (smart metering included in AMP7),
- Government led interventions and their impact on consumption,
- Changes in non-household demand (due to population, employment or Gross Value Added GVA forecasting),
- forecast climate change impacts,
- forecast long term impacts on consumption from Covid19,
- long term impacts from the introduction of Government led interventions ((White good labelling and mandatory design standards),
- Dry Year Annual Average uplift on demand.

4.1.2 'Base-line critical period' forecast (BL - CP):

4.1.5 This includes factors which drive the highest critical period demand reflecting a 3 day peak (note a 7 day peak has also been considered and tested) e.g. seasonal peak/summer consumption.

4.1.3 'Final plan dry year annual average' forecast (FP - DYAA):

4.1.6 The preferred final plan demand forecast, has been derived to reflect the Dry Year Annual Average demand, with adjustments to include savings resulting from additional (post 2025) demand management options identified through the option appraisal process and included in the demand management strategy, .

4.1.7 The forecasts will include assessments for the following influences on demand:

- Population changes,
- Water use; changes in behaviour (in both household & non-household customers),
- Metering and meter opting,
- The impacts of AMP7 smart metering on consumption and leakage (cspl),
- Increasing water efficiency and sustainable practices for both household and non-household,
- Changing design standards of devices that use water (e.g. efficiency),
- Changes in technology and practices for leakage detection and repair,
- Climate change and weather patterns,
- forecast long term impacts on consumption from the Covid19 pandemic,
- long term impacts from the introduction of Government led interventions ((White good labelling and mandatory design standards),
- Dry Year Annual Average uplift on demand.

4.1.4 'Final plan critical period' forecast (FP - CP):

4.1.8 A final plan critical period demand forecast has been derived, adjusted to include savings resulting from demand management options that have been identified through the option appraisal process. This includes factors which drive the highest critical period demand (3 day peak).

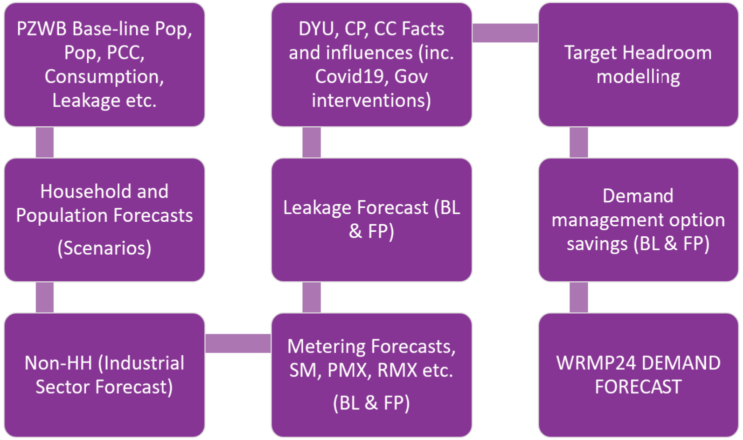
4.1.9 This new modelling system has been designed to easily produce multiple growth scenarios, with Local Planning data, 'local development intelligence' and strategic growth (the Oxford-Cambridge growth corridor) taking precedence. Growth trajectories have been designed to reflect both 'plan' and 'trend' based data, as appropriate in the forecast timeline. As required by the EA/UKWIR guidance, 'Local Authority plan' based information has been used as the core of the near term (5 to 15 year) demand forecast period. However, a variety of growth scenarios have been produced, as part of the WRE and WRMP24 evaluation process, which will be detailed in the relevant sections of the report.

4.1.10 For our revised draft WRMP24, we have taken a pragmatic approach to growth, including a conservative version of the strategic growth variants, in order to minimize future risk from potential population growth in our region (Our OxCam1b scenario).

4.1.11 This reflects the fact that the current Government position has been revised with regard to the OxCam strategic plan, whilst still including a heightened level of growth in the impacted region. The chosen scenario maintains near term Local Authority planned growth (higher than trend) beyond AMP7 (rather than returning to trend in the long term) in our known high growth areas. This would seem to be the most pragmatic approach, given recent growth in the areas covered by the arc, and the fact that the East of England has experienced the highest growth rates in the UK since the 2011 census (>8%). This forecast has been aligned with our WRE partners and is in accordance with WRMP24 Guidance.

4.2 Forecast modelling

Figure 13 Forecast process and elements



4.2.1 We have developed our demand forecast, using a variety of modelling processes, as shown above(Figure 13), identifying each demand segment and their respective influences, along with relevant planning factors and contingencies. These elements include;

- household demand - measured ('visual read' and smart metered)
- household demand - unmeasured,
- Leakage (distribution losses and cspl),
- Non-Household demand,
- DSOU (distribution system operational use),
- water taken un-billed.

4.2.2 Influencing factors (population growth, demand management option savings etc.) have been applied appropriately, to each designated segment of the water balance, for the forecast period. These aggregated demand elements produce the total demand consumption forecast for the required geography (Planning Zones), which are then aggregated to produce the respective Water Resource Zone forecasts for WRMP24 and WRE planning processes (noting that the WRMP24 and WRE water resource zones differ in geography).

4.2.3 The WRMP24 revised consumption model has fully integrated the consumption forecast, leakage forecast and demand management option (DMO) intervention forecasts into a single unified system; where all the relevant interdependencies (leakage, smart metering, plumbing losses, cspl reductions), have been accounted for. It has been designed to include separate input, calculation and output elements, clearly indicating constants, factors, reconciliations and making all calculations and assumptions transparent and explicit. Thus, in simple terms, the forecast process has been conceptualized as:

- data collation and validation;
- apportionment and attribution to the correct geographies;
- modelling, output and analysis.

4.2.4 In detail, the demand forecast elements may be visualized (Figure 14), as comprising a number of analysis elements/modules, which have been aggregated to derive the complete forecast, including all factors and influences on future demand.

Figure 14 Demand forecast elements

4.2.0.1 Demand forecast elements:

- **Household/Population Modelling** - The Household/Population forecast (derived using Anglian Water 'billing' premise, base-line data and ONS/ DCLG/Local Authority adopted/Emergent/Draft plan/Strategic growth data (collated by Edge Analytics). This also includes the forecast for non-household population based upon Census data.
- **Edge Analytics Data** - Edge Analytics has collated housing and population projections - LAUA Plan household growth trajectories (used to inform near term household growth projections) and alternate strategic growth scenarios.
- **Non-Household Forecast** -The Non-Household Consumption Forecast (Produced by Ovarro Technologies). Future non-household consumption forecasts are based upon internal non-household billing data, the internal AWS non-household consumption monitor dataset and an extrapolation of these to produce forecasts based upon non-household sector by sector growth, EEFM GVA forecasts and forecast sector employment rates.
- **WRZ/PZ-Water Balance data** -Water Resource Zone/Planning Zone Water Balance Analysis. Consumption data has been analysed at the planning zone (PZ) level, providing base-line information on consumption for all segments and leakage (household/non-household, measured, unmeasured).
- **Meter Segmentation base-line and forecast** - Water Resource Zone/Planning Zone level analysis has been produced for current meter segmentation (smart meter, visual read meter, optant, enhanced etc.) and forecast rates of change for each meter segment.
- **Leakage and Miscellaneous use analysis** - Future leakage, customer supply pipe leakage (cspl) and other miscellaneous demands have been assessed. Additional import/export factors have also been included.
- **PCC/MCA Base-line modelling** -Per Capita Consumption (PCC) has been evaluated using current AWS domestic consumption monitoring data (SODCON) and weather dependency. Micro Component analysis has also provided an assessment of customer usage based upon EA/UKWIR characterization.
- **Peaking Factors** - Dry Year Uplift (DYU) and Critical Period (CP), have been re- assessed and re-aligned for the new WRZ geographies.
- **Target Headroom** - Uncertainty modelling has been re-evaluated and uncertainty parameters re-assessed and re-aligned for the new WRZ geographies.
- **Household consumption forecast** - A new household consumption forecast has been produced, reflecting the behaviour/technology and efficiency savings (government led interventions and Covid19 impacts) expected to influence future water usage (not including

any further demand management savings included in the demand option development process).

- **Demand Management Options** - Options have been developed utilizing internal AWS data and external reported findings, to produce portfolios of demand interventions (leakage, metering, behaviour, efficiency, tariff) designed to reduce consumption.
- **Demand Forecast Consumption Model** - The model aggregates all demand components and influencing factors at the water resource zone (WRZ) level; it reports all components of demand in the appropriate WRMP24 table format.

4.3 Factors & influences

4.3.1 Whilst understanding the deep uncertainty associated with forecasting human behaviour and water consumption, the forecast has been devised to include as many influences and factors as currently feasible (quantifiable). These include:

- Population and demographic changes (driven by property increases and changes in births, deaths, migration and occupancy).
- Water use; changes in behaviour (in both household & non-household customers.
- Smart meter impacts (on behaviour, plumbing loss and customer supply pipe leakage), metering programs and meter opting.
- Increasing water efficiency and sustainable practices for both household and non-household, including demand management options.
- Changing design standards of devices that use water (e.g. Government led interventions).
- Changes in technology and practices for leakage detection and repair.
- Anglian water demand management options included in the plan.
- Climate change and weather patterns.
- Long term Covid19 impacts on behaviour and water usage.

4.3.2 In addition to housing and population changes, the demand characteristics of the various customer segments (measured, unmeasured, optants, 'switchers', and new-build consumers) have been modelled, taking into account how they vary initially and over time (base-lined to water balance consumption data).

4.3.3 These changes have been factored into the demand forecast, as delineated by the segment descriptions and meter status (household, non-household, metered dumb, metered smart, un-metered, enhanced-metered and optant), described in the WRMP24 guidance and tables.

4.3.4 Additional segmentation and 'cluster' analysis will be progressed, based upon smart meter data and associated demographic characteristics of customer groups, as consumption data becomes available through AMP7 (2023 to 2025) and beyond into WRMP29. This will be a key improvement for our understanding, to be developed as part of our 'demand management monitoring framework'.

4.3.5 The base-line demand forecast has been derived from 'billing' premise data and metering team analysis; customer survey data; SODCON metering analysis (SODCON is the Anglian Water Survey of Domestic Consumption - detailed demographic/ consumption data regarding 1000 measured/1000 unmeasured customers); leakage data; micro-component analysis and technological efficiency estimation. Smart metering consumption data (smart meter penetration is >500K in 2022/23) is now providing insight into measured and unmeasured household consumption, as well as customer supply pipe leakage (cspl) and this has been used to further inform the WRMP24 forecast.

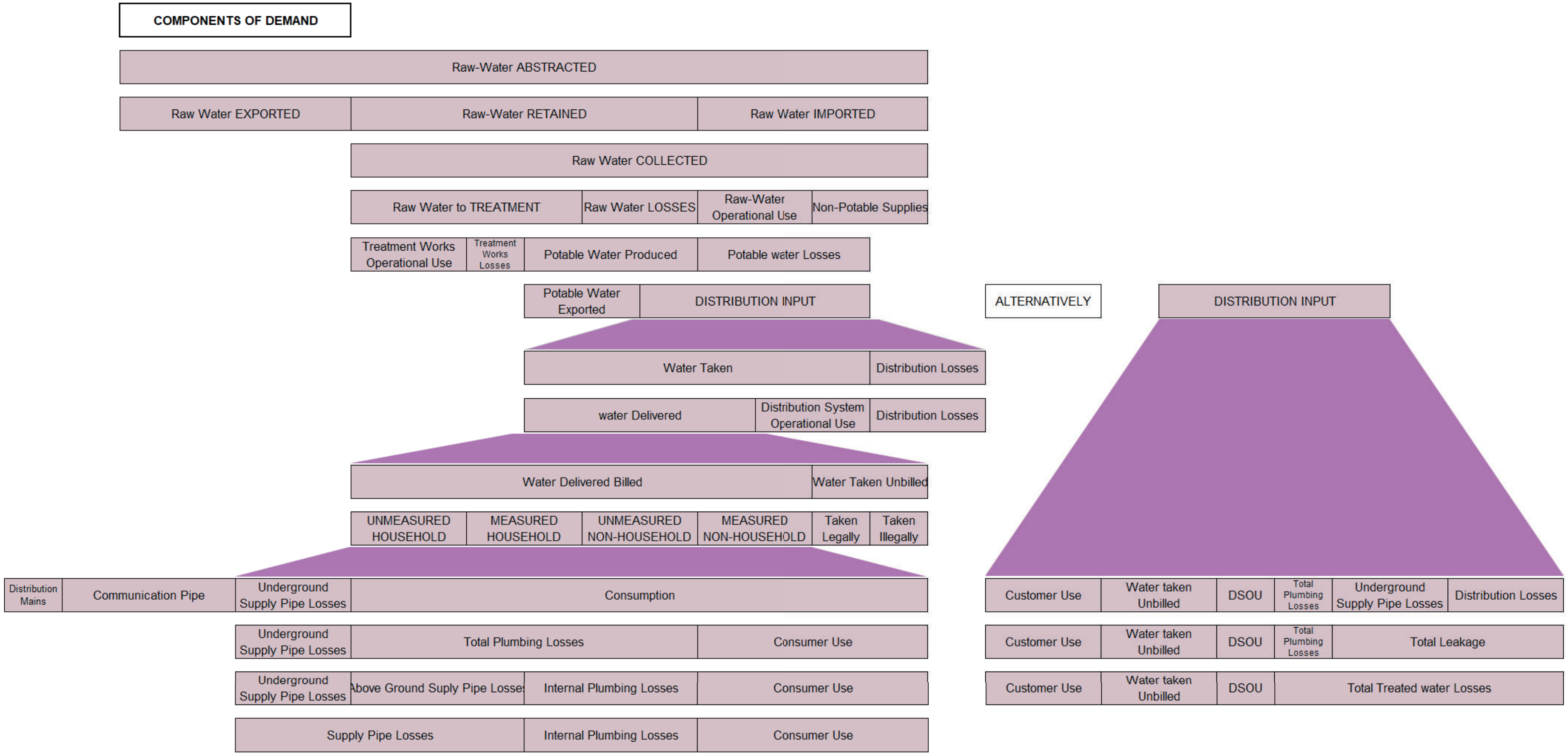
4.3.6 These datasets provide base-line and trend analysis for:

- Measured household demand (Visual Read)
- Measured household demand (Smart metered)
- Unmeasured household demand (Visual and smart metered)
- Customer supply pipe leakage - cspl - (measured, unmeasured, void property)
- Measured non-household demand
- Unmeasured non-household demand

- Water taken un-billed
- Distribution System Operational Use, and
- Distribution Losses (leakage)

4.3.7 The volumetric components of demand, as defined by the EA/UKWIR can be summarized as follows (note this does not include metering status or behavioural change segmentation). These components and their variation through time have been analysed, informing the quantitative assessment of water demand, as described in this document. The components of demand can be shown, as below in (Figure 15).

Figure 15 Components of demand as defined in 'Demand Forecasting Methodology Main Report Joint R&D WR-01/A' Pages 15-19



4.4 The water-balance and base-year assessment

4.4.1 In order to produce the demand forecast, an initial assessment has been made regarding base-year values for each of the components of demand. Base-year consumption and leakage data has been derived using internal water-balance (WB) analysis, in alignment with current derivation methodologies. The water balance calculations (WB) compare 'top-down' estimates of the total water delivered into supply with 'bottom-up' estimates of the demand, based on the measurement and estimation of components of usage. Due to the importance of this dataset, Anglian Water (AWS) has sought to improve its water balance and leakage calculations by creating its whole-company water balance from the aggregation of individual water balances undertaken at the planning zone level (82 no. PZs) to Water Resource Zones (WRZs). The table shows values from the 2021/22 base-line (Table 1).

Table 1 Water balance data

WRZ	Total Population	Demand (DI) Ml/d	MHH Properties	MHH Population	UMHH Properties	UMHH Population	Total Leakage Ml/d	Leakage (DL) Ml/d
Essex Central	37,123	9.5	11,147	28,077	4,006	9,046	2.73	2.42
Essex South	257,246	60.4	90,066	217,470	14,948	39,776	12.46	10.47
Fenland	195,303	60.4	76,408	157,948	12,766	37,356	9.50	7.57
Hartlepool	90,677	28.6	19,738	37,669	21,903	53,008	4.86	3.54
Lincolnshire Bourne	156,598	43.7	58,304	135,397	8,685	21,201	6.55	5.31
Lincolnshire Central	475,263	130.1	170,519	375,630	45,970	99,633	19.85	14.91
Lincolnshire East	381,529	110.1	139,834	304,076	40,294	77,453	17.65	13.17
Lincs Retford & Gainsborough	74,198	20.6	26,560	53,034	8,738	21,163	3.36	2.75
Norfolk Aylsham	22,162	4.5	9,291	20,052	1,008	2,110	0.61	0.41
Norfolk Bradenham	41,491	8.6	16,156	36,860	1,560	4,631	1.77	1.43
Norfolk East Dereham	20,626	4.8	7,711	17,871	1,034	2,755	1.29	1.13
Norfolk East Harling	12,079	3.7	4,220	9,498	857	2,581	0.61	0.51
Norfolk Happisburgh	16,504	4.1	7,114	14,383	1,056	2,121	0.83	0.69
Norfolk Harleston	35,706	9.5	13,469	30,360	1,674	5,346	1.54	1.26
Norfolk North Coast	65,013	16.9	30,268	55,882	4,868	9,131	2.88	2.15
Norfolk Norwich & the Broads	345,348	69.6	129,130	282,116	29,011	63,232	6.45	3.38
Norfolk Wymondham	49,860	10.8	19,123	43,098	2,395	6,761	1.47	1.06
Ruthamford Central	324,682	69.3	114,537	287,989	9,019	36,693	5.53	3.29
Ruthamford North	986,277	213.6	356,163	843,661	47,738	142,616	30.44	22.27
Ruthamford South	490,077	106.0	179,141	415,802	20,029	74,275	15.13	11.41
Ruthamford West	86,277	21.8	32,213	75,586	3,038	10,691	2.98	2.34
Suffolk East	327,977	70.4	123,810	279,446	13,873	48,531	9.69	7.07
Suffolk Ixworth	23,582	5.2	8,590	20,445	1,179	3,137	1.17	1.00
Suffolk Sudbury	32,235	7.1	12,960	28,473	1,484	3,762	1.30	1.04
Suffolk Thetford	35,337	9.5	13,148	28,877	1,655	6,460	1.39	1.11
Suffolk West & Cambs	254,491	62.4	97,112	222,056	11,842	32,435	11.50	9.47
Grand Total	**4,837,661**	**1161.20**	**1,766,733**	**4,021,755**	**310,630**	**815,906**	**173.54**	**131.13**

4.5 Dry year uplift and the ‘Dry Year Annual Average’ forecast

4.5.1 The derivation of appropriate dry year and peak demand forecasts is a key element of the demand forecasting methodology. An assessment has been derived for the ‘Dry year annual average’ demand (DYAA); defined as the average level of water demand in a dry year. This ‘Dry year annual average’ is considered to represent a period of low rainfall and unrestricted demand, and has been used as the basis of the base-line WRMP24 forecast scenario.

4.5.2 The dry year uplift has been calculated at the company level using the current PCC-MC (PCC - per capita consumption - MC - micro component) and peak/dry weather based model. Base year customer data and weather data for the years from 1994 has been assessed, resulting in a re-based mean annual Per Capita Consumption (PCC). The reference dry year has been defined as 2018, noting a number of other dry years (1995, 1996, 2003, 2006, 2011 and now 2023), based on an analysis of PCC (measured, unmeasured and combined; summer, winter and average) and rainfall (summer, winter). Note the reference year is still considered to be 2018, as the base-year for this forecast is 2021/22, pre-dating the most recent, exceptionally hot dry year of 2022/23 (where we experienced temperatures in excess of 40oC).

4.5.3 A ‘pure’ and final dry year uplift value has been calculated as follows:

- A ‘pure’ dry year uplift has been defined as the difference between the average PCC in the reference dry year (2018) and long-term average PCC (excluding years defined as dry).
- A ‘final’ dry year uplift has been defined as the difference between the reference dry year average PCC and the base-year (as calculated by the PCC- MC model).
- The ‘final’ dry year factor has been applied to household consumption in order to produce the Dry Year Annual Average (DYAA) Forecast for the WRMP24.

The table shows the peaking factors for measured, unmeasured and combined households (Table 2).

Table 2 Dry Year Uplift Factors

	Measured Households	Unmeasured Households	Combined
Dry Year Uplift Factor	1.026	1.032	1.027

4.6 Peak demand and the ‘Critical Period’ forecast

4.6.1 Short term weather related variation in demand has been accounted for in the demand forecast process, by the use of a critical period scenario demand forecast. The derivation of periods of peak demand strain, known as a ‘Critical period’, has been reassessed as part of the development of the new forecast.

4.6.2 Peak demand factors have been evaluated at the WRZ level, using the existing 'per capita consumption / micro component' (PCC-MC), 'peak/dry' models and distribution Input (DI) demand data, to produce a ‘Critical peak’ scenario, with factors for measured, unmeasured, household and non-household demand. The peak period is defined as any 3 days which relate to observed demand peaks. Base-year customer data has been used in addition to weather data for the years back to 1994 to identify these peaks.

4.6.3 We have also investigated the potential for using a set of 7 day peaking factors (at WRZ level), on the basis that we may be seeing longer periods of peak water consumption in the future. Obviously, such peaks produce lower overall peaking factors, but would produce higher total volumes over a 7 day period, (as opposed to a 3 day period). After further internal discussion with operations, we have, subsequently concluded that the 3 day peak produces demand values which are more reflective of the actual peaks we observe and is a more realistic indicator of peak demand.

4.6.4 A peak factor (rather than volume) approach has been selected to reflect our assumption that demand largely relates to the resident population, and the customer base will change due to growth and customers switching from being unmeasured to measured.

Table 3 Peaking Factors

WRZ	Measured Household	Unmeasured Household	Measured Non-HH
Essex Central (AWSEXC)	1.281	1.349	1.256
Essex South (AWSEXS)	1.281	1.349	1.256
Fenland (AWSFND)	1.394	1.468	1.395
Hartlepool (AWSHPL)	1.288	1.357	1.233
Lincolnshire Bourne (AWSLNB)	1.333	1.404	1.266
Lincolnshire Central (AWSLNC)	1.188	1.252	1.160
Lincolnshire East (AWSLNE)	1.285	1.354	1.259
Lincs, Retford & Gains (AWSLNN)	1.188	1.252	1.160
Norfolk Aylsham (AWSNAY)	1.464	1.542	1.261
Norfolk Bradenham (AWSNBR)	1.345	1.417	1.369
Norfolk East Dereham (AWSNED)	1.345	1.417	1.369
Norfolk East Harling (AWSNEH)	1.345	1.417	1.369
Norfolk Happisburgh (AWSNHA)	1.464	1.542	1.261
Norfolk Harlston (AWSNHL)	1.345	1.417	1.369
North Norfolk Coast (AWSNNC)	1.464	1.542	1.261
Norwich & the Broads (AWSNTB)	1.314	1.384	1.175
Norfolk Wymondham (AWSNWY)	1.345	1.417	1.369
Ruthamford Central (AWSRTC)	1.324	1.394	1.250
Ruthamford North (AWSRTN)	1.324	1.394	1.250
Ruthamford South (AWSRTS)	1.324	1.394	1.250
Ruthamford West (AWSRTW)	1.324	1.394	1.250
Suffolk East (AWSSUE)	1.281	1.349	1.256
Suffolk Ixworth (AWSSUI)	1.302	1.371	1.352
Suffolk Sudbury (AWSSUS)	1.302	1.371	1.352
Suffolk Thetford (AWSSUT)	1.302	1.371	1.352
Suffolk West & Cambs (AWSSWC)	1.302	1.371	1.352

4.6.5 Household peak per capita consumption (PCC) values are compared with DI peaks for the same customer period for each WRZ. Average (3-day) peaks have been identified for DI and a normalized DI peak factor is found by dividing this value by an equivalent 3-day peak that excludes the months of June , July and August (to show the difference between the summer and rest of the years average); this normalization process follows the UKWIR 2006 guidance. Each Resource Zone DI peaking factor has been derived, as a proportion of the company DI peak factor. These values are then multiplied by the calculated company PCC peak factor (calculated with outputs from the PCC-MC model) to produce the overall PCC peak factor for each WRZ.

4.6.6 Non-household peak factors have been derived using an alternative methodology, due to the lack of equivalent data at present, for non-household consumption. An implied non-household peak demand has been calculated by subtracting the household peak demand from the overall peak in DI. The implied additional non-household peak demand is thus, this value minus the average non-domestic demand, which is a sum of the following components for the base year:

- Distribution system water use.
- Water taken un-billed.
- Unmeasured non-household consumption.
- Measured non-household consumption.
- Total leakage.

4.6.7 The implied non-household peak demand factor has been applied to measured non-household demand only and is calculated by dividing the implied additional non-household peak demand by measured non-household demand. The peak factor for unmeasured non-household demand will be set at 1 (i.e. no peak) as there is little demand in this category (0.5%). Note that this process leads to more variability in the factors at WRZ level, given the disparate sizes in our WRZ populations.

4.6.8 Analysis of peak values of PCC has revealed that peaks are concentrated in the summer months of June, July and August. Ranking of 3-day rolling mean PCC revealed that peak values were concentrated in the years 1995, 1996, 1999, 2000, 2006 and 2017 and 2018.

4.6.9 As can be seen, below, there is some significant variation in peaking factors from zone to zone;

- for measured household peaks we see a differential from an 18% to a 46% uplift.
- for unmeasured household peaks we see a differential from a 25% to a 54% uplift.
- for measured non-household peaks we see a differential from a 16% to a 37% uplift.

4.6.10 These differences in peak demand are driven by both differences in resident demographic characteristics as well as the influx of population due to summer tourism (as can be seen in some of the coastal zones). Further investigation of these differences will be conducted as we progress our smart meter roll-out and analysis.

4.6.11 These factors have been used to produce the Critical Period (CP) Forecast for the WRMP24. For each Water Resource Zone the CP peaks are shown in the table (Table 3).

4.7 Climate change

4.7.1 To forecast the impact of climate change on household demand, annual percentage change factors, developed by UKWIR (2013) 'CL04B impact of CC on water demand', have been used. Average factors from the two models provided have been extrapolated to 2050 and cross referenced. It is noted that, UKWIR (2013) found no consistent weather-demand relationship for non-household demand; consequently, following guidance no climate change allowances will be required to be made.

4.8 Demand management options and the preferred plan

4.8.1 As part of the demand forecast process, demand management options have been evaluated for their feasibility in mitigating increasing demand from a growing population; deferring the necessity for additional supply side options and facilitating a more resilient and secure water resource position. Options have been developed for metering, smart metering, leakage, household and non-household water efficiency which have been combined into portfolios. In liaison with our Retail partners, we have developed a number of options targeting business demand and leakage.

4.8.2 Those options deemed to be most cost effective in addressing increasing demand have been quantified and the savings have been applied to the appropriate demand segments in the forecast (measured/ unmeasured customer consumption, business demand, customer supply pipe leakage (cspl) or distribution losses) in order to produce DYAA and CP final plan forecasts (including the demand management option savings).

Our preferred plan

We plan to build upon our proven track record of delivering demand management savings, through both our leakage and metering programs and the ambitious strategy for smart metering and leakage reduction being implemented in AMP7.

We are, therefore, proposing to expand our current ambitious program of demand management to support our new revised draft WRMP24 plan; one that provides economic benefits, delivers substantial water savings and is, also, achievable.

Our preferred portfolio

Our ambitious strategy will comprise three strongly interlinked programs:

Water metering program

We intend to complete our current smart meter rollout which will replace our entire meter stock over 10 years (2 AMPs), for both our household and retail/business customers (noting that >1M smart meters will be installed by 2025).

The information revolution resulting from 'smart metering' will help inform our customers regarding water usage and assist in our ability to influence this behaviour. It will also help with our ability to detect leakage and understand our network. Retail and business customers will also benefit from real time data and leakage detection.

Leakage reduction

Our aim is to reduce leakage by more than 45Ml/d (this would imply a 38% reduction from the National Framework 2017/18 base-line of 191.31ml/d) from 2024/25 to 2049/50 (Including 11Ml/d of cspl reductions), building upon our ambitious program of leakage reduction in AMP7 (a 14% reduction of 27Ml/d by 2024/25 from the National Framework 2017/18 base-line of 191.31ml/d). Note our leakage reduction program has been formulated, whilst taking into account our current frontier leakage position, cost/benefit analysis relating to this position and our commitment to National targets.

We are aiming to reduce leakage by targeting both losses in our distribution system and losses due to customer supply pipe leakage (noting that we also aim to reduce internal plumbing losses, which impact per capita consumption).

Household and non-household water efficiency measures

New technologies and our interventions will help promote the careful use of water by both our household and non-household (business) customers.

Additional water efficiency programs will include, the promotion of 'Smart' devices; further development of our Multi-utility web-portal, garden advice; support for vulnerable customers with plumbing loss and cspl and community reward schemes

We have worked with Retailers and our WRE partners to develop our views on non-household demand management and have made significant progress in identifying actionable options. As part of our revised draft WRMP24 we have now included 'water efficiency visits' and leakage reduction measures. These options have been developed whilst bearing in mind the Defra/EA 2038 target of a 9% reduction in business demand.

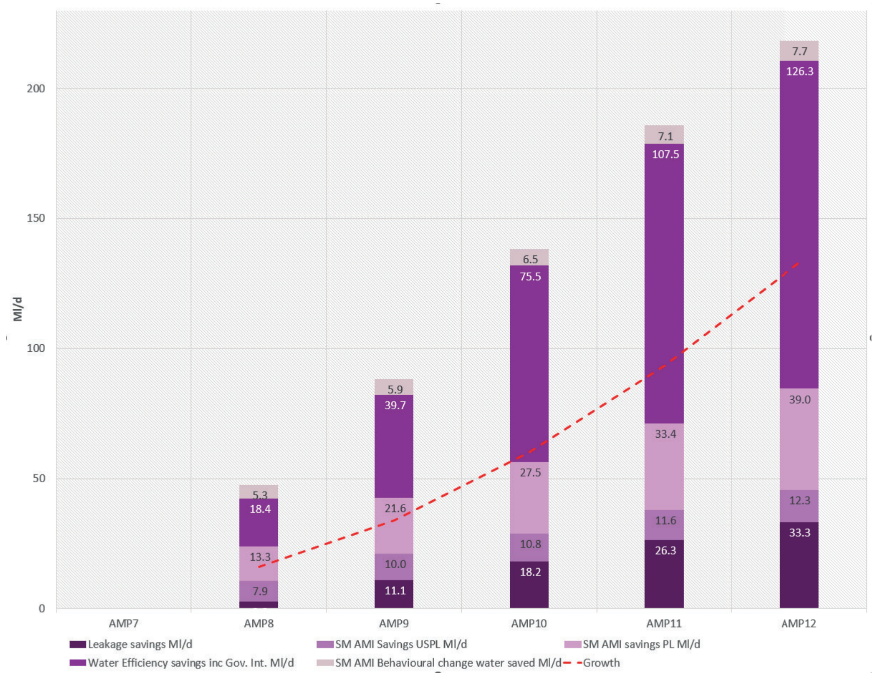
4.8.3 Demand management option benefits can be shown for the 25 year period, 2024/25 to 2049/50 (AMP8 to AMP12) as below (Table 4).

Table 4 Our preferred plan - Benefits

	AMP8 - 2030	AMP12 -2050
	Water Savings Final Year AMP8	Water Savings Final Year AMP12
Smart Metering (2AMP rollout)	18.08 Ml/d	31.91 Ml/d
Water Efficiency - excludes Gov. interventions	9.37 Ml/d	14.61 Ml/d
Leakage	6.53 Ml/d without smart meter benefits (10.57 Ml/d with 2AMP rollout)	37.23 Ml/d without smart meter benefits (44.92 Ml/d with smart meter benefits)
Non- Household Options	10.08 Ml/d	50.4 Ml/d
Government led interventions	3.52 Ml/d *	84.35 Ml/d *
Total savings for the preferred portfolio	44.06 Ml/d excluding Gov. Interventions 47.58 Ml/d including Gov. interventions	134.15 Ml/d excluding Gov. Interventions 218.50 Ml/d including Gov. interventions
PCC Out-turn	126.00 l/h/d AMP8 (DYAA)	109.74 l/h/d AMP12 (DYAA)
Modelling factors	For the revised plan we have assumed that 2022 BL does reflect a2.5% uplift due to Covid19 and due to the re-base, and will argue that there, consequently, should now be a slight -ve impact from Covid19 going forward. The Artesia trajectory has been revised to a combined 'Gov. labelling/no-standards' projection reflecting initially the near-term Low trajectory, and in the longer-term High trajectory. (14 l/h/d reduction in PCC by 2050) 2% behaviour change for Smart metering - cspl / pl savings have been revised on the basis of additional smart meter findings. Leakage to save 10Ml/d by 2030 - 45Ml/d by 2050 (38% overall reduction by 2050)d	

4.8.4 For our preferred portfolio the demand management option savings can be shown as below (Figure 16). These savings have been incorporated into our final plan demand projections. As can be seen the savings from our preferred plan more than compensate for the expected growth in demand.

Figure 16 Demand management option savings per AMP (preferred plan) Ml/d



Water efficiency option savings can be shown, as described below:

- 'Leakage savings' - associated with cspl reduction, mains replacement, shared supply cspl reduction.
- 'SM AMI savings PL' - plumbing loss reduction associated with smart meters.
- 'Metering water saved' - Smart meter behavioural change savings.
- 'SM AMI Savings USPL' - customer/underground supply pipe leakage reduction associated with smart meters.

- 'Water Efficiency savings inc. Gov Int' - water efficiency savings for both households and non-households, including government led intervention savings.
- 'Growth' - demand growth associated with additional population and non-HH growth in the preferred plan

4.8.5 As part of our final plan assessment we have also included the reductions in demand which could potentially be facilitated by Government led interventions (white good labelling and mandatory standards). We have referenced the WUK 'Pathways to long-term PCC reductions' [10]report, to include a conservative scenario, in our preferred plan (as described in the WRPG), but not in the base-line forecast. Note that forms a significant part of the water efficiency savings shown (84Ml/d included in the water efficiency segment by 2050).

4.8.6 For further information reference the 'Revised draft WRMP24 Demand management preferred plan technical supporting document' and the 'Revised draft WRMP24 Demand management option appraisal technical supporting document'.

10 Water UK (Project reference: 2346: Report number: AR1286: 2019-08-15), *'Pathways to long-term PCC reduction'*

5 Forecasting Population and Properties

In this section we will:

- Describe how we have aligned our method for forecasting population and property growth with recent local plans published for the Anglian Water Region.
- Show that where no local plan project(s) exist to inform our plan, we have used other appropriate methods such as ONS household projections or the methods outlined in Population, household property and occupancy forecasting (UKWIR, 2016).
- Show how we have taken into account potential strategic growth in the Anglian Water Region.
- Account for the planning period in our forecast property and population figures and explain how different forecasting methods have been applied to different time horizons, especially as the planning period is longer than 25 years. (WRE)
- Document and explain assumptions and data sources used.
- Demonstrate that the plan does not constrain supply such that it does not limit planned property forecasts.
- Indicate limitations in the forecast, associated uncertainties and how we have used scenario based analysis in order to understand this.
- Explain how we have allocated unaccounted for populations for each WRZ, including our assumptions.
- Show how we have engaged with local planning authorities to inform our analysis.

5.1 Overview

5.1.1 Underpinning the forecast for future water demand must be a detailed understanding of demographic change, new development, household formation, population and occupancy changes in the Anglian Water region. Robust housing and demographic forecasts are a key consideration in the planning guidelines established for both the Water Resource Management Plan (WRMP24) and WRE processes.

5.1.2 WRMP Guidance states that forecast population and property figures shall be based, where-ever possible, upon plans published by local authorities (particularly by utilizing published ‘adopted’, ‘emergent’, ‘consultation’ and ‘draft’ local plans). It is, however, noted that all local councils are at different stages of publication of local plans and that these plans usually cover a period of only 15 years.

5.1.3 With respect to growth, it is indicated that the WRMP24 should reflect Local Authority projections and include strategic growth (such as the Strategic growth corridor) where applicable.

- *‘Where your area includes major strategic housing and growth developments such as the Strategic growth corridor or Garden Communities, you should include the planned growth in your plan.*
  - *check whether the adopted or draft local plan contains and uses information on local housing need*
  - *use whichever forecast has greater numbers of properties and population in your WRMP*
  - *you should demonstrate that you have incorporated local council information (particularly in relation to their published adopted local plans) in England.’*[11]

5.1.4 To support the WRPG demographic guidance, UKWIR produced a suite of documents which provide advice on the development of population, property and occupancy forecasts. The UKWIR documentation is in three parts: A Guidance Manual; a Worked Example; and a Supplementary Report. This Guidance Manual identifies six key stages in the development of demographic forecasts, the second stage of which involves engagement with local Councils:

11 Environment Agency (March 2023), '*Water Resources Planning Guideline for WRMP24*', p. 71

- *'Task B. Assess Local Development Plans - This involves collating and assessing the housing growth forecasts set out in Local Development Plans, and engaging with local authorities, as appropriate, to obtain further information and understanding about the housing plans.'*

5.1.5 In order to facilitate the collation of Local Authority Planning information, we have utilized a specialized demographic analysis company 'Edge Analytics'. This company has been commissioned to collate and produce assessed household build trajectories for all the 69 Local Authorities in the Anglian Water Region for both the WRE and WRMP 2024 planning processes. We have also sought to align core scenarios with our key neighbouring regional groups, including Water Resources South East (WRSE). These 'Plan' based projections (and supporting data) have been used to inform near term projections of both housing and population growth. Edge Analytics has also been instrumental in developing a set of regional scenarios that might reflect the potential strategic growth corridor (Oxford through Cambridge), which have been modelled for the impact on demand in the long term. These strategic scenarios are founded upon the Local Authority Plans, whilst using reasonable extrapolation to model additional growth.

5.1.6 Where 'plan' based datasets for property development have been used, plan based derivations of population have also been generated for each Local Authority, based upon the revised household projections and trend derived occupancy rates. Official ONS (Office of National Statistics) datasets have informed time frames beyond those included in 'Plan' based datasets (approximately 2035-2050). The methodology has been kept simple and flexible (using official statistics), using an approach based upon apportioned ONS data, Local Authority Planning data and DCLG household projections, in alignment with policy guidance. It is understood that this method of analysis is robust, well-established and based upon reliable statistical methodologies, subject to expert panel review.

5.1.7 Base-line population figures have been derived from official ONS census and sub-national population projections (snpp) at the local authority level. Additionally, ONS Mid-Year Estimates (MYE) have been used, as released, to update population projections.

5.1.8 Plan based forecasts for population have been generated using Local Authority plan based' household projections and trend based occupancy values. These forecasts have been used as the near term population projections, in order to assess demand and ensure that supply is not constrained (such that it may not meet planned property/population forecasts). Households and populations have been apportioned using internal billing 'premise' data, spatially mapped to Planning Zone (PZ) and Water Resource Zone (WRZ) geographies, (determining the percentage of households (and, therefore, population) within intersecting Local Authorities). This has allowed the production of forecast WRZ household/population projections for the revised draft WRMP 2024, based upon the applied percentages to the respective 'plan' and 'trend' based LAUA/DCLG projections.

5.1.9 Non-household population projections have been determined for all Local Authorities in our region, using Water Resource Zone (WRZ) apportioned Census data.

5.1.10 Uncertainty with regard to property and population forecasts has been assessed using EA/UKWIR 'look-up' tables, based upon historical ONS discrepancies. (See the 'Managing uncertainty and risk report').

5.1.11 More importantly, uncertainty has been understood using a suite of scenarios based around the highest envisaged growth (Strategic growth variants), lowest ONS trend-based forecasts and a variety of completion and Local Authority Plan based scenarios along with projections based upon recent completion data.

5.1.12 These scenarios have been used to inform the Water Resources East (WRE) regional planning process. This aligns with Guidance which stresses that forecasts for the WRMP and regional plans should be aligned (WRE).

5.1.13 *'Your forecasts should reflect the forecasts of the regional plans... You should demonstrate how you have collaborated at a regional level with neighbouring water companies and non-public water supply abstractors to generate your forecasts and how you have made use of best available data and information.* [12]

12 Environment Agency (March 2023), *'Water Resources Planning Guideline for WRMP24,'* p.63

5.1.14 *Following on from above we have included:*

- *sharing consumption and segmentation data to increase sample sizes for modelling*
- *sharing sub annual data for seasonal peak analysis (including weather, economy and tourism driven factors)*
- *pooling data, expertise and modelling resources to assess a wider range of viable models and modelling techniques.*

5.1.15 As described, Edge Analytics have been commissioned to produce a suite of property and population projections for the WRE appraisal process, including the core WRMP24 projections for LAUA plan and potential strategic development (the strategic growth corridor).

5.2 Geography and spatial attribution

5.2.1 With regard to our understanding of population and properties, geography and spatial data analysis is at the core of the demand forecast process.

5.2.2 Population and property data is produced to reflect many external geographic boundaries (derived from the office of National Statistics; for example Output areas (OAs) and Local Authority boundaries). This data needs to be aligned between these diverse geographic spatial areas and must be re-apportioned, or reallocated to internal AWS reporting requirements (WRMP24 Resource Zones (WRZs), Water Resources East Resource Zones (WRE), planning zones, (PZs)). This alignment and combination of diverse spatial datasets is, thus, key to formulating both base-line and trend figures in order to produce accurate demand forecasts.

5.2.3 Where required, Graphical Information System (GIS) has been used to facilitate attribution, and where geographies are nested (PZs to WRZs) data has been aggregated for the final WRMP24 Water Resource Zone reporting.

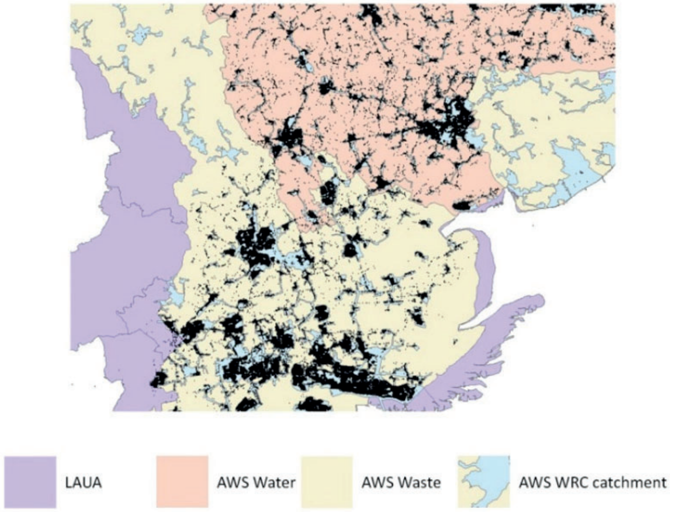
Figure 17 Spatial datasets aligned to appropriate areas (Internal and External) - sequenced largest to smallest

5.2.4 GIS has also enabled the apportionment of households (AWS billing customer premise data) to their respective WRZ, PZ and LAUA (local Authority, Unitary Authority) geographies, allowing the assessment of the percentage of households from given LAUAs within WRZ boundaries. This facilitates the correct apportionment of LAUA projected growth to the intersected WRZs. Similarly, non-household premises have been allocated to their respective AWS and Local Authority geographies (Figure 17).

5.3 Base-line property and population figures

5.3.1 Base-line population and property figures have been derived for each Water Resource Zone and LAUA, utilizing ONS data. Actual recorded properties in our 'billing' system, for the base-year have then been compared with the LAUA household official totals. This has allowed the percentage of households served by Anglian Water to be determined and consequently, the percentage of population. Note that a small proportion of properties will have their own supply of water (Figure 18).

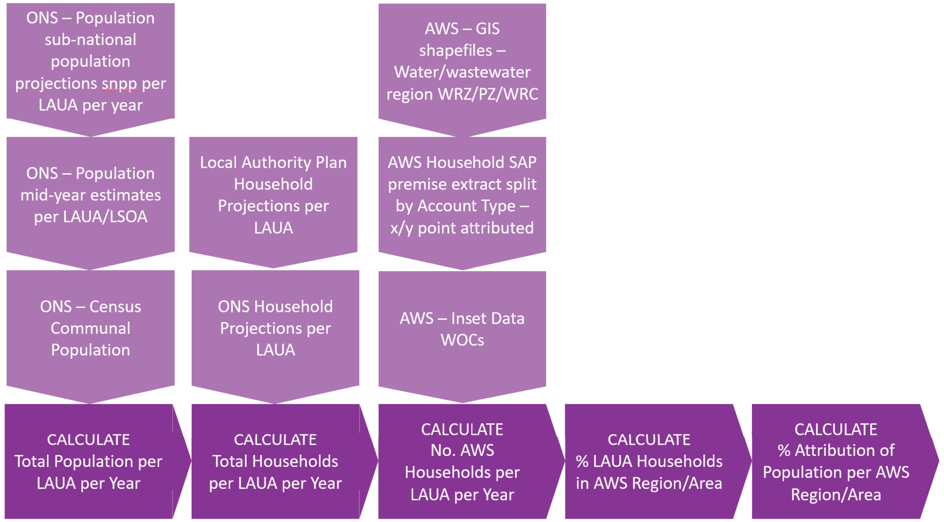
Figure 18 Household point data and mapping geographies



5.3.2 These property totals for the Anglian Water statutory water and wastewater geographies, once derived are cross referenced internally, and are then used to provide the base-line for the Annual performance Review, water-balance and forecast models. Base-line population totals have been derived using the known household percentages ascertained from the comparison of Anglian Water and ONS totals and applying these to the ONS sub-national population projection (snpp) population figures (per LAUA). Similarly, projections have been derived using these percentage allocations to determine the proportions of each Local Authority within the Anglian Water statutory boundary and within each WRZ. The calculation of our base-line population can be visualized (Figure 19).

5.3.3 For the purposes of the revised draft WRMP24, we have used the 2021/22 water balance, property and population totals for our base-year values for the 25 year forecast projections. This base-line has been chosen as a post pandemic year in which the effect of the Covid19 pandemic has subsided, removing potentially anomalous values.

Figure 19 Base-line population derivation



5.3.4 The table below shows baseline property and population values for each water resource zone. As can be seen water resource zones vary considerably in size, with our smallest WRZ (Norfolk East Harling) having a population of 12K, as opposed to our largest WRZ (Ruthamford North) with a population of 986K. Water resource zones, will, consequently, display very different demographic and water consumption properties. Occupancy rates also vary significantly across the region, dependent upon the demographic and age profile characteristics of different areas within the Anglian Water region. Overall household occupancy rates lie within the range 1.7 to 2.6 and all WRZ occupancy rates are forecast to decrease over the planning period

Table 5 Base-line Properties and Occupancy by WRZ (2021/22)

WRZ	Measured HH Props	Measured Population	Measured Occupancy	Unmeasured HH Props	Unmeasured Population	Unmeasured Occupancy	% Measured Billed HH
Essex Central	11,147	28,077	2.519	4,006	9,046	2.258	74%
Essex South	90,066	217,470	2.415	14,948	39,776	2.661	86%
Fenland	76,408	157,948	2.067	12,766	37,356	2.926	86%
Hartlepool	19,738	37,669	1.908	21,903	53,008	2.420	47%
Lincolnshire Bourne	58,304	135,397	2.322	8,685	21,201	2.441	87%
Lincolnshire Central	170,519	375,630	2.203	45,970	99,633	2.167	79%
Lincolnshire East	139,834	304,076	2.175	40,294	77,453	1.922	78%
Lincs, Retford & Gains	26,560	53,034	1.997	8,738	21,163	2.422	75%
Norfolk Aylsham	9,291	20,052	2.158	1,008	2,110	2.094	90%
Norfolk Bradenham	16,156	36,860	2.281	1,560	4,631	2.968	91%
Norfolk East Dereham	7,711	17,871	2.317	1,034	2,755	2.665	88%
Norfolk East Harling	4,220	9,498	2.251	857	2,581	3.013	83%
Norfolk Happisburgh	7,114	14,383	2.022	1,056	2,121	2.009	87%
Norfolk Harleston	13,469	30,360	2.254	1,674	5,346	3.193	89%
North Norfolk Coast	30,268	55,882	1.846	4,868	9,131	1.876	86%
Norwich & the Broads	129,130	282,116	2.185	29,011	63,232	2.180	82%
Norfolk Wymondham	19,123	43,098	2.254	2,395	6,761	2.823	89%
Ruthamford Central	114,537	287,989	2.514	9,019	36,693	4.069	93%
Ruthamford North	356,163	843,661	2.369	47,738	142,616	2.987	88%
Ruthamford South	179,141	415,802	2.321	20,029	74,275	3.708	90%
Ruthamford West	32,213	75,586	2.346	3,038	10,691	3.519	91%
Suffolk East	123,810	279,446	2.257	13,873	48,531	3.498	90%
Suffolk Ixworth	8,590	20,445	2.380	1,179	3,137	2.661	88%
Suffolk Sudbury	12,960	28,473	2.197	1,484	3,762	2.535	90%
Suffolk Thetford	13,148	28,877	2.196	1,655	6,460	3.902	89%
Suffolk West & Cambs	97,112	222,056	2.287	11,842	32,435	2.739	89%

5.3.5 Additional uncertainty is also associated with the analysis of these smaller geographic areas, due to their size. The number of customers who currently have a meter is 90% (2021/22), with customers who are billed on their measured consumption at 83% (2021/22). The differences in WRZs in metered/measured customers can also be seen, with the Ruthamford Central WRZ having 93% and Hartlepool WRZ having 47% metered/measured customers. We are aiming at increasing metering and measured 'billed' penetration to our feasible limit over the revised draft WRMP24 plan period (Table 5).

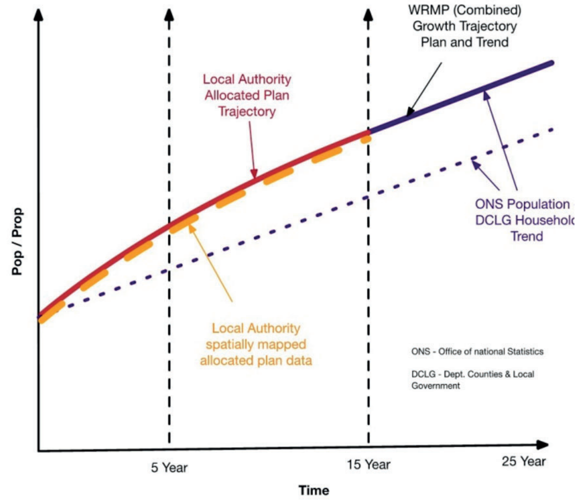
5.4 Household projections

5.4.1 The latest forecasts of demographic change in the UK suggest that population and household growth will be a common characteristic of local communities over the next 25 years. A sustained period of new housing growth, ageing population profiles and a reducing average household size are key considerations for planners and policy makers. Great uncertainty surrounds future property and demographic change, and we have, therefore, endeavoured to derive a number of potential forecasts in order to inform our final plan.

5.4.2 It is noted that regional growth should not be constrained by the availability of water and consequently, Local Authority plans should form a key basis of the revised draft WRMP24.

5.4.3 Population and housing growth trajectories produced utilizing plan and trend-based data have been modelled separately. In accordance with EA Guidelines, Local Plan yearly additional household totals have been selected as initially dominant for the forecast period from 5 to 15 years and have then been superseded by ONS trend based yearly totals over the longer term, to the end of the plan projection. Thus, for population forecasting, trajectories have been produced, based upon Local Authority Development Plans (medium term - 0 - 15 years). Robust official ONS (Office of National Statistics) trend-based trajectories have been produced to extrapolate beyond ‘Plan’ projections (15 - 25 years). As can be seen, we expect near term growth based upon Local Authority Plans to reflect a higher initial trajectory as opposed to long term ONS growth a lower trajectory. Including Local Authority planned growth will lead to a higher outcome than ONS only (Figure 20).

Figure 20 Plan and trend projection combination over time



5.4.4 In order to facilitate the collation of Local Authority Planning information, we have utilized a specialized demographic analysis company, Edge Analytics, which has collated and produced assessed household-build trajectories for all Local Authorities in the Anglian Water Region. (Note that Edge Analytics has also been commissioned to work with WRSE, allowing further consistency in approaches across the South East). Edge Analytics, along with Anglian Water have contacted all the 69 no. local authorities that are either wholly or partially included within the Anglian Water operational boundary, in order to collect Local Plan housing growth evidence. Each of the 69 local authorities are at a different stage of Local Plan development, with each collating a variety of demographic and economic evidence to inform its plan-making process. Some plans have been adopted; others remain under development or open for consultation.

5.4.5 The starting point for the collection of Local Plan data has been each Council's planning pages of their websites. Each Council typically has a webpage designated to its Local Plan, which contain links to the published Local Plan drafts and any evidence documents. These published sources have been used to collect the latest information on the status of Local Plans, the time-period to which the Local Plan relates, its housing growth target within the plan-period and any underpinning trajectory or phasing of the housing growth.

5.4.6 Documents and data that have been collected from each local authority has included the following:

- Housing Trajectory
- Local Plan (issues and options, draft, main modifications)
- Annual Monitoring Report (AMR)
- 5-year housing supply documents
- Strategic Housing Land Availability Assessment (SHLAA)
- Strategic Housing Market Assessment (SHMA)
- Housing & Economic Land Availability Assessments (HELAA)
- Housing & Economic Development Needs Assessment (HEDNA)

5.4.7 Planning Officers within Councils have been contacted to confirm details published online, to seek to obtain pertinent information not currently in the public domain and to source additional housing data, particularly digital information relating to planned site developments. (This has mainly been used to inform the Drought and Wastewater Management Plan, which is more sensitive to site locations (DWMP)).

5.4.8 For the Local Plan housing trajectories, a short history of the most recent and most relevant documents and associated housing data has been compiled for each local authority. This has provided the basis for the derivation of a housing growth trajectory for each local authority.

5.4.9 Each local authority's housing growth trajectory is drawn from published information, combining information on past and projected housing completions. Trajectories will typically incorporate the most recent projected housing completions or five-year housing supply figure. This produces an assessed set of Plan based build-out trajectories for all Local Authorities in the Anglian Water region, including;

- Summary worksheets which lists all local authorities, their plan status, publication date and current housing targets.
- Detailed worksheets for each local authority which contains the following:
- Local Plan status
- Housing target summaries
- Housing trajectory detail (level and timing of developments)
- Links to a compiled set of all the key documents: Local Plan, Site Allocations, Annual Monitoring Report, Five-Year land Supply)

5.5 Local Authority planning methodologies

5.5.1 The foundation of our property and population planning processes are ONS trend data and Local Authority Plans. We note that there are strict guidelines regarding the assessment of Local Authority Plans, as detailed below and our aim is to ensure secure and resilient water supplies to meet these needs.

5.5.2 The National Planning Policy Framework (NPPF) requires local planning authorities to identify 'Objectively Assessed housing Need' (the OAN). Local Plans translate those needs into land provision targets. According to the NPPF, housing targets should be informed by robust and proportionate evidence, such that a plan aimed to meet aspiration, rather than assessed demand, would risk being undeliverable and be contrary to paragraph 173 of the NPPF. Additionally, Local Plans go through statutory processes for review, including independent examination in public by an Inspector appointed on behalf of the Secretary of State. Developers, agents and the public are also able to challenge the methodology, during this assessment.

5.5.3 We have, consequently utilized the expertise of an external demographic company, Edge Analytics to collate LAUA (Local Authority/Unitary Authority) plans (including all supporting data) for all Local Authorities in our region. It is also noted as part of our liaison with Local Authorities that a number of authorities are looking to establish joint spatial plans. These non-statutory documents will not seek to determine housing need in their own right, but are expected to be based on the sum of housing targets across the area they cover.

5.5.4 Additional future changes which are expected to impact planning include:

- Non statutory spatial plans
- Oxford - Milton Keynes - Cambridge Corridor - the OxCam Arc -**Strategic Growth Corridor**
- Impacts on migration patterns resulting from Brexit
- Methodology changes by DCLG
- London Overspill
- Garden Settlements

5.5.5 In developing, a risk averse WRMP24 plan projection we have used a growth scenario, which is based on near term Local Authority Planning totals, whilst in the longer term including an element for the, what has been termed the 'Strategic Growth Corridor' (an area of Anglian Water where we know we are experiencing significant growth). This is designated as the OxCam_1b_r_P scenario. Note that for the revised draft WRMP24, we commissioned an updated view of key variants including the preferred OxCam_1b_r_P scenario.

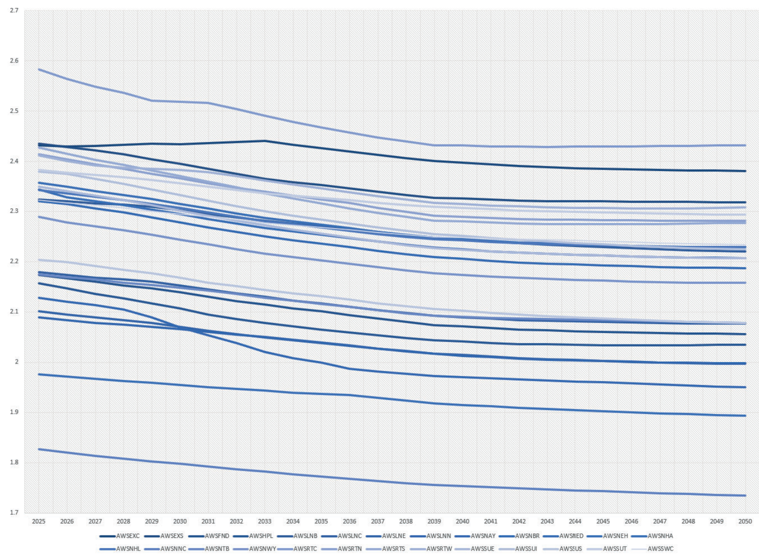
5.5.6 We intend to anticipate future development on the basis of an adaptive approach, through phased decision-making, flexible strategies and a comprehensive water/waste water strategy. This should minimise the probability of over investment or under investment (required to meet demand) and enable us to take effective measures in the short term that can be adapted to new insights or developments in the long term.

5.6 Occupancy and age demographics

5.6.1 Trend based household occupancy values have been derived at WRZ (and Planning Zone) level for the forecast period using data from the ONS (sub-national population projections) and ONS household projections, apportioned from LAUA to WRZ level. This has provided a trend-based forecast and base-line set of occupancy rates for each Local Authority within the AWS region. This has allowed the derivation of trend-based occupancy rates for each WRZ, via the apportionment of AWS properties from the WRZs to their respective LAUAs. These average WRZ occupancy rates have provided the basis for the derivation of the 'Plan' based population forecasts; applying the LAUA trend occupancies to the plan-based housing projections.

5.6.2 Occupancy rates vary significantly across the region, dependent upon the demographic and age profile characteristics of different areas within the Anglian Water region. Overall household occupancy rates lie within the range 1.7 to 2.6 and all WRZ occupancy rates are forecast to decrease over the planning period, with the lowest 2049/50 rates being seen in Norfolk Happisburgh, Norfolk Aylesham and North Norfolk Coast and the highest rates being seen in Ruthamford Central, Essex Central and South Essex (Figure 21).

Figure 21 Household Occupancy Rates by WRZ - 2022-2050



5.7 Non-Household and communal population

5.7.1 Values for non-household and communal populations have been derived from official sources (ONS Census) and apportioned to AWS geographies. These values have been reviewed in line with AWS 'official' reported totals and the water-balance base-line values. Additional analysis on Non-household population has been provided by Edge Analytics. For the purposes of dWRMP24 we have estimated that non-household population will approximate a similar growth trend to that shown for household population.

5.7.2 Non-household population includes estimates for residents in; Medical and care establishments, NHS, Psychiatric hospitals, Local Authority Children's homes, Nursing Homes, Residential Care Homes, Other establishments, Defence establishments (including ships), Prison Service establishments, Probation / Bail hostels, Educational establishments (including Halls of residence), Hotels, Boarding Houses, Guest Houses and such.

5.7.3 Demand for these customers has been derived as part of the non-household forecast and does not bear a direct link to the population forecast totals, as so much non-household demand is linked to manufacturing and other processes. Thus, the actual non-household demand forecast will be based upon sector by sector regression analysis and future forecasts of population (where appropriate; i.e. schools / hospitals) , GVA and employment per sector.

5.8 WRE Scenarios and simulator alignment

5.8.1 As part of the Water Resources East (WRE) planning process (and to further understand forecast uncertainties) a suite or library of property and population projections has been developed, in order to reveal how different growth trajectories will impact demand over the long term. Coherent demand forecast scenarios have been developed for participating water companies using in-house modelling processes (or collaboratively where agreed), with aligned datasets and agreed assumptions where feasible. These projections have been complemented by forecasts for water usage by key non-household sectors whose demand is met outside of the PWC (Public Water Company) domain (namely Agriculture and Energy).

5.8.2 The WRE projection library has involved the development of theoretical demand management option scenarios (based around National Framework targets; 110 l/h/d PCC and 50% leakage reduction) but has ultimately been aligned with the preferred plan forecasts developed by the PWCs for the revised draft WRMP24. These alignments have ensured that the WRE regional planning and option appraisal process may be viewed as being 'back to back' with the development of the company WRMPs.

5.8.3 However, it is noted that the respective PWCs have been left to develop their own preferred demand management option packages for the revised draft WRMP24, based upon their respective metering and leakage positions.

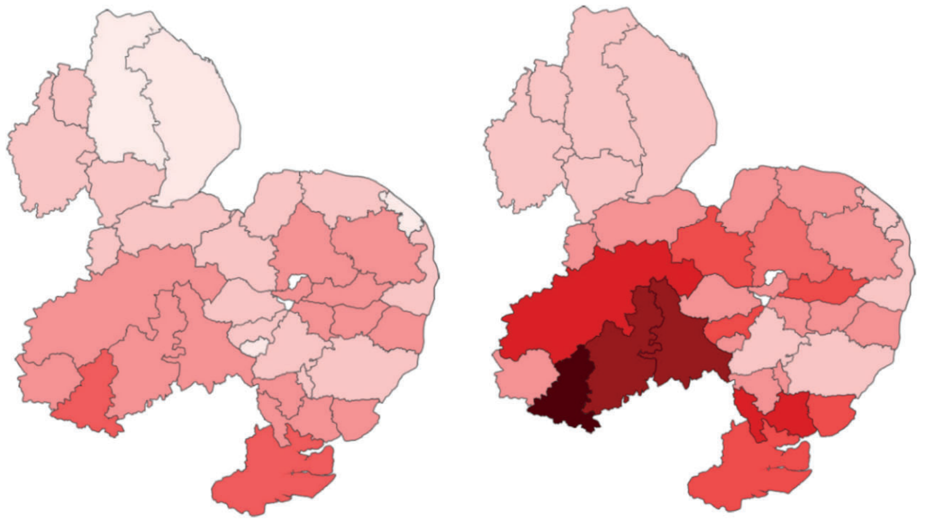
5.8.4 Additionally, alignment has been sought between neighbouring regional groups with regard to the core assumptions driving their WRMPs (i.e. the inclusion of the strategic growth corridor) and any wider scenarios being modelled (especially with regard to WRSE).

5.8.5 As can be seen, the inclusion of the the highest strategic growth in the WRE scenarios causes a significant increase in population above that projected in Local Authority Plans, providing worst case scenarios for the simulator.

5.8.6 For the revised draft WRMP24, and in alignment with WRMP Guidance, we have selected the more conservative variant of projected strategic growth, 'OxCam1b_r_P' (leading to growth for the 2025 to 2030 period similar to that predicted by Local Authority Planned projections, but giving higher growth rate from 2030 to 2050). This reflects the recent local government policy position, which has taken on board community sentiment for a reduction in the level of new housing development within the region. This aligns with WRSE growth projections. The scenario accounts for some strategic growth, mainly post 2030.

5.8.7 For Water Resources east regional planning (and WRMP24 sensitivity testing) we have also modelled a worst case scenario, 'OxCam2b_r_P', which illustrates the potential areas where additional growth may be experienced, as shown below (Figure 22).

Figure 22 Projected population growth (2100) for the plan projection and worst case OxCam growth scenario (OxCam_2b_H - showing % change (range 120% to >200%) WRE resource zones,



5.9 Development of WRE property & population scenarios

5.9.1 A suite of variant property and population projections has been generated (by Edge Analytics) for the WRMP24 and WRE region (for the period 2020 to 2100). For the purposes of WRE scenario testing, this broader set of variants has been developed in order to derive alternate potential future outcomes to 2100 (low ONS trend population growth and worse case strategic scenarios (very high population growth).

5.9.2 For the Water Resources East (WRE) regional planning process we have:

- Produced variant property projections based upon LAUA Plan, ONS trend, LAUA completion rates, strategic growth (OxCam Arc) scenarios, with population forecasts allowing for variations in fertility, mortality, migration.
- Aligned scenario selection with other regional groups (WRSE) where feasible.
- Ensured alignment with the WRMP24 core forecast, in alignment with EA Guidance.
- Produced hidden and transient (H&T) population estimates for the WRE region (to inform both population forecasts and potential peaking factors).

5.9.3 Population and property projection, over the long term, is subject to significant uncertainty, being influenced by many factors; economic activity, government strategies, migration, fertility rates and mortality. Consequently, in order to understand the level of uncertainty, Edge Analytics has been commissioned to compile all relevant evidence required to produce a suite of projections for both population and properties for the WRE region (this will align with WRSE). This has produced a suite of 25 near term property/population forecasts (up to 2050) and 75 (high, medium, low) long term variants up to 2100, as described in detail below. Scenarios have been developed to reflect both planned housing, GLA (Greater London Authority) projections, recent completions, econometric and trend population variants in the nearer term, as described in the Edge Analytics report 'WRE Population & Property Forecasts - methodology and Outcomes - July 2020'.

5.9.4 The 25 key variants have been extrapolated to 2100 using ONS based long term factors to produce a suite of 75 potential Household/Population scenarios, for use in generating demand forecasts. A sub-selection of these (highest, median, plan-based, lowest) have then been chosen for further analysis in the WRE simulation process, with the remaining variants providing evidence for further detailed sensitivity testing.

5.9.5 The table below describes these 25 key variants (Table 6).

Table 6 Key household/population scenarios developed for WRMP/WRE

No.	Scenario		No.	Scenario	
1	ONS-14	ONS trend 2014 snpp base	14	Housing-Need	LAUA Housing need led
2	ONS-16	ONS trend 2016 snpp base	15	Housing-Need-r	LAUA Housing need led - representative rates for young adults returning
3	ONS-18	ONS trend 2018 snpp base	16	Housing-Required	LAUA Housing Required
4	ONS-18-Alt	ONS trend 2018 Alternate international migration	17	Housing-Required-r	LAUA Housing Required - representative rates for young adults returning
5	ONS-18-High	ONS trend 2018 High international migration	18	Housing-Plan	LAUA Housing Plan led
6	ONS-18-Low	ONS trend 2018 Low international migration	19	Housing-Plan-r	LAUA Housing Plan - representative rates for young adults returning
7	ONS-18-10Y	ONS trend 2018 10 year international migration	20	Employment-1	Employment led 1% growth London to 2030 - 0.8% outside growth
8	GLA-18-Central	Greater London Authority Central	21	Employment-2	Employment led 0.5% growth London to 2030 - 0.4% outside growth
9	GLA-18-15Y	GLA - 15 year history	22	Oxcam-1a-r	New settlement 23K dpa scenario
10	GLA-18-5Y	GLA - 5 year history	23	Oxcam-1b-r	Expansion 23K dpa scenario
11	GLA-18-Housing	GLA - Housing led	24	Oxcam-2a-r	New settlement 30K scenario
12	Completions-18Y	Completion rates - Housing led - 18 year history	25	Oxcam-2b-r	Expansion 30K dpa scenario
13	Completions-5Y	Completion rates - Housing led - 5 year history			

5.9.6 The graph below ([Figure 23]) shows the forecast outcomes for property projections which have been developed. These property variants have been used to produce aligned population projections at a sub-regional level, and these have, consequently, been used to generate consumption and demand forecasts.

5.9.7 Key variants have been selected from this library ([Table 7]), reflecting alternate growth outcomes (high, medium and low). Scenarios have also been considered, based upon recent Local Authority new-build completion data (potentially being more 'realistic' in the near term) and have been designed to account for current economic conditions (post Covid19). All growth scenarios have been agreed, between WRE member PWCs and key stakeholders (including EA consultation) and have been aligned with other regional groups. Scenarios for WRE have been chosen with WRSE modelling in mind (noting they also use Edge Analytics data).

5.9.8 Key scenarios utilized for stress testing have included ([Table 7]).

5.9.9 For the revised draft WRMP24 we have chosen a growth projection which reflects a limited level of strategic growth (as reflected in the 'OxCam-1b_r_P' variant). This scenario projects housing and population growth at a similar level to the housing plan projections for AMP8 (2025 to 2030), but maintains a higher level of growth in impacted areas from 2030 onwards. This growth scenario would appear to be a more risk averse selection for the revised draft WRMP24 and is in line with recent population growth seen in the region. This selection also aligns with the Water Resource Planning Guidance. This scenario has been updated in January 2023 for the revised draft WRMP24 submission.

5.9.10 Note that the East of England has been determined to be the region with the highest growth since the 2011 census, and has experienced an 8.3% increase in population (a gain of approximately 488,000 residents), according to official data.

5.9.11 As can be seen in the figure below ([Figure 23]) our revised draft WRMP24 projections, sit within the envelope of previously generated WRE demand projections. Note that the revised draft WRMP24 base-line forecast, does not include government led interventions (in accordance with the WRPG). Additionally, the 2022 values on the graph now differ, as the WRE forecasts were originally baselined to 2019/20 and the revised draft WRMP24 forecast is now base-lined to 2021/22.

Figure 23 WRMP24 BL/FP demand projections and WRE key forecasts

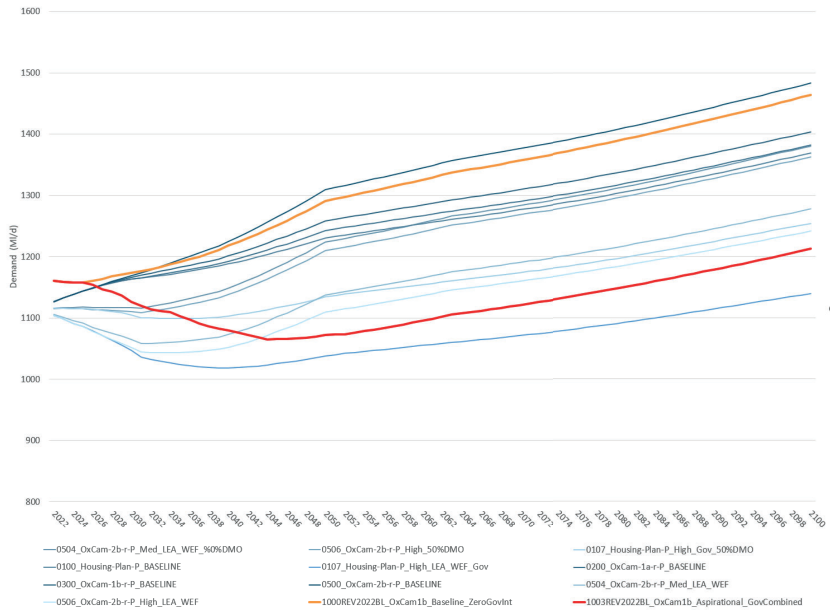


Table 7 WRE sensitivity testing scenarios

Scenario	Description
0100_Housing-Plan-P_BASELINE	Housing Plan growth - Base-line - No DMOs
0102_Housing-Plan-P_Low_LEA_WEF	Housing Plan growth - Low demand management , leakage reduction
0104_Housing-Plan-P_Med_LEA_WEF	Housing Plan growth - Medium demand management , leakage reduction
0106_Housing-Plan-P_High_LEA_WEF	Housing Plan growth - High demand management , leakage reduction
0107_Housing-Plan-P_High_LEA_WEF_Gov	Housing Plan growth - High demand management , leakage reduction - Gov. led interventions
0200_OxCam-1a-r-P_BASELINE	'OxCam' strategic growth 1a - Base-line - No DMOs
0300_OxCam-1b-r-P_BASELINE	'OxCam' strategic growth 1b - growth - Base-line - No DMOs (WRMP preferred projection)
0302_OxCam-1b-r-P_Low_LEA_WEF	'OxCam' strategic growth 1b - Low demand management , leakage reduction (WRMP preferred projection)
0304_OxCam-1b-r-P_Med_LEA_WEF	'OxCam' strategic growth 1b - Medium demand management , leakage reduction (WRMP preferred projection)
0306_OxCam-1b-r-P_High_LEA_WEF	'OxCam' strategic growth 1b - High demand management , leakage reduction (WRMP preferred projection)
0500_OxCam-2b-r-P_BASELINE	'OxCam' strategic growth 2b - Base-line - No DMOs
0502_OxCam-2b-r-P_Low_LEA_WEF	'OxCam' strategic growth 2b - Low demand management , leakage reduction
0504_OxCam-2b-r-P_Med_LEA_WEF	'OxCam' strategic growth 2b - Medium demand management , leakage reduction
0506_OxCam-2b-r-P_High_LEA_WEF	'OxCam' strategic growth 2b - High demand management , leakage reduction
0507_OxCam-2b-r-P_High_LEA_WEF_Gov	'OxCam' strategic growth 2b - High demand management , leakage reduction - Gov. led interventions
0700_ONS-18-High-P_BASELINE	ONS-18-High-P growth - Base-line - No DMOs
0702_ONS-18-High-P_Low_LEA_WEF	ONS-18-High-P growth - Low demand management, leakage reduction
0704_ONS-18-High-P_Med_LEA_WEF	ONS-18-High-P growth - Medium demand management, leakage reduction
0706_ONS-18-High-P_High_LEA_WEF	ONS-18-High-P growth - High demand management, leakage reduction

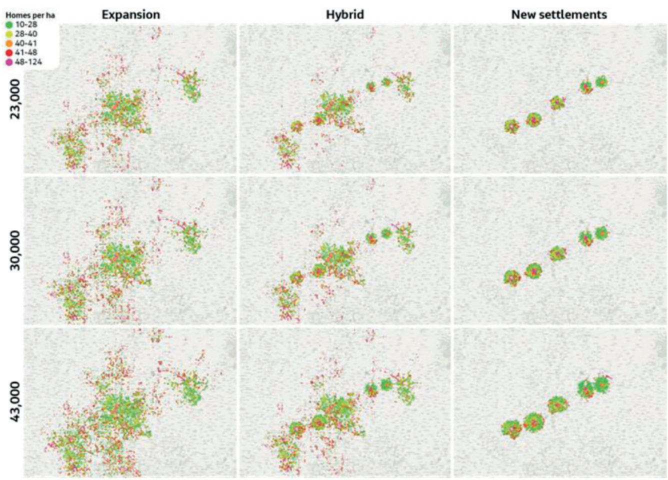
5.10 Strategic growth scenario development

5.10.1 Recently released data from the ONS indicates that over the past 10 years the East of England has experienced the highest level of population growth in the UK of 8.3% (a gain of approximately 488K people).

5.10.2 Key scenarios have, consequently, been developed for both WRMP24 and WRE reflecting strategic growth areas such as the Oxford-Cambridge growth corridor (OxCam Arc). These growth variants have been generated by Edge Analytics, in alignment with government expectations, based upon either new town development, urban extensions or a mixture of the two.

5.10.3 The four scenarios, OxCam, 1a, 1b, 2a, 2b (Scenarios 21-24 in Table 4, and in Table 6) have been produced in alignment with research carried out by the government in their report '*Planning for sustainable Growth in the Oxford Cambridge Arc*', in which six scenarios were developed based upon either urban extension or new settlements or a hybrid of the two) as shown theoretically below (Figure 24).

Figure 24 Theoretical distributions of strategic growth



5.10.4 The application of these scenarios has been aligned between the participating WRE water companies and between WRE and WRSE to ensure that strategic growth has been reflected, coherently across the PWCs and Regional planning areas. In accordance with WRMP Guidance, we have included a low variant of strategic growth (OxCam-1b-r-P) as our principal revised draft WRMP24 population and property projection, following a risk based approach, reflecting our current understanding of Local Authority Planning development.

5.10.5 These strategic growth variants can be described, as below (Table 8).

Table 8 Description of Strategic Growth Scenarios (OxCam)

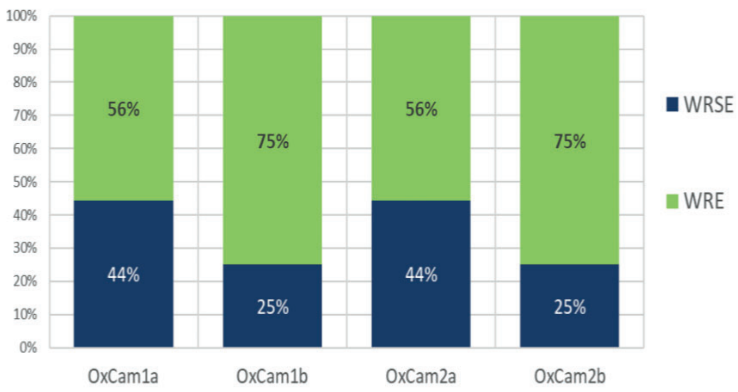
Scenario	Description
Housing-Plan-P	LAUA Housing-Plan
OxCam-1a-r-P	23k dpa (dwellings per annum), New Settlements - 56%% of growth in AWS
OxCam-1b-r-P	23k dpa (dwellings per annum), Expansion - 75%% of growth in AWS PREFERRED PLAN WRMP24)
OxCam-2a-r-P	30k dpa (dwellings per annum), New Settlements - 56%% of growth in AWS
OxCam-2b-r-P	30 dpa (dwellings per annum), Expansion - 75% of growth in AWS
Note Expansion based upon cities - Milton Keynes, Luton, Bedford, Cambridge, Northampton Peterborough New Settlement - includes areas in Cherwell / Aylesbury Vale, Central beds, South Cambs	

5.10.6 Note the Government preliminary scenarios include a maximum 40K, 30K and 23K additions per year, with a 30K per annum additional properties as the central scenario. Edge Analytics has, however, discounted the 40K variants due to their improbability.

5.10.7 Additional analysis has indicated that the scenarios based upon new settlement or urban expansion, delivered a different growth split (Figure 25) between the WRE and WRSE region (based upon the theoretical spatial distribution of new build properties).

Agreement has, therefore been sought to align the chosen strategic growth scenarios, such that growth is not under-represented, or double counted between WRE / WRSE.

Figure 25 Strategic growth variants - WRE/WRSE split



5.10.8 The size of development associated with this strategic growth will have a significant impact on water demand, wastewater treatment, flood risk management and environmental protection. Although demand management may alleviate the increased water requirements, population driven wastewater treatment will have no equivalent mitigation. Given the scale of growth in the Anglian Water region, continuous monitoring will be required, and planning should be adaptive to future changes in development growth.

5.11 Forecast results

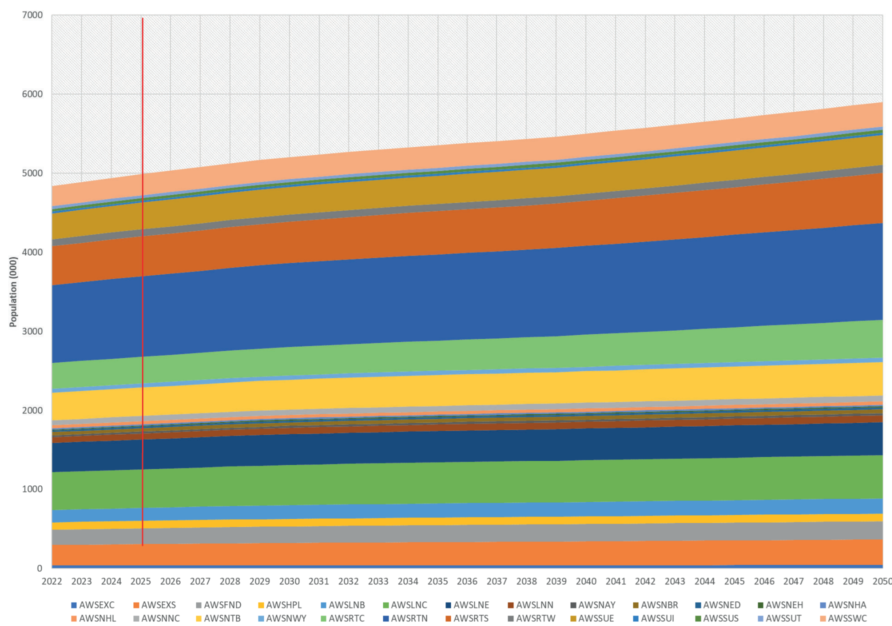
5.11.1 **Base-line population and housing totals have been derived from WRZ (PZ) water balance data.**

- Base-line Household Population 4.987M (2024/25)
- Base-line Properties 2.162M (2024/25 - excluding voids)

5.11.2 **Forecast population and housing totals have been based upon the Strategic Growth Corridor (Oxcam1b_r_P) scenario:**

- Population is forecast to increase by 0.911M from 4.987M (2024/25) to 5.898M (2049/50), during the WRMP 2024 planning period.
- Note population is forecast to increase by 18% over the WRMP24 planning period, reflecting official ONS reducing occupancy rates (including the low variant of strategic growth, OxCam1b_r_P).
- Population also increases more rapidly at the end of the planning period, similar to the initial rate of growth (Figure 26 and Table 10) - reflecting 'baby boom' waves of growth.

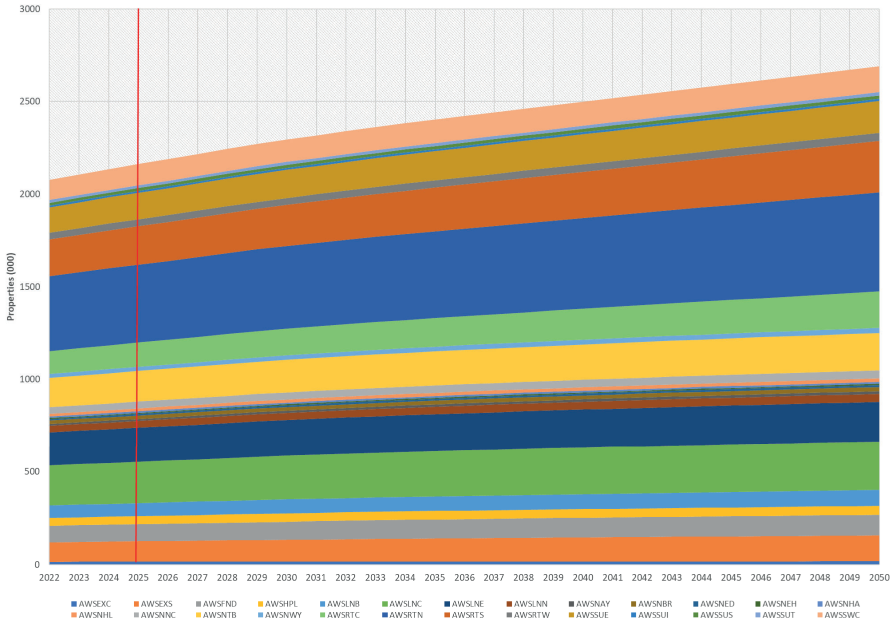
Figure 26 Population by WRZ 2022-2050



- Households are forecast to increase by 0.527M from 2.162M (2024/25) to 2.689M (2049/50), during the WRMP24 planning period (Figure 27 and Table 9).

- Households are forecast to increase by 24% from over the WRMP24 planning period, reflecting LAUA planning projections and a low variant of strategic growth (Oxcam1b_r_P).
- Note there is an additional allowance for communal non-household population. The consumption for this is accounted for in the Non-Household forecast.

Figure 27 Properties by WRZ - 2022 to 2050



5.11.3 Property and population forecasts can be shown for our preferred WRMP24 projection (OxCam_1b_r_P). This projection includes Local Authority plan projections and an uplift (over the longer term) to account for some strategic growth in the south of our region.

Table 9 Property projections for preferred growth scenario

	2025	2030	2035	2040	2045	2050
Total Properties	2.162M	2.295M	2.402M	2.499M	2.595M	2.689M

	2025	2030	2035	2040	2045	2050
Additional props per AMP		132,785	107,087	97,247	95,458	94,340

5.11.4 Population Growth can be shown at the Planning Zone (PZ) level as a percentage increase over the WRMP24 plan period (2024/25-2049/50).

Table 10 Population projections for preferred growth scenario

	2025	2030	2035	2040	2045	2050
Total Population	4.987M	5.204M	5.354M	5.500M	5.693M	5.889M
Additional Pop per AMP		217,168	150,165	146,003	193,115	204,592

5.11.5 Percentage growth can be shown across the region, as below and visualised in (Figure 28).

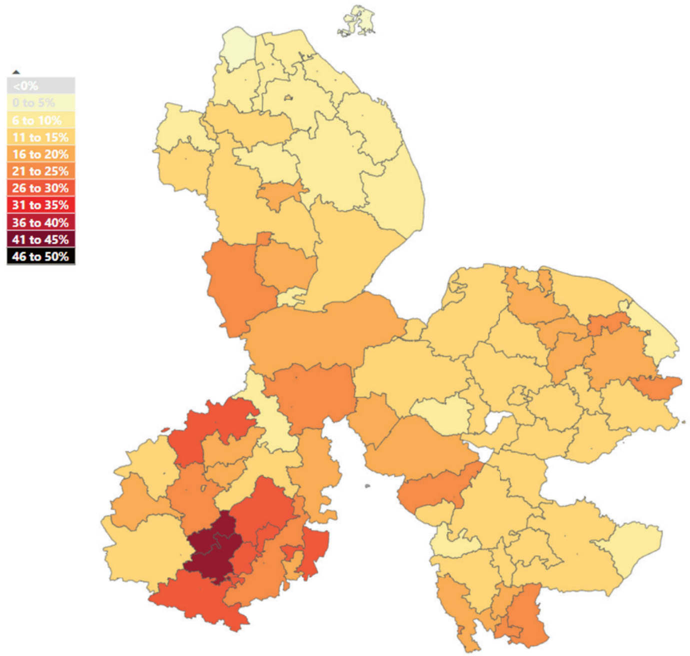
- The highest level of growth is seen in the Ruthamford Region;
  - Milton Keynes (45% from 2024/25 to 2049/50)
  - Newport Pagnell (44% from 2024/25 to 2049/50)
  - Clapham (34% from 2024/25 to 2049/50)
  - Woburn (32% from 2024/25 to 2049/50)
  - Bedford (31% from 2024/25 to 2049/50)
  - Corby (29% from 2024/25 to 2049/50)
- The lowest growth areas are seen in Hartlepool and Lincolnshire;
  - Hartlepool (4% from 2024/25 to 2049/50)
  - Scunthorpe North (5% from 2024/25 to 2049/50)
  - Scunthorpe South (6% from 2024/25 to 2049/50)
  - Barrow (6% from 2024/25 to 2049/50)

5.11.6 These levels of growth will have a direct impact on the amount of water required to supply this growing population (Distribution Input).

5.11.7 Thus, for the Dry Year Annual Average base-line (BL) scenario, unrestricted consumption, without demand management options (and excluding Government interventions), is projected to increase by 136Ml/d over the planning period (2024/25-2049/50 - DYAA forecast); rising from 1177Ml/d (2024/25) to 1313Ml/d (2049/50). Note that this is influenced by population growth, but is also impacted by saving from our WRMP19 smart meter rollout in AMP7 (approx. 1.1 million smart meters). Note that Government led interventions are now only included in the preferred final plan for the revised draft WRMP (in alignment with the WRPG).

5.11.8 For the preferred plan (FP) scenario, we expect demand to be 1091Ml/d in 2050 (a significant decline from the initial 2024/25 value of 1177Ml/d). This decline is driven by the completion of our full smart meter rollout, leakage reduction, the inclusion of the impact from Government led interventions and non-household water efficiency measures.

Figure 28 Population growth % change from 2025-2050



6 Forecasting Household Consumption

In this section we will:

- Demonstrate that we have selected a method for forecasting demand that is appropriate to each WRZ, based on the supply-demand situation; any problem characterization approaches that have been considered and the data available.
- Show that our method for forecasting demand is aligned with the following guidelines:
- *WRMP-19 Household demand forecasting - Integration of behavioural change into demand forecasting and water efficiency practices (UKWIR 2016).*
- *Customer behaviour and water use - good practice for household consumption forecasting (UKWIR, 2012).*
- Document the reasons for the choice of method, including the assumptions and their associated uncertainties.
- Detail the demand forecast for the critical period scenario as well as the dry year annual average.
- Provide a breakdown of total consumption, per capita consumption and micro- components within the water resources planning tables.
- Demonstrate an understanding of the how property and population influences future household demand.
- Show how we have included forecast savings data for existing water efficiency initiatives in our base-line forecast.

6.1 Household demand factors

6.1.1 In order to understand how household demand will change over time, households have been segmented into cohorts with definable consumption characteristics, for both the base-year and forecast period.

6.1.2 The core cohorts for populations have been defined as; unmeasured, optant (customers who switch from being unmeasured to measured) and measured (basic 'visual read' and smart (AMI) metered'). These segments along with their respective consumption and PCC values drive the ‘population and PCC’ based household demand forecast.

6.1.3 It is understood that measured and unmeasured customers have different demographic characteristics, with higher average occupancy rates for unmeasured properties and with differing consumption profiles for each segment. Unmeasured customers tend to have higher per capita consumption rates, which has been observed to reduce upon being switched to being measured customers. Consequently, understanding how the measured and unmeasured customer profile is reflected at water resource zone level (WRZ) is key to determining household consumption over the WRMP24 planning period. Additionally, the influence of smart metering in reducing PCC (and cspl-leakage) will be assessed and included, as smart metering is rolled out across the AWS region.

6.1.4 Household customers will be segmented for WRMP24 period, to separate:

- Customers - measured ('visual read' metered)
- Customers - measured (smart metered)
- Customers - unmeasured (may be metered or unmetered, but are not billed on used volume)
- Customers forecast to switch from being unmeasured to measured (as determined by the metering team);
  - Meter optants (customers who decide to become measured)
  - Change in status upon change of occupant (Properties automatically switched to being measured upon a change of occupancy)
- New customers added each year (derived from the Local Authority Plan based household forecast). All new properties will be metered and 'billed' measured.

6.1.5 A revised (from WRMP19) cohort-model, based upon population and per capita consumption has been created for the revised draft WRMP24. Building upon the demand forecasting methodology and framework for WRMP19, we have improved all aspects of the forecast system for WRMP24, such that multiple scenario forecasting of demand might be more easily facilitated. The WRMP24 revised consumption model now fully integrates the consumption forecast, leakage forecast, non-household forecast and DMO (demand management option) intervention forecasts into a single unified system, where all the relevant interdependencies (leakage, smart metering, cspl), are accounted for.

6.1.6 For household consumption, the forecast demand is driven by an understanding of the changes in population for each of the segments, as the unmeasured population is forecast to decrease, and the measured population increases due to opting and as additional population enters measured/metered (smart metered) new-build properties.

6.2 Base-year information

6.2.1 In order to produce the demand forecast, an initial assessment has been made regarding base year values for each of the components of demand. For the revised draft WRMP24 we have chosen 2021/22 as the base year for the forecast, taking into account recent volatility in demand due to post pandemic conditions.

6.2.2 Base year consumption and leakage data have been derived using internal water-balance (WB) analysis. The water balance calculations compare 'top-down' estimates of the total water into supply with 'bottom-up' estimates of the demand, based on the measurement and estimation of components of legitimate usage. Differences between these estimates are then distributed between the major components based on an assessment of their uncertainty using the industry established method of Maximum Likelihood Estimation (MLE). The computation of MLE adjustments to the water balance calculations use relatively accurate AWS data regarding:

- water resource outputs,
- domestic and commercial metering,
- property numbers
- leakage management data
- estimates of other components of water use (based on industry standard best-practice assumptions)

6.2.3 However, for un-metered/unmeasured properties and consumers, a sample based upon the Survey of domestic customers (SODCON) and smart meter data (for metered/unmeasured customers) has been used to estimate this diminishing component of demand. This un-metered /unmeasured element of the WB tends to accumulate errors, causing a potential over or under-estimate of the per household (PHC) and per capita consumption (PCC) and other demand components; with PHC being calculated from the unaccounted-for remainder of the water supplied and the number of unmeasured properties and PCC being additionally derived using Local Authority based occupancy rates.

6.2.4 Due to the importance of this dataset, Anglian Water (AWS) has sought to improve its water balance and leakage calculations by creating its whole-company water balance from the aggregation of individual water balances undertaken at the planning zone level (81 no. PZs) to Water Resource Zones (26 no. WRZs).

6.2.5 The demand forecast relies fundamentally upon the initial understanding of base-year information (water-balance data);

- The number of measured household properties per WRZ. (water-balance data, based upon AWS 'billing' information)
- The number of measured smart metered properties per WRZ. (metering team information)
- Measured household occupancy rates per WRZ. (derived from internal 'SODCON' surveys, demographic data and apportioned Official ONS Local Authority trend-based occupancy rates)
- Measured household population rates per WRZ. (derived from internal Billing data (properties) and apportioned Official ONS Local Authority trend-based occupancy rates)
- Measured per capita consumption (PCC) values per WRZ. (water-balance data)
- The number of unmeasured household properties per WRZ. (PZ water-balance data (aggregated to WRZ), based upon AWS 'billing' information)

- Unmeasured household occupancy rates per WRZ. (derived from internal 'SODCON' surveys, demographic data and apportioned Official ONS Local Authority rates)
- Unmeasured household population rates per WRZ. (derived from internal Billing data (properties) and apportioned Official ONS Local Authority trend-based occupancy rates)
- Unmeasured per capita consumption per WRZ. (PCC) values (water-balance data)
- Numbers of void properties (household/non- household) per WRZ.
- WRZ Distribution Loss Leakage values.
- Customer supply pipe leakage values for measured/unmeasured/household/non- household customers (per WRZ)
- 'Distribution System Operational Use' and 'Water taken unbilled' values per WRZ.

6.2.6 Once combined with the forecast data below, this will allow future household consumption to be determined.

- The number of optants properties per year.
- The optant/switcher population per year (based upon an assumed value for optant/switcher occupancy).
- Additional New-build Properties. (LAUA plan based data)
- Additional Population per year (Assumed to be measured and derived from the overall WRZ 'plan' based projection for households and ONS trend-based occupancy rates)

6.2.7 For measured customers the base-year values are (Table 11):

Table 11 Base year values for measured customers (2021/22)

WRZ	Measured household properties void	Measured Population	Measured Household Occupancy	Measured household properties void	Measured Household consumption (Ml/d)
Essex Central	11,147	28,077	2.519	176	3.49
Essex South	90,066	217,470	2.415	1979	28.73
Fenland	76,408	157,948	2.067	1743	20.99
Hartlepool	19,738	37,669	1.908	903	5.39
Lincolnshire Bourne	58,304	135,397	2.322	1176	17.02
Lincolnshire Central	170,519	375,630	2.203	3796	47.62
Lincolnshire East	139,834	304,076	2.175	3778	36.14
Lincs, Retford & Gains	26,560	53,034	1.997	725	7.37
Norfolk Aylsham	9,291	20,052	2.158	161	2.44
Norfolk Bradenham	16,156	36,860	2.282	321	4.24
Norfolk East Dereham	7,711	17,871	2.318	141	2.03
Norfolk East Harling	4,220	9,498	2.251	74	1.22
Norfolk Happisburgh	7,114	14,383	2.022	150	1.79
Norfolk Harlston	13,469	30,360	2.254	225	3.56
North Norfolk Coast	30,268	55,882	1.846	773	7.39
Norwich & the Broads	129,130	282,116	2.185	2558	35.36
Norfolk Wymondham	19,123	43,098	2.254	396	5.13
Ruthamford Central	114,537	287,989	2.514	2540	38.73
Ruthamford North	356,163	843,661	2.369	7656	104.32
Ruthamford South	179,141	415,802	2.321	3685	56.10
Ruthamford West	32,213	75,586	2.346	565	10.47
Suffolk East	123,810	279,446	2.257	2543	36.42
Suffolk Ixworth	8,590	20,445	2.380	196	2.61
Suffolk Sudbury	12,960	28,473	2.197	269	3.87
Suffolk Thetford	13,148	28,877	2.196	234	3.60
Suffolk West & Cambs	97,112	222,056	2.287	2366	28.86

6.2.8 For unmeasured customers base-year values are (Table 12):

Table 12 Base-year values for unmeasured customers (2021/22)

WRZ	Unmeasured household Properties	Unmeasured Population	Unmeasured Household Occupancy	Unmeasured household properties void	Unmeasured Household consumption (Ml/d)
Essex Central	4,006	9,045	2.258	56	2.10
Essex South	14,948	39,775	2.661	223	7.23
Fenland	12,766	37,355	2.926	445	6.74
Hartlepool	21,903	53,008	2.420	1133	6.90
Lincolnshire Bourne	8,685	21,201	2.441	186	4.22
Lincolnshire Central	45,970	99,633	2.167	882	20.24
Lincolnshire East	40,294	77,453	1.922	1048	16.90
Lincs, Retford & Gains	8,738	21,163	2.422	220	4.31
Norfolk Aylsham	1,008	2,110	2.093	24	0.44
Norfolk Bradenham	1,560	4,631	2.969	31	0.86
Norfolk East Dereham	1,034	2,755	2.664	31	0.64
Norfolk East Harling	857	2,581	3.012	23	0.49
Norfolk Happisburgh	1,056	2,121	2.009	23	0.47
Norfolk Harlston	1,674	5,346	3.194	26	0.85
North Norfolk Coast	4,868	9,131	1.876	113	2.12
Norwich & the Broads	29,011	63,232	2.180	326	12.18
Norfolk Wymondham	2,395	6,761	2.823	36	1.35
Ruthamford Central	9,019	36,693	4.068	331	4.80
Ruthamford North	47,738	142,616	2.987	906	22.71
Ruthamford South	20,029	74,275	3.708	370	11.13
Ruthamford West	3,038	10,691	3.519	76	1.59
Suffolk East	13,873	48,531	3.498	269	7.56
Suffolk Ixworth	1,179	3,137	2.661	11	0.51
Suffolk Sudbury	1,484	3,762	2.535	21	0.56
Suffolk Thetford	1,655	6,460	3.903	24	0.77
Suffolk West & Cambs	11,842	32,435	2.739	245	5.24

6.3 Key forecast calculations

6.3.1 Key demand forecast calculations, that have informed our modelling processes are described in the following sections.

6.4 Population

6.4.1 The cohort model functions, such that year-on-year changes in population are calculated as below, with total WRZ populations being based upon the Household/Population Forecast Model (Local Authority plan derived).

6.4.2 The forecast population (measured and unmeasured) year-on-year change is calculated, as described: For measured population:

$$Pop_{\text{(meas)}} = Pop_{\text{(meas-previous year)}} + Pop_{\text{(switcher)}} + Pop_{\text{(newbuild)}} +/- Pop_{\text{(inter-year change birth/death/migration)}}$$

6.4.3 Where:

- *Pop* (meas) = The Measured Population
- *Pop* (meas-previous year) = The Previous Year's measured population
- *Pop* (switcher) = This year's Switcher Population
- *Pop* (newbuild) = This year's New-build Population (Plan derived)
- *Pop (inter-year change birth/death/migration) = The adjustment to reconcile to the 'top down' population total, accounting for all population changes in the WRZ (change, split by meter penetration)*

6.4.4 And for the unmeasured population:

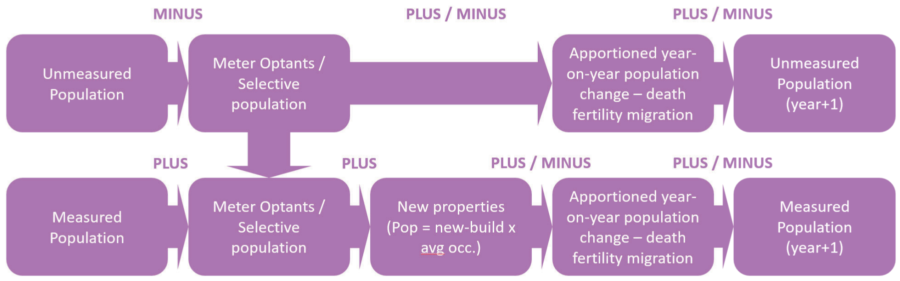
$$Pop_{\text{(unmeas)}} = Pop_{\text{(unmeas-previous year)}} + Pop_{\text{(switcher)}} + Pop_{\text{(newbuild)}} +/- Pop_{\text{(inter-year birth/death/migration)}}$$

6.4.5 Where:

- *Pop* (unmeas) = The Measured Population
- *Pop* (unmeas-previous year) = The Previous Year's measured population
- *Pop* (switcher) = This year's Switcher Population
- Pop (inter-year change birth/death/migration) = The adjustment to reconcile to the 'top down' population total, accounting for all population changes in the WRZ (change, split by meter penetration)

6.4.6 These calculations can be shown graphically, as below (Figure 29).

Figure 29 Model Population calculations



6.4.7 A value is calculated for the assumed New build population = New property (year on year) x average WRZ occupancy.

- Note that planned new properties are used to calculate the total WRZ population per year in the household/population model, but this uses the average overall WRZ trend-based occupancy rates for the derivation of the yearly total WRZ population. This overall occupancy determined population will also include demographic changes due to births, deaths and migration rates, such that additional WRZ populations per year do not equal the previous year's total plus the new-build x average WRZ occupancy population. Consequently, we apply an additional inter-year change to fully reconcile the 'top down' population forecast.

6.5 Occupancy and switcher population

6.5.1 Given that the metering optant forecast is based upon properties and the model is based upon population and PCC, switcher/optant populations have been calculated using the following assumptions:

- The Base-year and forecast 'Average WRZ Occupancy' is derived from Household/Population Model (Plan derived)
- 'Switcher Occupancy' = Average of [('Unmeasured Occupancy') and ('WRZ Average occupancy' (Plan derived)] -This reflects the fact that the switcher population is not expected to fully align with the average unmeasured demographic.
- 'New-build Occupancy' = 'Average WRZ Occupancy' derived from Household/Population Model (Plan derived)

- 'Base-year RZ measured/unmeasured Occupancy' is generated by Water-Balance.
- 'Forecast measured/unmeasured occupancy' derived post switcher and post additional year on year population.

6.5.2 Thus, as populations are transferred from unmeasured to measured, the measured occupancy tends towards the WRZ average and unmeasured occupancy rates tend to increase. Note, as opting and switchers decline (as meter penetration reaches saturation) the unmeasured occupancy rate tends to reflect the declining overall occupancy rates for the region.

6.6 Household consumption

6.6.1 For consumption, base-year measured/unmeasured consumption is derived from the water-balance PCC and population totals.

6.6.2 Switcher Consumption is assumed to be;

- Pre-switch (deducted from unmeasured) = Previous year (unmeasured PCC x population)
- Post-switch (added to measured consumption) = Previous year (unmeasured PCC x 85%) x population)

6.6.3 Unmeasured consumption is, therefore, assumed to decrease by 100% of the switcher consumption and measured consumption increase by 85% of the switcher consumption (i.e. a 15% saving)

6.6.4 New-build Consumption is assumed to be equivalent to the measured consumption for the particular WRZ for that year.

6.6.5 Thus forecast household consumption is calculated as;

6.6.6 Measured Consumption = (Current Year measured population x Previous Year measured PCC (inc. Gov interventions)) + (New-build population x Previous Year measured PCC (inc. Gov interventions)) + (Switcher population x (Unmeasured PCC x 85%)); see below,

6.6.7 Measured Consumption:

$$Con_{(meas)} = [\, Pop_{(meas\text{-}current\ year)} \times PCC_{(prev\ -\ meas)}\,] + [\, Pop_{(new\text{-}build)} \times PCC_{(prev\ -\ meas)}\,] + [Pop_{(switcher)} \times (PCC_{(unmeasured)} \times 85\%)\,]$$

6.6.8 And unmeasured consumption is calculated;

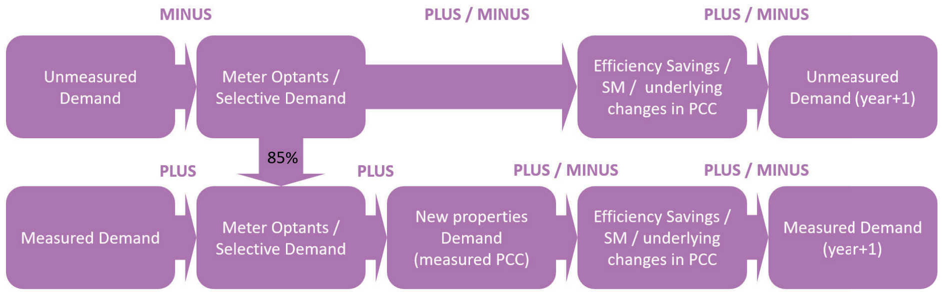
6.6.9 Unmeasured Consumption = (Current year unmeasured population x Previous year unmeasured PCC) - (Switcher population x previous year Unmeasured PCC)

6.6.10 Unmeasured Consumption:

$$Con_{(unmeas)} = [Pop_{(unmeas\text{-}current\ year)} \times PCC_{(prev\ -\ unmeas)}] - [\, Pop_{(switcher)} \times (PCC_{(unmeasured)} \times 100\%)\,]$$

6.6.11 These calculations can be shown graphically as below (Figure 30).

Figure 30 Model household consumption calculations



6.7 Smart meter impacts on consumption and leakage

6.7.1 As part of the revised draft WRMP24, we have re-evaluated potential savings from smart meters base upon:

- data from the full rollout of smart meters across the Anglian Water region (we have concentrated the analysis of a cohort of approximately 150K smart metered properties with more than a full year of continuous data, from the current installed base of >500K smart meters (2022/23)).
- as opposed to the Newmarket and Norwich trial data (with a duration of more than 2 years) originally used for the draft plan.

6.7.2 Smart meters highlight customer consumption in a new dynamic fashion and enable the identification of continuous flows (after detection for 3 consecutive days). This data has been used in order to determine the current and future 'normal' for customer supply pipe leakage (cspl - leakage impact), 'plumbing loss' (PCC impact), break-out rates and average run times. We have also considered the impact of smart meters in driving behavioural change savings. Options have been considered which should lower the average leak duration below the current run-time, and, therefore, increase savings, beyond what can be achieved with traditional metering.

6.7.3 Current evaluation of continuous flow data has indicated that the Newmarket/Norwich trial area is not representative of the entire Anglian Water region. Analysis does, however, indicate that there is still a similar volume of continuous flow to be rectified.

6.7.4 We have, therefore, concluded that current continuous flow savings attributable to smart metering should be initially limited to 40% of those originally estimated for the draft WRMP24 (for 2021/22) and that this should then increase, as systems become embedded (and as an indication of our ambition) on a glidepath to a value of 90% of the original estimation by 2031/32 (and beyond).

6.7.5 This revised analysis indicates that we may potential expect continuous flow savings for cspl and plumbing loss as below (Table 13).

Table 13 Smart meter continuous flow reduction glide-path

10 year profile - 90% outcome	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
cspl saving profile (l/prop/d)	2.68	3.01	3.35	3.69	4.02	4.34	4.69	5.03	5.36	5.70	6.03
plumbing loss profile (l/prop/d)	4.84	5.45	6.05	6.66	7.26	7.87	8.47	9.08	9.68	10.23	10.89
total saving (ex. Behaviour) (l/prop/d)	7.52	8.46	9.40	10.34	11.28	12.22	13.16	14.10	15.04	15.98	16.92

6.7.6 Note that we still expect significant reductions in continuous flow (both for plumbing losses which impact PCC and customer supply pipe leakage (cspl) which then impacts our leakage total) from 7.5 l/prop/day, which we are currently seeing, to 16.9 l/prop/d by 2031/32.

6.7.7 We will continue to analyse data to ascertain the potential final 'new normal' for household leakage/continuous flow and to realise the full potential for smart meter benefits.

6.7.8 For our revised draft WRMP24 we have continued to assume a 2% impact on customer behaviour (per capita consumption). We, therefore expect to realise:

- a 2% impact on customer behaviour (per capita consumption).
- an average reduction of 10.89 l/prop/day, due to the timely identification of plumbing loss leaks and their repair by the customer. This is an approximate 3% reduction in per capita consumption.
- an average reduction of 6.03 l/prop/day, due to the timely identification of customer supply pipe leaks and their repair by

the customer. This is an approximate 2% reduction in per capita consumption.

6.7.9 This can be visualised as below (Figure 31):

Figure 31 Revised SM continuous flow saving assessment for final WRMP24

	Base-line pre-smart		2022 with smart	2032 with smart		2022 Saving	2032 Saving
Baseline - cspl. (leakage)	9.8 l/prop/day	With SM - cspl. (leakage)	7.12 l/prop/day	3.77 l/prop/day	SAVING - cspl	2.68 l/prop/day	6.03 l/prop/day
Baseline - Plumbing Loss. (PCC)	20.4 l/prop/day	With SM – Plumbing loss. PCC)	15.56 l/prop/day	9.51 l/prop/day	SAVING – Plumbing Loss	4.84 l/prop/day	10.89 l/prop/day
Current BL – cspl/PL total Per Property	30.2 l/prop/day	Total cspl/PL with a Smart Meter	22.68 l/prop/day	13.28 l/prop/day	Total SAVING Per Property	7.52 l/prop/day	16.92 l/prop/day
Current Base-line assessment of cspl/PL per property		Assumed 'new normal' level of cspl/PL per property with SM for 2022 and 2032			SM SAVINGS for cspl/PL per property for 2022 and 2032		

30 l/prop per day base-line assumption has been agreed in alignment with the water balance assessment.

Behaviour change SAVING assumed to be 2% per person for consumption, due to water efficiency (note potential for double counting with WEF options has been considered)

6.7.10 Note that these savings from our smart meter program are key to achieving our target of 110 l/h/d by 2050.

6.8 Forecast assumptions

6.8.1 As described all base-line values for the measured/ unmeasured properties, population, occupancy, and per capita consumption have been aligned with water balance data at WRZ level.

6.8.2 Additionally, it has been assumed that:

- The optant/switcher occupancy is calculated, as the average of the yearly value for unmeasured occupancy and WRZ average occupancy (as it will be assumed that the optants/switchers form a slightly different cohort to the 'standard' unmeasured population, with lower than average unmeasured consumption and demographic characteristics, either being a driver for opting/switching, or reflecting the nature of customers who are optants upon 'moving in'.
- New build properties, for the forecast period have been assumed to be metered and measured, as they are added to the total number of properties per year.
- Additional population per year has been adjusted to reflect the overall changes in average occupancies for the WRZ per year, in order to reflect declining occupancy rates and changes due to birth rates, death rates and migration (Thus, additional population will not be calculated as 'new properties' x 'occupancy' as this would not account for the other demographic changes)
- We have assumed that as customers switch, their consumption reduces to reflect their new status (or reflect their demography in the case of optants who choose to be measured upon 'moving in'); this reduction has been assumed to be 15% of the pre-switch, unmeasured, consumption value for the particular WRZ.
- Within the model, switcher consumption is NOT conserved. Consequently, as the switcher consumption is recalculated from 'Pre-switch' to 'Post-switch' (i.e. Average unmeasured consumption - 15%); the 15% reduction is removed from the overall household demand total. This reduction has been assumed, in alignment with the findings of other water companies who have reported savings of 16.5 and 17%.
- The influence of smart metering on PCC and cspl has been reassessed and included in the base-line forecast, accounting for the AMP7 smart meter program (>1m smart meters installed) with a reassessment of the impact smart meters have on household behaviour and consumption.
- Smart meters have been estimated to save an additional 2% of PCC/PHC, due to behavioural change. This has been marginally reduced from the 3% change provisionally estimated in WRMP19, due to the increased reassessment of plumbing loss savings (attributable to smart metering and impacting PCC), and additional savings from water efficiency measures tied to smart meter communication. We have, therefore made this more

conservative assessment in line with updated smart meter findings.

- Initial analysis is showing a positive impact from smart meters in reducing plumbing losses (internal leaks which are included in PCC estimation) and customer supply pipe leakage (which impacts leakage reduction). Smart meter data is now allowing our leakage teams to inform customers of these continuous flows, 3 days after they are discovered. This analysis indicates a current saving of 7.52l/prop/day for plumbing losses, raising to 16.92 l/prop/d by 2031/32 for smart metered properties (which is equivalent to a 5% saving on PCC). Customer supply pipe leakage reduction is estimated to currently be 2.68 l/prop/day which will increase to 6.03 l/prop/d by 2031/32, as our strategy advances.
- The influence of smart metering on PCC and cspl has been reassessed and included in the base-line forecast, accounting for the AMP7 smart meter program (>1m smart meters installed) with a reassessment of the impact smart meters have on household behaviour and consumption.
- Smart meters have been estimated to save an additional 2% of PCC/PHC, due to behavioural change. This has been marginally reduced from the 3% change provisionally estimated in WRMP19, due to the increased reassessment of plumbing loss savings (attributable to smart metering and impacting PCC), and additional savings from water efficiency measures tied to smart meter communication. We have, therefore made this more conservative assessment in line with updated smart meter findings.
- Initial analysis is showing a positive impact from smart meters in reducing plumbing losses (internal leaks which are included in PCC estimation) and customer supply pipe leakage (which impacts leakage reduction). Smart meter data is now allowing our leakage teams to inform customers of these continuous flows, 3 days after they are discovered. This analysis indicates a current saving of 7.52l/prop/day for plumbing losses, raising to 16.92 l/prop/d by 2031/32 for smart metered properties (which is equivalent to a 5% saving on PCC). Customer supply pipe leakage reduction is estimated to currently be 2.68 l/prop/day which will increase to 6.03 l/prop/d by 2031/32, as our strategy advances.

6.9 A micro-component approach

6.9.1 According to the Household Consumption Forecasting Guidance Manual (UKWIR, 2015), Micro Components should be used in the assessment of a water company's current and forecast household consumption - i.e. a "bottom-up" household demand forecast.

6.9.2 Our "top-down" base year household consumption estimates will be derived from the Planning Zone Water Balance, which calculates demand from water into supply data. The "top-down" household forecast is driven by year-on-year changes in:

- The number of Switcher properties based on the AWS metering plans and the assumption of consumption being reduced, as customers change from being unmeasured to measured (assumed to involve a 15% reduction in consumption).
- The impact of the introduction of smart meters across the AWS region, through behavioural change and reductions in cspl and plumbing losses.
- The number of new-build properties and population based on WRZ property, population and occupancy forecasts derived from Office for National Statistics (ONS) forecasts and Local Authority Plans.
- The impact of climate change on demand taken from the 50th percentile forecast in UKWIR (2013); and
- The water efficiency impacts due to government led interventions and 'white goods' labelling .

6.9.3 It is considered that the micro component approach (MCA) to forecasting demand is a suitable way for companies to understand their customers' demand for water and to identify the scope for changing water use. Using this approach, companies need to consider how advances in technology, changes in society and the role of regulation will influence growth or decline in water use over the next 25 years. This approach considers how socio-economic characteristics influence patterns of water use and affect appliance ownership.

6.9.4 For the "bottom-up" forecast approach, we have analysed the following micro-components (MCs):

- WC flushing;

- Clothes washing;
- Personal washing;
- Dishwashing;
- External use; and
- Miscellaneous (internal) use.

6.9.5 The Environment Agency (EA) believes from this base-line forecast, options for further 'enhanced' demand management (over and above the technological and behavioural changes assumed in the MCA forecast) could be developed and added to the final planning solution, if found to be beneficial.

6.10 DEFRA Market Transformation Program and Long-Term PCC Reduction

6.10.1 Defra and Water UK (WUK) recently conducted research into long term PCC reduction and concluded that a significant impact might be made to PCC, by the adoption of 'government led' interventions such as changes to building regulations, mandatory water efficiency standards and 'white good' labelling.

6.10.2 These interventions alongside those that are planned by water companies, have been considered as part of the WRMP24 planning process. For the revised draft WRMP24 we have considered it prudent to include a conservative assessment of savings attributed to 'government led' interventions, in final plan forecasts (in accordance with the WRPG). This in part indicates how all stakeholders should be part of the future drive to lower household consumption and achieve the National Framework target of 110l/h/d.

6.10.3 Historically, the MTP has provided research to support the development and implementation of UK Government policy on sustainable products. The analysis has collated MCA data from studies by water companies to provide ownership, frequency and volume estimates of currently available devices. It also includes forecasts for England and Wales for total water demand under three alternative policy scenarios which relate to increasing levels of policy-led interventions by Government (UKWIR, 2012).

6.10.4 The 'Reference Scenario' is a projection of what is likely to happen without any new policy intervention. The scenario is based on current trends, technology development and policies that are already in place. The MTP also uses the 'Policy Scenario' and the 'Earliest Best Practice Scenario'. The 'Policy Scenario' estimates what could be achieved through an ambitious, but feasible, set of policy measures, if the agreement of all stakeholders could be obtained. The 'Earliest Best Practice Scenario' is a projection of what could happen if the best available products and technologies were adopted, coupled with ambitious Government policies. For the purposes of the Micro component analysis the 'Reference Scenario' has been assumed to be the standard applied. This is consistent with the base-line forecast (i.e. without demand management options).

6.10.5 Note that as part of our revised draft WRMP24 final plan we have also taken into account the analysis described in the WUK report 'Water UK - Pathways to long-term PCC reduction' regarding the potential for government led interventions and and 'white good' labelling. This has been factored into our preferred plan trajectory.

6.11 Micro component details and PCC

6.11.1 As part of the WRMP24 program, assessments have been reviewed regarding Micro Components including:

- WC Flushing
- Clothes washing
- Personal washing
- Showers
- Bathing
- Basin tap usage
- Dish washing and hand washing
- External usage
- Miscellaneous use

6.11.2 We have reviewed the socio-economic trends which are likely to influence future household consumption, including:

- switching from taking baths to showering
- an ageing population and increased home working
- potential covid19 pandemic and post pandemic effects
- potential impacts from government led interventions and 'white good' labelling

6.11.3 According to UKWIR (2012), personal washing is likely to be a key area where behaviour may alter consumption in the future with an increase of showering, as more people switch from taking baths. This is mainly due to the immediacy and convenience of showering compared to taking baths. Increasing numbers of existing homes are also being modified to include additional bathrooms and/or en-suite facilities.

6.11.4 These factors will have the potential to reduce PCC;

- customers using water more wisely, appreciating its value and the consequences of wasting it;
- water companies actively encouraging demand management to protect customer and environmental needs; and
- water efficiency playing a prominent role in achieving a sustainable supply-demand balance, with high standards of water efficiency in new homes and water-efficient products and technologies in existing buildings.

6.11.5 These behavioural changes highlight the complexity in differentiating long-term changes that should be included in the base-line and those that constitute enhanced demand management in the revised draft WRMP24 options appraisal, particularly water efficiency options that target behavioural change. For this reason, we will ensure that the base-line and final plan demand forecasts do not double count demand management options, or the water efficiency savings in the base-line forecast.

6.11.6 PCC could also potentially increase as a result of an ageing population and trends towards increased home working (UKWIR, 2012). However, there is still limited evidence available to determine exactly how these changes will impact over time.

6.11.7 Although it was previously thought that the impact of home working would be neutral on demand (as the customer water footprint would be shifted from non-household demand to household demand), we have seen during the Covid19 pandemic that there is a net impact on water demand (i.e. more home use of flush toilets, rather than zero flow urinals).

6.11.8 It is noted that Covid19 has also had a significant impact on PCC values (2020/21), increasing PCC by over 10%. The longer-term consequences of changes in behaviour due to the pandemic have been considered within scenario testing for WRMP24 and included in the final plan.

6.12 WC flushing

6.12.1 The 'MTP briefing note BNWAT01: WCs: market and product details' projects that WC water consumption will decrease from 2010 to 2030. We have assumed that this trend is likely to continue to 2050.

6.12.2 It is, therefore, assumed:

- Ownership of WCs and frequency of use for WC flushing will remain constant; and
- Volume per use for WC flushing will reduce. This will result in a 5.9% decrease in the volume of water used per person per day for WC flushing between 2015 and 2050.

6.12.3 **Ownership** - According to UKWIR (2012), multiple WCs in a property have a limited effect on the total number of uses. Base-year ownership has, therefore, been assumed at one per household. This is unlikely to change over the next 25 years.

6.12.4 **Volume** - Dual flush 6/4 toilets are the industry standard. Over time it is expected that sales of this product will decrease, and sales of 6/3 dual flush toilets and toilets with even lower flush volumes will increase. However, the decrease in the volume of water used per flush would continue to be less each year as households would already have these types of low flush WCs installed. WC flushing has, therefore, been assumed at 5.02 litres. By 2050, volume per use is forecast to decrease to 4.72 litres.

6.12.5 **Frequency** - Base-year frequency of use per person per day is assumed at 4.71. The MTP assumes that the frequency of use will remain constant. However, frequency of use could potentially increase as a result of an ageing population and trends towards increased home working (UKWIR, 2012). However, there is no evidence available to determine what this change would be.

6.13 Clothes washing

6.13.1 There is a disagreement between water companies regarding clothes washing in the future. Some companies forecast that the volume of water used per person per day will decline, whilst others forecast a constant or rising trend. The EA has forecasted a slight decline. This is based on the assumption that, whilst washing machine use may increase in the future, the average volume will reduce as machines become more efficient.

6.13.2 It is, therefore, assumed:

- Ownership and frequency of use of washing machines will remain constant; and
- Volume per wash cycle will decrease by 17%. This will result in a 11% decrease in the volume of water used per person per day for clothes washing between 2015 and 2050.

6.13.3 **Ownership** - The vast majority of clothes washing is assigned to washing machines. The Office for National Statistics (ONS) reports washing machine ownership at 96% in 2010. According to the MTP, there is no further capacity for growth in washing machine and washer-drier percentage ownership. Base-year ownership is, therefore, assumed at 0.96. This is unlikely to change over the next 25 years.

6.13.4 **Volume** - The average litres per wash cycle has historically been reported at 50 litres. With new water efficient models likely to use less water (between 35 and 45 litres of water per load), there could continue to be a decline in the volume of water used per wash cycle. However, there is also a growing trend towards larger load machines that may counteract their improved water efficiency. Therefore, it has been assumed that reduction in litres used per wash cycle will be minimal. Base-year volume per wash cycle is, therefore, assumed at 50 litres. From 2030, and it has been assumed that the volume per wash cycle would gradually reduce to 43 litres by 2050.

6.13.5 **Frequency** - The MTP assumes washing machines and washer-driers will be used 260 times per year. Base-year frequency of use is, therefore, assumed at 0.57 (EST, 2015). The MTP does not forecast further changes in frequency of use. There is no evidence to suggest that frequency of use will change post 2030.

6.14 Personal washing

6.14.1 This group contains bath, shower and hand basin sub-components and have been grouped together because of the inherent interdependence between them. Personal washing is likely to be a key area where behaviour may alter consumption in the future (UKWIR, 2012).

6.15 Showers

6.15.1 Information from the MTP regarding customers' shower usage has been supplemented by additional study findings, which have indicated that:

- The average shower is eight minutes long. An eight minute shower, with an average flow rate, uses 62 litres of water compared to 80 litres for a bath, expelling the myth that a shower uses considerably less water than a bath.

6.15.2 It has been assumed that between 2015 and 2050:

- Ownership of showers will increase by 11%;
- Volume per use for showering will increase by 33%; and
- Frequency of use for showering will increase by 18%.

6.15.3 This will result in a 75% increase in the volume of water used per person per day for showering between 2015 and 2050.

6.15.4 **Ownership** - The current ownership of showers is not 100% (UKWIR, 2012) and is expected to increase. This is partly related to the addition of new homes and increasing numbers of existing homes are also being modified to include additional bathrooms and/or en-suite facilities. Multiple ownership is not assumed to directly impact on consumption, although, in some households, multiple showers may permit more and/or longer showers during a limited morning period (UKWIR, 2012). Base-year ownership is, therefore, assumed at 0.89 (sum of electric, gravity mixer and power shower ownership). It has been assumed that the overall ownership of showers will increase to 0.99 between 2015 and 2050 (based on the rate observed between 2015 and 2030 in the MTP forecast data).

6.15.5 **Volume** - The main factors affecting the amount of water used when showering are shower flow rate and duration.

6.15.6 Flow rate varies depending on the type of shower. Electric showers are particularly popular and have the lowest flow rate of approximately 5 litres per minute. Mixer showers and power showers have a considerably higher flow rate and are becoming more common. This will result in an increasing volume of water being used for showering. Base-year volume per use is, consequently, assumed at 44.4 litres. The volume of water used for showering is likely to continue to increase to 2050, as customers switch from using electric to power showers. It has been assumed that by 2050, 70% of customers will own showers with a volume per use of 44.4 litres (also the base-year assumption) and 30% will own showers with a higher volume per use of 87 litres (average of the median and 90th percentile figures taken from EST (2015). This ratio is based on evidence published by the MTP stating that, by 2030, 23% of households will own power showers and 77% will own electric or mixer. By 2050, volume per use is forecast at 59.31 litres.

6.15.7 **Frequency** - The frequency of showering (excluding other forms of bathing) has historically been reported as 1.04 times per person per day. There is an overall increase in showering evident in the MTP data as more people switch from taking a bath to showering. This is because of the immediacy and convenience of showers compared with baths. Base-year frequency of use for showering is assumed at 1.09 and continues to increase to 1.29 by 2050.

6.16 Bathing

6.16.1 It has been assumed that between 2020 and 2050:

- Ownership of baths and frequency of use for bathing will decrease; and
- Volume per use for bathing will remain static from 2025.

6.16.2 This will result in a 42% decrease in the volume of water used per person per day for bathing between 2017 and 2050.

6.16.3 **Ownership** - The growth of showering and the wide range of showers now available may reduce the sales and hence ownership of baths. Base-year bath ownership is assumed at 0.94. It has been assumed that ownership of baths per property would decline by 143% between 2017 and 2050.

6.16.4 **Volume** - A reduction in litres per use over time reflects the uptake of more efficient baths with a lower volume. The trend towards smaller properties means that bathroom space is limited, and, therefore, smaller baths are likely to be installed more often in the future. Base-year volume per use is estimated at 84.83 litres. However, lack of evidence on this trend means that volume per use is assumed to remain at 84.95 litres from 2020.

6.16.5 **Frequency** - The frequency of showering is increasing and bathing decreasing as more people switch from taking a bath to showering. Base-year frequency of use is assumed at 0.28 (based on previous analysis) and it has been assumed that the frequency of use per person per day will continue to reduce by 1% per annum to 0.20 by 2050.

6.17 Basin taps

6.17.1 It has been assumed that basin tap usage will continue to remain constant between 2015 and 2050.

6.17.2 **Ownership** - A base-year assumption of 100% basin tap ownership is considered reasonable (UKWIR, 2012). It has been assumed that multiple pairs of basin taps have a limited effect on the total number is uses. There is no evidence to suggest this assumption will change over time.

6.17.3 **Volume** - The average duration of tap use is 39.3 seconds. Wash-basin tap flow rates range between 3.54 litres per minute (standard) and 1.68 litres per minute (most efficient), resulting in a water consumption of between 2.32 litres and 1.10 litres per use. Base-year volume per use is, therefore, assumed at 2.32 litres. There is no evidence to suggest this assumption will change over time.

6.17.4 **Frequency** - According to the MTP, each person uses a washbasin tap approximately 8 times a day. However, this frequency of use is based on limited evidence separating hand basin uses from kitchen tap use. There is no evidence to suggest this assumption will change over time.

6.18 Dish-washing and hand washing

6.18.1 It has been assumed that between 2015 and 2050:

- Ownership of dishwashers will remain constant;
- Volume per wash cycle will reduce by 3%; and
- Frequency of use will decrease by 2.5%.

6.18.2 This will result in a 0.3% decrease in the volume of water used per person per day for dishwashing between 2015 and 2050.

6.18.3 **Ownership** - The ONS (2017a) reports dishwasher ownership at 40% in 2010. It is assumed that those owning a dishwasher will do some washing up by hand. It has been assumed that the remaining 60% wash up by hand. According to the MTP, ownership of dishwashers is not expected to rise much further.

6.18.4 **Volume** - The volume of water used by a dishwasher can vary from 50 litres per cycle to as little as 10 litres (Waterwise, 2012). According to 'Which?', the main wash program on a full-sized dishwasher uses about 16 litres of water. The Energy Saving Trust (2015) report volume per use at 13.4 litres. There may be a slight decline in the volume of water per use as older models are replaced with more water efficient models, however, customers may not buy the most water efficient models available. It has, therefore, been assumed that volume per use will reduce to 12.9 litres by 2050. People who have a dishwasher will also do some washing-up by hand. Data on the volume of water used for hand dish washing is limited. Historic research reports a weighted average for washing-up by hand of approximately 10 litres per person per day. The MTP assumes a similar consumption of 9.9 litres per person per day and this has been assumed as the base-year volume per use. Additionally, it has been assumed that the volume of water used for washing-up by hand per property per day will continue to remain constant over time as no evidence has been found on predicted manual washing-up trends. However, due to the average occupancy of households reducing between 2017 and 2050, the volume of water used per person per day for washing-up by hand will increase slightly.

6.18.5 **Frequency** - There is little reliable data regarding dishwasher use in the UK. Dishwashers are assumed to be used an average of 246 times per year and this is expected to decline gradually to 237 in 2030. The decline takes into account the potential for less frequent use in smaller households and the increase in capacity of future machines. Base-year frequency of use is therefore assumed at 0.79 (EST, 2015) and it has been assumed that frequency of use will reduce to 0.77.

6.19 External use

6.19.1 Domestic external water use refers to any potable water that is consumed outside of the domestic dwelling after being drawn from the mains distribution system. There are several different activities that contribute to external water use. The major contributors include: garden watering; vehicle washing; ponds and water features; pressure washers; and recreational use. Based on the Environment Agency research, most water company forecasts for external use (excluding car washing) are consistent, with only minor increases in the volume of water used per person per day over the forecast period.

6.19.2 Waterwise (2017) reports the percentage of household water use that is external at 7%. Results have shown that those who actively water their garden tend to be older than average. The percentage of the population that is 65 years or older is projected to continue to grow significantly by 2050 (ONS), which suggests that external water use could increase over time. Despite this, it has been assumed that external water use will remain constant over the planning period, as there is no firm evidence to determine a quantifiable increase.

6.20 Miscellaneous use

6.20.1 Miscellaneous use comprises all the components of use that have not been included explicitly. Most water companies forecast that miscellaneous use will largely remain constant throughout the planning period.

6.21 Conclusions

6.21.1 In conclusion, research has identified three main socio-economic trends which are likely to influence future household consumption, including:

- switching from taking baths to showering
- an ageing population and increased home working

6.21.2 However, additional drivers have been identified which aim to reduce PCC, include:

- customers using water more wisely, appreciating its value and the consequences of wasting it;
- water companies actively encouraging demand management to protect customer and environmental needs; and
- water efficiency playing a prominent role in achieving a sustainable supply-demand balance, with high standards of water efficiency in new homes and water-efficient products and technologies in existing buildings.

6.21.3 For our revised draft WRMP24 submission, we have taken into account the described changes in consumption patterns in our appraisal of micro-component reporting.

6.21.4 We are currently starting to analyse smart meter consumption data in order to provide greater insight into usage patterns and customer behaviours. This will greatly increase our ability to engage with customers with regard to water efficiency, whilst effectively monitoring the impacts of demand management, demographic behavioural change and technological progress to more water efficient products. This analysis will form a key element of our adaptive planning process, as we develop our 'Smart meter monitoring framework'.

6.22 Forecast Results

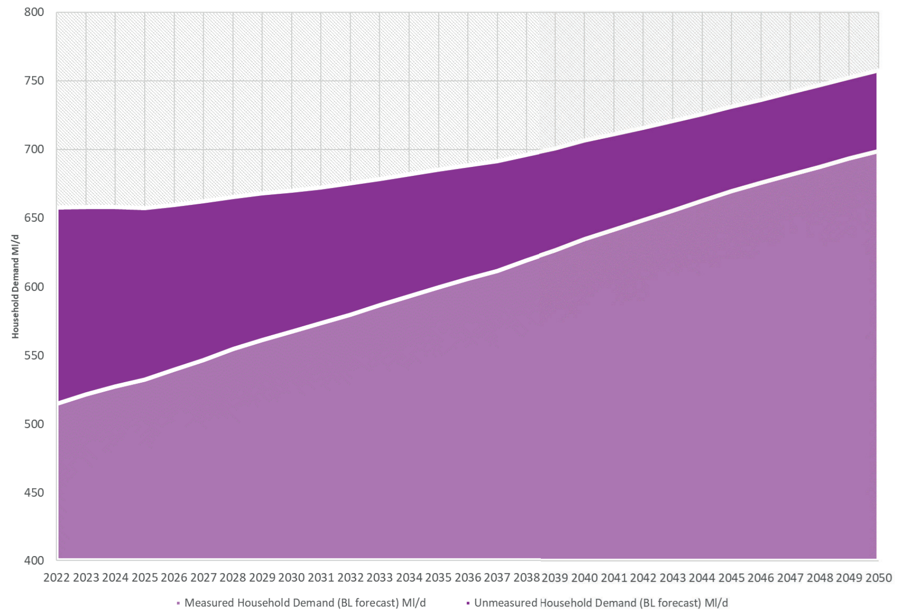
6.22.1 For our revised draft WRMP24 forecast, base-line household consumption was recorded to be 658Ml/d in 2021/22 (NYAA - 515Ml/d measured consumption; 143Ml/d unmeasured consumption).

6.22.2 For the beginning of the plan period, 2024/25, household consumption is expected to be 657Ml/d (NYAA - 532Ml/d measured consumption; 125Ml/d unmeasured consumption). This accounts for the rollout of our smart meter program (with revised smart meter savings), meter switching and AMP7 population growth.

6.22.3 For the base-line forecast we predict that household consumption will be 768Ml/d by 2049/50 (NYAA - 709Ml/d measured consumption; 59Ml/d unmeasured consumption). Note that this excludes government led interventions.

6.22.4 Base-line household consumption can be shown as below (Figure 32):

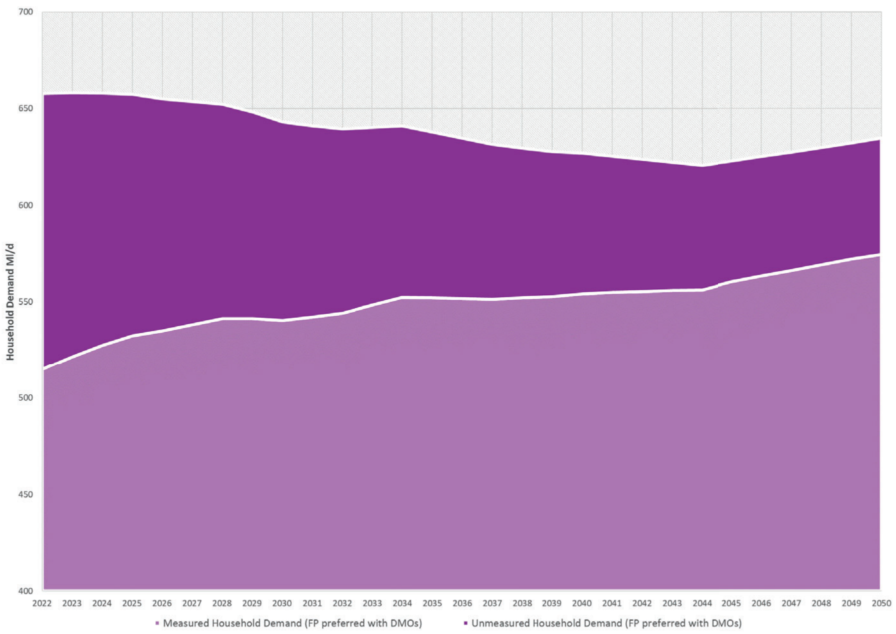
Figure 32 Base-line measured and unmeasured demand



6.22.5 For the preferred plan with demand management options we anticipate that household consumption will be 635Ml/d by 2049/50 (NYAA - 574Ml/d measured consumption; 60Ml/d unmeasured consumption).

6.22.6 Preferred plan household consumption (once demand management options have been implemented) can be shown as below (Figure 33):

Figure 33 Preferred Plan measured and unmeasured demand



7 Forecasting Non-Household Demand

In this section we will:

- Describe how we have calculated a demand forecast for non-household consumption.
- Describe the assumptions about customer/property types that we have considered as non-household and demonstrate that our decisions are aligned with part 17C of the Water Industry Act 1991 and guidance on non-household customers.
- Show how we have consulted with retailers of water to non-household customers.
- Show how we have segmented non-household demand into different economic groups.
- Show how we have assessed the likely new uptake of public water from non-household customers/ sectors that previously used private supplies.
- Show how we are accounting for water saving initiatives by both the wholesaler and retailers.

7.1 Overview

7.1.1 Non-household consumption accounts for a substantial proportion of overall demand in Anglian Water, representing 27% of our total demand (2022/23). Understanding and forecasting this segment of demand is crucial to the demand forecasting process. Additionally, developing water efficiency strategies for non-household sectors will form a key additional element for any demand reduction strategy, for water companies, Retailers and other major sectors that are heavily dependent on water.

7.1.2 As stated in the National Framework

7.1.3 *'Reducing the demand for water from non-household sectors will play an important part in reducing demand overall. It can go hand in hand with increasing the efficiency of processes and business and reducing energy consumption. Regional groups should work with other companies, non-household water retailers and new appointments and variations (NAVs) to align the approach to planning water resources, reducing demand, forecasting and monitoring non-household use of mains water.'*[13]

7.1.4 Additionally, the Water Resources Planning Guidance states:

7.1.5 *'You should clearly demonstrate how you will deliver non-household water efficiency. Your final plan should see an overall reduction in non-household consumption In England, you should set our how it contributes to Defra's water demand target and associated Environmental Improvement Plan, which seeks a 9% reduction of non-household water consumption by 2037/38, from a 2019/20 baseline, as part of the delivery of the distribution input per person reduction.'*[14]

7.1.6 We have, therefore, commissioned a suite of forecasts for annual average non-household demand across the Anglian Water region for the period up to 2049/50 reporting to all WRZs.

7.1.7 This suite of forecasts has been aligned with the population/property forecasts provided by Edge Analytics for both WRE/WRMP24 analysis. The analysis has characterized non-household customers by geographic area and industrial sector.

7.1.8 Separate regression models have been produced at WRZ level for each sector, and company averages have been obtained by aggregating the outputs from these models. The calibration of each model has been based upon the appropriate selection of explanatory variables, such as numbers in employment or the level of economic activity (GVA), which most appropriately account for

13 Environment Agency (March 2020), '*Meeting our future water needs: a national Framework for water resources*,' p. 37
14 Environment Agency (March 2023), '*Water Resources Planning Guidance*', p. 77

historical trends and variations in demand; the forecasts have been calibrated to the population/property variants produced for WRE/WRMP24.

7.1.9 The following data has been used to derive the non-household forecasts:

- An extract of our billing data for non-household properties covering the periods between 2011 and 2021.
- An extract of our billing data covering the periods between 2006 and 2010 for non-household properties not included in previous billing data.
- GIS boundaries at WRZ and Planning Zone level.
- The ‘billing’ history for non-household properties.
- The East of England Forecasting Model (Oxford Economics) which includes forecasts of Gross Value Added (GVA), Employment and Population.
- Public domain evidence for prospective new Anglian Water major customers.

7.1.10 Historical billing data, from 2006, has been analysed to identify discrepancies, missing data and validate genuine consumption trends.

7.1.11 During the pandemic period, we experienced significant changes in the magnitude and spatial distribution of demand in both the household and non-household sectors. We have, therefore, chosen to utilize the, post covid19 pandemic, 2021/22 water balance as our base-line for the revised draft WRMP24 forecast, whilst taking into account short and long term covid19 impacts.

7.1.12 The Covid19 pandemic definitely had an impact on non-household demand, during the lockdown periods when schools, retail and hospitality were effectively closed. At the peak we saw a decrease in non-household demand of approximately 10% for short periods, during the most severe lockdowns. However, the pandemic has also caused increases in some sectors, particularly due to 'stay-cationing' in our region, as travel was curtailed. Post pandemic we have seen non-household consumption levels return to pre-pandemic levels, with a potential small difference due to the continuation of homeworking patterns for sections of the workforce. Consequently, although we saw a decrease in demand in 2020/21 to 275.7Ml/d, we have now seen demand rebound to pre-pandemic levels of 296.5Ml/d for 2021/22. We continue to see increased volatility in non-household demand, which we potentially ascribe to supply chain changes and the 'cost of living' crisis, and are working to understand this.

7.1.13 Work has progressed with our Retail partners and business customers to develop water efficiency options. Selected water efficiency options have now been included in our revised draft WRMP24.

7.2 Industrial sector breakdowns

7.2.1 Each of the Water Resource Zones (WRZs) in the Anglian Water region has been modelled as an individual area, such that, each of the models aggregates industry sectors into seven Night Use groups, which have been aligned with the Standard Industrial Classification (SIC) codes.

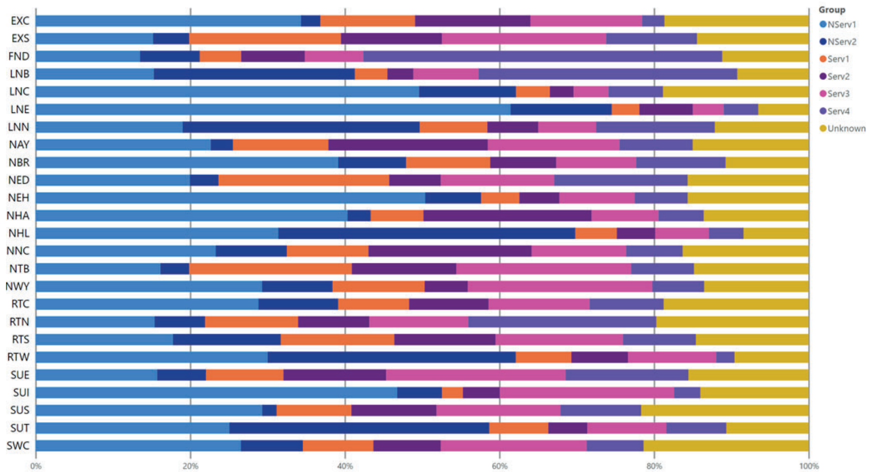
- Group 1 (Serv1): “Education” and “Health” which are public sectors and tend to be more related to household population
- Group 2 (Serv2): “Hotel”, “Holiday Camp”, “Restaurant”, “Sport and Leisure”, “Pubs and Clubs”, “Amusement Parks” and “Hairdressing” (mostly recreational activities), which are more private sector focused and tend to be related to household population
- Group 3 (Serv3): “Office”, “Media”, “Renting and Leasing”, “Domestic”, “Washing and Dry Cleaning”, and “Transport” (mostly office or domestic activities), which are industries more focused on providing professional services
- Group 4 (Serv4): “Retail” on its own, which is both public and private sector focused, and it has the largest proportion of demand across all industry sectors in AWS
- Group 5 (NServ1): “Arable Agriculture”, “Agricultural Support”, “Aquaculture”, “Pastural Agriculture”, “Construction”, “Materials Manufacturing”, “Materials Production”, “Product Manufacture”, “Textile Manufacture” and “Mining”

- Group 6 (NServ2): The remaining non-service sectors, namely “Food Processing”, “Beverages”, “Facilities”, “Utilities”, “Repair and Maintenance” and “Waste”
- Group 7 (Unknown): Consumption without a known sector.

7.2.2 It is noted that for the 'N - unknown sector’, the demand from these properties, without a known designation have been forecast for each of the resource zones. This sector is forecast to steadily decrease over the period to 2050.

7.2.3 Demand for each of these segments can be shown by WRZ, as below (Figure 34):

Figure 34 Non-HH Sectors by WRZ



7.2.4 Water resource zones show differing dominant sectors (by percentage), dependent upon their size, location and geography; Water resource zones such as Lincolnshire East (large) and Norfolk East Harling (Small) are dominated by ‘agriculture’ (NServ1), whilst WRZs such as Ruthamford North, show a much more mixed picture with all sectors equally represented, with Retail (Serv4) representing a large sector.

7.3 Unmeasured Non-household Demand

7.3.1 The estimated unmeasured component of non- household demand only represents approximately 0.5% of the total. In the absence of any evidence to the contrary, it is reasonable to assume that unmeasured non-household demand per property will remain constant. We, therefore, apply the current unmeasured non-household demand assumptions to the forecast unmeasured non-household property counts.

7.4 Non-household properties and population

7.4.1 Historical data indicates that there is no evidence of a causal link between the number of measured non-household properties and the total non-household demand. The number of properties has shown a relatively steady reduction over the historical period with demand also reducing. However, in the recent past we have seen a marked increase in non-household demand, despite little change in business property numbers.

7.4.2 Consequently, for non-household properties, we have applied a combined factor taking into account this historic decline, but also accounting for the overall property growth associated with the preferred projection, given that there would be an expectation that there would be growth in the non-household sector associated with population and employment growth.

7.4.3 For unmeasured customers, the historical data shows a steady downward trend as would be expected given that there will be no new unmeasured customers and that existing customers may become void properties, may be demolished or become metered. It has, consequently, been assumed that the average reduction in percentage terms will be 8.4% per year (in line with our analysis); giving a small residual number of unmeasured properties likely to remain at the end of the WRMP24 period. It should be noted that this property derivation does not directly impact modelled consumption, due to the indeterminacy of this causal link. We have, therefore, assumed that the split between measured and unmeasured consumption will remain static as a 99.5% to 0.5% split in the forecast.

7.4.4 Values for non-household and communal populations have been derived from official sources (ONS Census), and apportioned to Anglian Water geographies. These values have been aligned with Anglian Water 'official' reported totals and water-balance base line values. This non-household population includes estimates for residents in; Medical and care establishments; NHS Psychiatric hospitals; Local Authority Children's homes; Nursing Homes; Residential Care Homes; Defence establishments (including ships); Prison Service establishments; Probation/Bail hostels; Educational establishments (including Halls of residence); Hotels, Boarding Houses, Guest Houses and others.

7.5 Forecast assumptions

7.5.1 It is noted that non-household consumption is not linearly or directly linked to non-household population totals. Modelled inputs regarding population, therefore, represent the total area resource zone population based upon data at LAUA level, rather than the population of the non-household customer base (noting that the health and education industries serve the whole local population). The effect of new or demolished properties is already reflected by the rise or decline of demand, and hence is already assumed to be reflected in the forecast. No adjustments have been applied (e.g. related to Meter Under-Registration or Supply Pipe Leakage) to the forecast values given the close historical agreement with the total demand.

7.5.2 The forecast implicitly assumes that historical trends in factors, such as the impact of current water efficiency programs will continue.

7.5.3 Additional demand management initiatives have been evaluated and suitable adjustments to the final plan forecast have been included (See the 'Revised draft WRMP24 Demand management preferred plan technical supporting document' and Revised draft WRMP24 Demand management option appraisal technical supporting document).

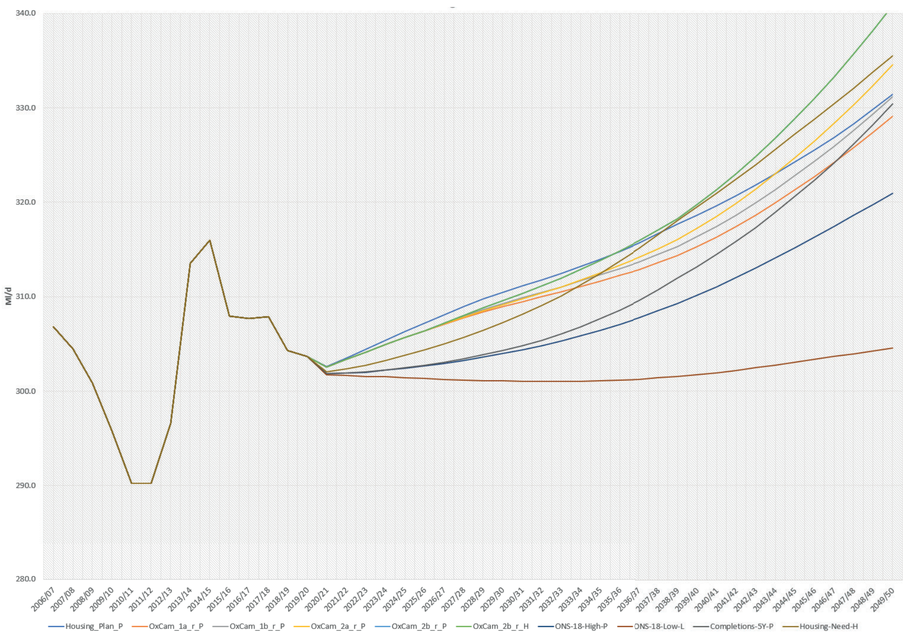
7.6 Forecast scenarios and uncertainty

7.6.1 As part of our non-household demand forecast process, we have generated a number of scenarios based upon the different population and property variants that have informed the WRE and WRMP24 sensitivity testing process (Figure 35).

7.6.2 For our lowest scenario we have used the ONS_18_Low_L projection which shows a sustained low level of population growth and results in a substantially lower forecast of consumption compared to the other population scenarios (This is the lowest demand projection). The 'Housing_Need_H' and 'OxCam_2b_r_H' scenarios result in substantially higher forecasts of consumption, particularly towards the end of the century (These are the highest demand projections). Alternate consumption forecasts based upon variant population scenarios are clustered around the middle of these two extremes.

7.6.3 Our revised draft WRMP24 non-household demand forecast, has been based upon a high Oxcam property and population variant, reflecting our current assessment of uncertainty regarding future growth.

Figure 35 Non-HH Consumption (raw-data) for alternate growth scenarios



7.6.4 Additionally, high, medium and low variants have been generated for the preferred growth scenario, based upon:

- Low, medium and high estimations of employment derived from the East of England Forecasting Model assumptions.
- Low, medium and high estimations of GVA derived from the East of England Forecasting Model assumptions.

7.6.5 The core scenario assumes a continuation of current trends involving, for example, pressures from the Environment Agency to reduce demand, metering and water efficiency programs and use of effective appliances to reduce water consumption.

7.6.6 Impacts of climate change have also been considered, however, no strong evidence of correlation between annual demand and climate change has been found, and so the variables associated with climate change have not been used in the forecast.

7.6.7 It is noted that, although in aggregate terms, these high/low scenarios produce higher and lower values, when disaggregated to Water Resource zones, this is not always the case, as the factors do not act in a linear fashion. Note that these scenarios have been used to inform the Target Headroom assessment.

7.6.8 The ten population scenarios give a wide range of consumption forecasts, and the range is further increased when adjustments are made to the forecasts of employment and GVA to account for low and high scenarios of economic growth. The extreme examples presented demonstrate that there is considerable uncertainty in the estimate of consumption at the end of the forecast horizon.

7.7 Non-Household water efficiency and Retail separation

7.7.1 Since Retail separation, we have been working constructively with Retailers:

- on operational matters,
- with respect to water demand and drought,
- providing an awareness of where we hold relevant information in our plans and
- with regard to the specific characteristics of our region.

7.7.2 Each Retailer has a dedicated 'Wholesale Account Manager' and water efficiency is now a standing item on the agenda, reflecting our keenness to engage in innovative ways of collaboration, to ensure the efficient use of water. In addition, we have maintained our shop window project in Newmarket, which includes Retailers in our water efficiency efforts in this particular area. Retailers have been provided with direct access to the project manager and in turn Retailers have been supportive of our engagement directly with their end user customers in this area. A number of Retailers have shown a considerable appetite to do more and go further.

7.7.3 In recognizing that the Retailer owns the relationship with the end-user non-household Customer and that they will, in most cases, have a greater understanding of water consumption for their customers, we have a scheme which seeks to work with Retailers in helping us manage demand and optimize our network.

7.7.4 As part of the revised draft WRMP24 demand management option development process, and in conjunction with our WRE partners, we have engaged with our regional Retailers and business customers, in order to gauge opinion on further water efficiency measures for the business sector.

7.7.5 This recent engagement (in association with WRE and 'Blue Marble') has been conducted:

- to understand the Retailer perspective regarding the promotion of water efficiency.
- to develop and refine propositions and understand and overcome barriers.
- to explore these propositions and how they might be implemented with retailers and non-household customers

7.7.6 We are, consequently, in accordance with the EA Water resource planning guidelines, actively engaged in developing water efficiency options for inclusion in our revised draft WRMP24. These include;

- measures to reduce customer supply pipe leaks, based around the provision of smart meter data and further potential incentives
- measures to reduce leakage from internal plumbing losses, based around the provision of smart meter data and further potential incentives (leaky loo find and fix)
- assistance and incentivization with regard to water visits and the retrofit of water efficient devices (these potentially funded by wholesalers)

7.7.7 We will also look into evaluating additional measures with our partners, including:

- water recycling / reuse (grey/green/blackwater reuse); provision of information/scheme design/consultancy support
- Incentives and rebates for water consumption reduction; potentially linked to other utilities (energy)

7.7.8 For the revised draft WRMP24 we have now assessed and quantified options for further development and trials, see table below (Table 14), whilst also considering how we might address barriers to their implementation (funding issues, access issues etc.).

7.7.9 Whilst developing these options we have also been mindful of the EA (Defra) target of an absolute 9% reduction in non-household demand by 2037/38 (from a 2019/20 base-line). The initial estimates of future demand and water efficiency savings indicate that this will be a very challenging target (given that we expect growth in non-HH consumption, aligned with population growth in the region).

7.7.10 Our preferred portfolio of options currently is anticipated to reduce non-household demand by approximately 9% by 2037/38 (and 15% by 2049/50), but only relative to the projected demand, once growth has been factored in.

7.7.11 More detail is provided regarding our non-household water efficiency portfolio in our "Revised draft WRMP24 Demand management preferred plan technical support document".

7.7.12 Currently, we have been made aware of a number of potential non-household customers looking to transition from private to public water supplies, and this has been factored into the non-household forecast for the relevant WRZs. Identifying the timing and scale of new non-household requirements for water, is still a problematic area, as requests for large volumes of water (>1Ml/d) can significantly impact the supply/demand balance.

7.7.13 We have noted that the incidence of 'New appointments and variations' (NAVs), where alternate companies are appointed to provide a water and/or sewerage service to new development customers, are increasing. A new appointment is made when a limited company is appointed by Ofwat to provide water and/or sewerage services for a specific geographic area. A new appointee has the same duties and responsibilities as the previous statutory water company. These companies install their own metering systems for their customers independent of our smart meter installation program, and as such might not achieve the savings we would expect. Despite the fact that these customers would not fall directly into our domain, we would still need to supply water as the regional wholesaler, which would impact our overall supply demand balance.

Table 14 Non-household water efficiency options

Type of visit	Size of customer (consumption)	Expected no. Properties impacted per year (based upon our customer base)	Expected saving (per property per day)
Delivery of smart meter targeted water saving efficiency packages, similar to household drop20 campaigns. This will be undertaken on a scaled basis (dependent on the size of water consumption).	Low Consumption	3000	86 litres per water efficiency package
Specialist water efficiency audits, with find and fix for consumers using approximately 25,000 litres per property per day.	Medium Consumption	79	2,127 litres per property
Specialist water efficiency audits with find and fix for larger consumers (approx. 500,000 litres per property per day).	High Consumption	10	43,775 litres per property
Retailer incentives for plumbing loss reduction A £100 incentive to retailers to reduce plumbing losses.	All users	3000	59 litres per property
Smart meter identified plumbing loss fix Non-household plumbing loss repairs for properties identified, through smart metering, to have continuous flow. These visits will be aligned with water efficiency visits.	All users	3000	240 litres per property
Smart meter identified customer supply pipe leakage (cspl) fix. Non-household repairs for properties identified, through smart metering, to have continuous flow. These visits will be aligned with water efficiency visits.	All users	3000	9 litres per property

7.7.14 Currently we have included all future property growth and related demand, as being served by Anglian Water, given the uncertainty around these appointments. However, we are closely monitoring the incidence of these NAV applications and are in discussion regarding how smart metering and water efficiency benefits might be provided to these customers. (Note that for business customers we are installing smart meters despite these not being our customers, being served by Water Retailers). We are liaising with these NAV companies in order to align our water efficiency programs, and ensure that customers in these areas also achieve the levels of water efficiency that we expect to achieve as part of our revised draft WRMP24 (110 l/h/d by 2049/50).

7.7.15 As part of our consultation, we have also been liaising with companies who will be involved with the South Humber Bank Hydrogen production and carbon capture development. These industries have provided Anglian Water with their current assessments of water requirements, indicating that they envisage an initial estimate of 60Ml/d will be needed in the near term (next 10 years). These requirements will, in the main, be for non-potable water, which does not appear in our potable water demand forecast, as described above. However, we have included a 60Ml/d export for non-potable demand, glide-pathed to 2031/32 (as well as an assessed volume of approximately 1Ml/d in the Central Lincolnshire WRZ for potable water) in the revised draft WRMP24.

7.8 Forecast outcomes

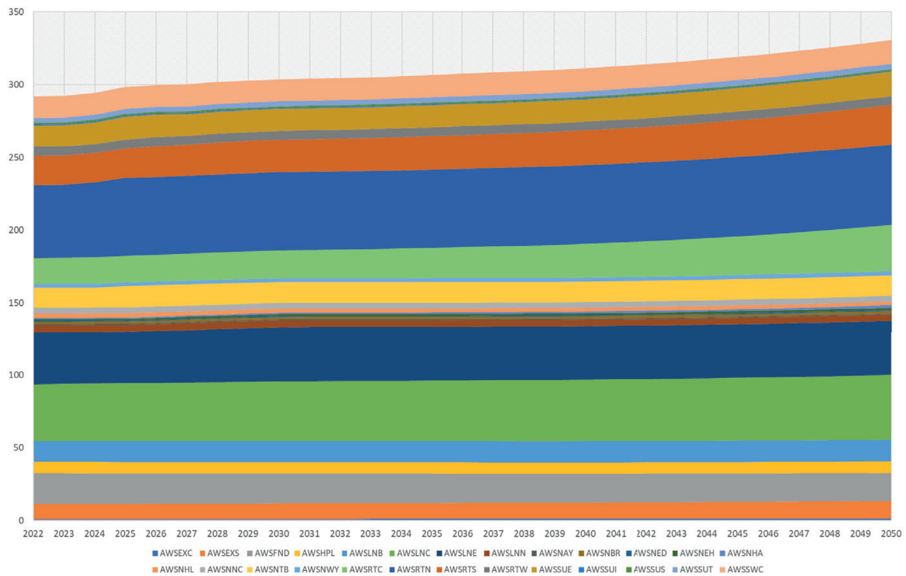
7.8.1 For the base-year (2021/22) we have assessed non-household demand to be 297Ml/d. We expect the base-line non-household consumption forecast to increase over the planning period in line with population growth. Given current uncertainties around business demand and the recent increases we have experienced, we have taken a more risk averse view to future growth and included a higher non-household growth scenario aligned with the OxCam2b_r_P scenario. Note this is for non-household growth only, with our preferred household forecast being based upon the OxCam1b_r_P variant.

7.8.2 Currently, 99.5% of the non-household customers are metered and billed on measured volumes.

7.8.3 Work is currently progressing, with our Retail partners and business customers to develop water efficiency options for inclusion in our Final WRMP24 plan. We have now made an initial assessment of the savings that we might expect for the revised draft WRMP24 submission.

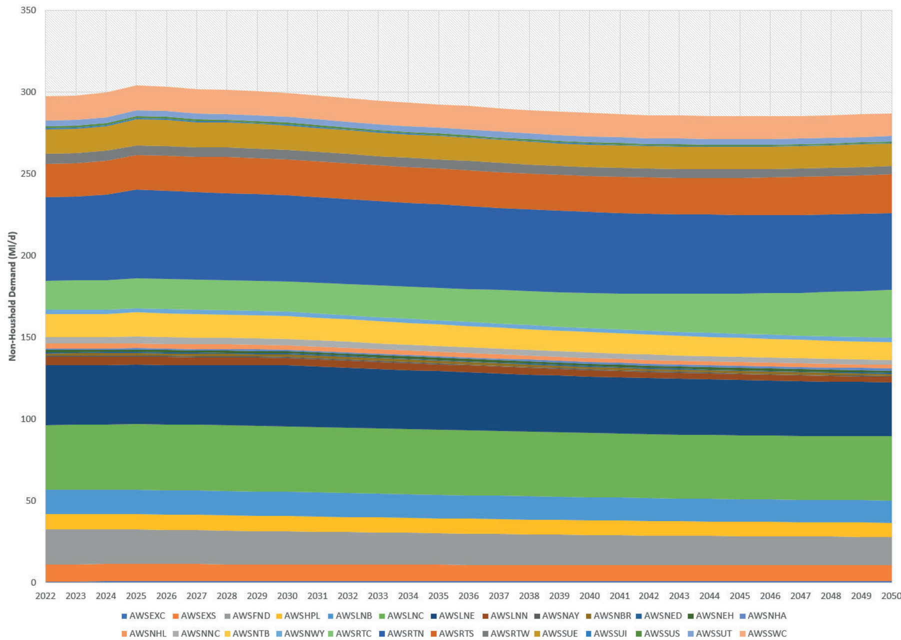
7.8.4 Base-line, forecast non-household consumption is expected to rise from approximately 304Ml/d in 2024/25 to 337Ml/d by 2049/50 and can be visualized split by water resource zone, as seen below (Figure 36).

Figure 36 Base-line Non-household demand forecast



7.8.5 For our preferred plan which includes demand management, non-household demand is expected to reduce from 304Ml/d in 2024/25 to 287Ml/d in 2049/50 for our preferred plan (a 50Ml/d reduction from the base-line projection). (Figure 37).

Figure 37 Preferred plan Non-Household demand forecast

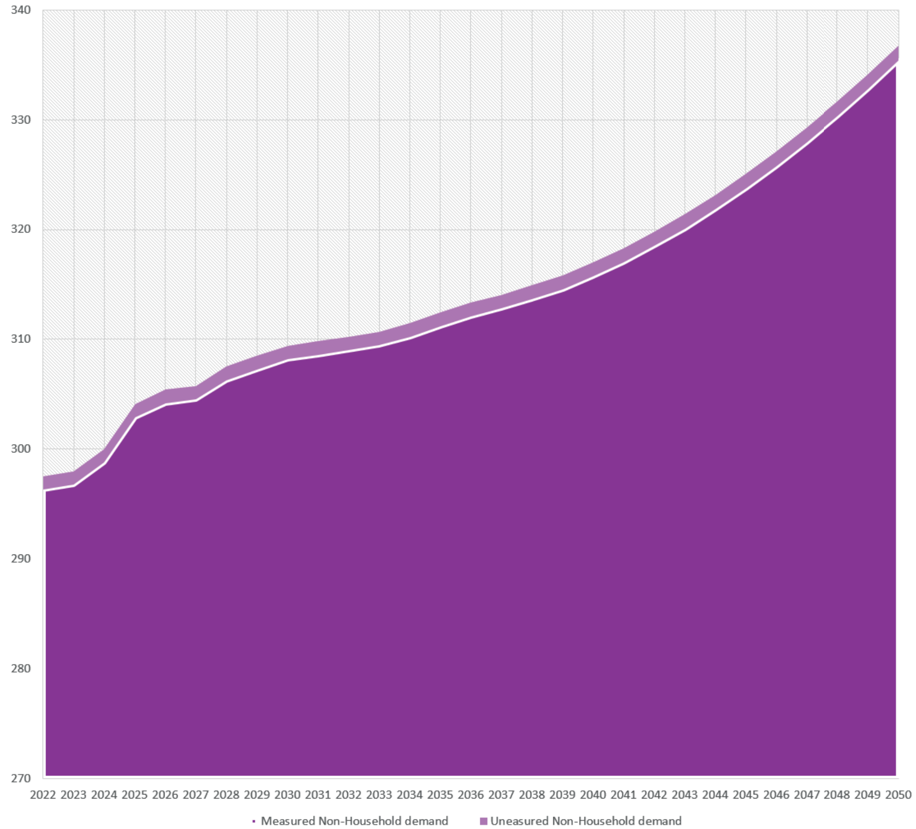


7.8.6 Overall, the updated base-line forecast for non-household demand shows an increase in demand over the planning period of approximately 33Ml/d (an 11% increase). However, with demand management options taken into account non-household demand is anticipated to decrease by 17Ml/d (a 6% decrease from the baseline).

7.8.7 This has been aligned with our high population forecast, OxCam_2b_r_P (for non-household growth only) as a risk averse option. This forecast is consistent with increasing demands from industries that serve a growing population, balanced by trends for reduced consumption in non-service industries. Over time the non-service demand decreases to the point where the reductions no longer cancel out the service sector increases, and overall consumption rises.

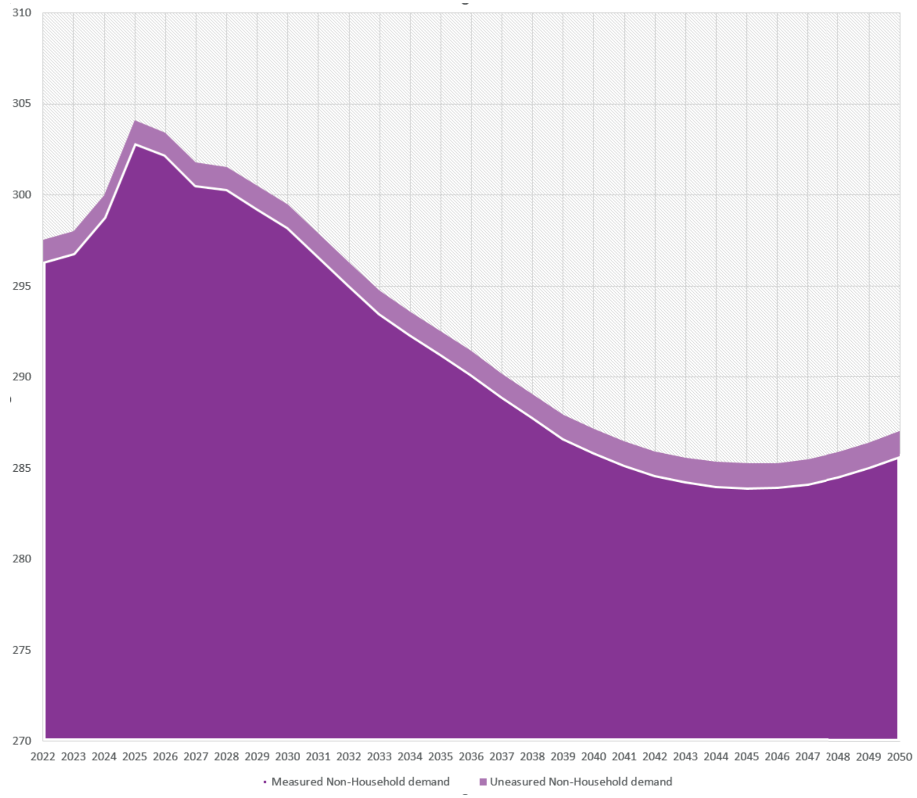
7.8.8 For the base-line forecast measured and unmeasured non-household demand can be shown as below (Figure 38):

Figure 38 Base-line non-household forecast, measured, unmeasured demand



7.8.9 For our preferred plan, with water efficiency measures, measured and unmeasured demand can be shown as below (Figure 39):

Figure 39 Preferred plan non-household forecast, measured, unmeasured demand



7.8.10 Note that historically (over the recent past), we have seen little overall change in non-household demand (reflecting little non-household consumption growth and limited ambitions with respect to water efficiency). However, we expect to see increased uncertainty in the future, due to current evidence of non-household demand growth (potentially due to Brexit, licence cap changes, new energy industry requirements and supply chain issues), but also with regard to the effectiveness of potential Non-household water efficiency measures.

7.8.11 Note that in addition to the trend based growth, we have included in the revised draft WRMP24 forecast, we have also included a number of specific sites which have been recently identified. Separately, we have also included an allowance for demand growth related to hydrogen production and carbon capture based upon values provided by relevant stakeholders during our WRMP24 consultation. This volume of approximately 60Ml/d, which will potentially be required by the early 2030s, is for non-potable water and consequently does not appear in our potable non-household demand forecast.

8 Leakage

In this section we will:

- describe how we have determined base-line and forecast leakage.
- describe how we have used UKWIR Consistency reporting performance measures (2017) to forecast levels of leakage
- describe how our approach to calculating base year leakage has affected our ability to meet government aspirations to reduce leakage over the planning period.
- account for any actions or policies that may reduce leakage (e.g. mains improvements) in the leakage forecast.
- account for customers' views on leakage reduction and their resulting willingness to participate in demand management activities.
- include all feasible options for further leakage control, and any other options we are actively investigating with support from our customers.

8.1 Overview

8.1.1 In 2007 Ofwat published its final report on 'Alternative approaches to leakage target setting' and following subsequent consultations this guidance was issued for PR09, including contemporary 'best practice'. Since this time Ofwat has continued to encourage additional studies, in co-operation with water companies and the industry research group UKWIR, and has produced reports directed towards more consistency in leakage management accounting practices. In this regard, our Optimized Networks Strategy (ONS) has made a significant contribution, as described in the 2015 EU reference document. Most recently we and other water companies have been working together, co-ordinated by WaterUK and supported by Ofwat, to develop more consistent leakage reporting methodologies.

8.1.2 Leakage is now assessed using the methodology set out by Ofwat in the reporting guidelines published during the PR19 process. Consequently, the calculated leakage level has now increased from that reported in WRMP19 reflecting changes made to the leakage assessment, conforming to the latest regulatory guidance (averaging of whole months' data rather than weekday data) and new rules on adjusting for metering failures. Increased levels of confidence in night-flow records have followed from the progressive increase in the size of the domestic consumption monitor, supported by data from smart meter trials (Newmarket and Norwich - 3 year's data) and the more general roll-out of smart metering from April 2020 (as of 2022/23, we now have in excess of 500K smart meters installed).

8.1.3 For the revised draft WRMP24 base-year of the forecast (2021/22) we have calculated leakage to be 173.44 Ml/d in-year (with a three year value of 182.48 Ml/d). Note that this value is a record low for Anglian Water. Subsequently, we have been focused on reducing leakage in order to achieve our AMP7 target of 161 Ml/d by 2024/25 (the start of the WRMP 2024 planning period).

8.1.4 Our AMP7 leakage strategy continues some of the themes that we started in AMP6, such as network optimization and intensive leakage investigation. It is supplemented with new SMART strategies such as permanent noise logging, Smart metering (cspl and plumbing loss detection) and widespread transient pressure monitoring.

8.1.5 The company has re-structured its procurement of maintenance activities since AMP6 and now has a joint operating company with contractors (Integrated Maintenance and Repair Alliance) which is incentivized on outputs supporting improved KPI and ODI rewards. Leakage management has also been restructured to give operational teams more ownership of leakage management targets, with a larger operational team, which generates reports, develops strategies and manages budgets to deliver the ODI incentives.

8.1.6 AMP7 outcomes from our strategies can be described for the year 2022/23 (our latest reported year):

8.1.7 **Proactive Leakage Resource:**

- In 2022-2023 we had 227.8 FTE dedicated proactive leakage operational roles. (170.8 FTE are field based detection roles).

- The average leakage technician productivity for 2022-2023 was 1.02 leaks per technician per day (an increase of 76% when compared to the 2020 baseline)
- In 2022-2023, 14,134 leaks were located through proactive detection activities.
- In addition to proactive detection activities, Leakage Operations supported c3,500 customer reported visible leaks during the summer drought period and supported incident response through network operations and bottled water deployment centres during the summer demand (drought) and winter freeze-thaw events. (PA120 Little Downham & Haddenham, PA124 Ely & Mildenhall, PA126 Grafham).

8.1.8 Leakage capital delivery programmes:

8.1.9 Leakage SENSORS

- Our fixed network hydrophone monitoring system now incorporates 307 DMA's (an increase from 285 DMAs in 2021-2022)
- The total number of leaks found from SENSOR detection in 2022/23 was 4,556. This brings the total number of leaks detected using this technology to 16,469 since 2020.
- In 2022-2023 the SENSOR programme delivered 1.07ML/d of leakage benefit.

8.1.10 Intensive Investigation

- Our intensive investigation process continues to develop well and now incorporates a comprehensive programme of virtual step testing using flexible metering assets, camera insertion detection and mains condition assessment, and the use of drones with thermographic imagery. In 2022-2023 we established a contract with a company to image and analyse 5,000km of targeted large rural distribution and trunk mains each year. This technology uses Synthetic Aperture Radar with patented analysis to detect underground leaks. To compliment the satellite detection, we now use leakage detection dogs as part of our investigation process.
- In 2022-2023 the Intensive Investigation Process delivered 3.54ML/d of leakage benefit.

Teams have continued their approach to auditing historically high leakage zones whilst also being focused on gaining a better understanding of inoperable zones.

8.1.11 Customer supply pipe leakage / internal private leakage

- We continue to work closely with our customers to ensure they are supported through the process of repairing private leaks in a timely manner. Excluding the SMART metering programme, the customer leakage policy support team resolved 10,270 cases in 2022/23 with only 1,036 Waste of Water notices requiring to be issued.
- We have installed 233,365 smart meters in the year 2022/23. This is in addition to the 164,400 & 145,099 smart meters installed in the previous years (2020/21 & 2021/22 respectively), giving a current total of 542,864 smart meters installed overall this AMP. As discussed previously, we have reviewed the rollout of smart meters for AMP7 and have re-targeted the installation program, in order to address near term supply/demand (SDBI) issues.
- The total number of interventions for 2022/23 is 101,685, with the total number of fixes from these interventions being 83,926. The peak flow volume of these rectified leaks is 30.2Ml/d.
- 12,976 of these leaks have been rectified by customers with no additional intervention. The peak flow volume of these rectified leaks is 5.98 Ml/d.
- For 2022/23 smart meters have helped to identify 107,847 home leaks, combined with the previous year to identify 182,266 in total this AMP.

8.1.12 We continue our process of working with customers to ensure that they repair leaks on their supply pipe or internally to the property in a timely manner.

8.1.13 Network/pump optimisation schemes

- There have been 162 optimisation schemes implemented this year, delivering 4.56 Ml/d leakage reduction. This was split between:
- 43 schemes to optimise existing pressure management assets, delivering 0.4 Ml/d leakage reduction.

- 112 schemes introducing first time pressure management, delivering 2.64 Ml/d leakage reduction.
- pump optimisation schemes delivering 0.44 Ml/d leakage reduction
- system optimisation schemes delivering 1.08 Ml/d leakage reduction

We are committed to our downward glide path towards meeting our ambitious goals for leakage reduction and our specific targets for the end of this AMP of reducing leakage by 15%.

8.2 Base-line leakage forecast

8.2.1 Leakage of water from the water distribution network is a significant component of demand, currently accounting for approximately 15% of demand (2022/23). The demand forecast estimates leakage over the planning period. This includes forecasts for;

- Distribution losses
- Measured household customer supply pipe leakage (cspl)
- Unmeasured household customer supply pipe leakage (metered) (cspl)
- Unmeasured household customer supply pipe leakage (unmetered) (cspl)
- Measured non-household customer supply pipe leakage (metered) (cspl)
- Unmeasured non-household customer supply pipe leakage (metered) (cspl)
- Household Void customer supply pipe leakage (cspl)

8.2.2 Base year leakage values for all these elements, have been derived from the actual leakage as reported in the water-balance analysis (2021/22).

8.2.3 Existing policies and the impacts of any planned non-supply demand balance actions that may reduce leakage have been included, in the leakage forecast.

8.2.4 The revised draft WRMP24 base-line leakage value for 2021/22 has been derived as 173.23Ml/d. This is the lowest value for leakage ever recorded by Anglian Water. This value has been based upon the post-2017 methodology (the UKWIR 'Consistency of reporting performance measures' (2017)). The revised consistent base year leakage methodology has reallocated water between leakage and demand.

8.2.5 In order to meet the government aspirations, of reducing leakage by 15% by the end of AMP 7 (to 161Ml/d) and potentially by 50% by 2050, we have reviewed all feasible demand management options for the WRMP24 planning period. We have also assessed leakage reduction in the context of our current 'frontier' leakage position in the industry, potential cost and bill impacts.

8.2.6 We anticipate our AMP7 out-turn to be to 164.2Ml/d by the end of AMP7 in 2024/25. Taking 2017/18, as a base-year, we are now targeting a reduction of 14.0% by 2024/25.

8.2.7 Considering the wider context and consultation responses, for our revised draft WRMP24 we intend to reduce overall leakage to 118.49Ml/d (significantly below our initial draft WRMP24 plan of 145.7 Ml/d) by the end of the WRMP24 planning period (2049/50). This would be a reduction of 45.71Ml/d from our 2024/25 value of 164.2Ml/d.

8.2.8 This would represent a reduction of 72.51Ml/d or a 38% reduction from our 2017/18 base-line of 191.3Ml/d.

8.2.9 This revised leakage reduction program represents a very significant expansion from our Draft WRMP24 (originally a 23.4% reduction), having taken into account the strength of response regarding the original position, and achieves the maximum leakage reduction that we believe is feasible with current technology.

8.2.10 However, this augmented plan does come at a very significant cost in the longer term (>£4 billion). We have, therefore, sequenced the plan such that the vast majority of the cost should impact AMP9 and beyond (post 2030). As we review the plan for WRMP29 we will investigate how technological improvement can mitigate these costs.

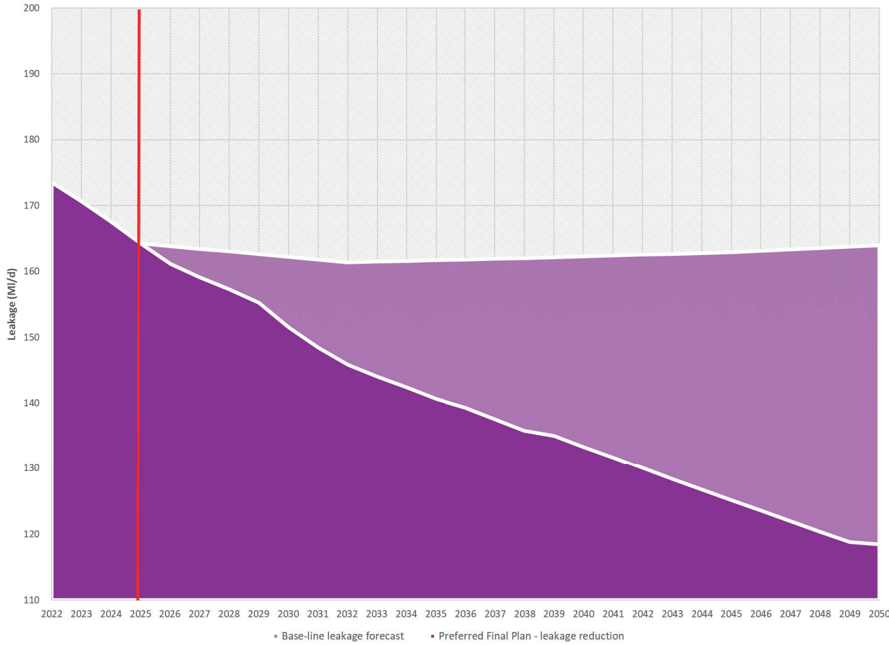
8.2.11 This strategy along with all feasible leakage reduction options is discussed in more detail in our 'Revised draft WRMP24 Demand management preferred plan technical support document' and the 'Revised draft WRMP24 Demand management options appraisal technical supporting document'.

8.3 Base year and forecast outputs

- Total leakage for the forecast base-year (2021/22) was 173.49Ml/d
- Total leakage predicted for the AMP7 out-turn (start year for the WRMP24 plan period (2025/26) is 163.8Ml/d.
- For the revised draft WRMP24 planning period 2024/25-2049/50 the base-line leakage level has been derived to reflect changing levels of customer supply pipe leakage due to the increase in properties caused by growth. Base-line leakage, consequently, remains relatively stable despite metering changes ('visual read' to AMI smart) at 164.0Ml/d (due to an increase of 528K properties).
- Our preferred plan leakage projection for the revised draft WRMP24 planning period (2025-2050) forecasts leakage to be 118.49Ml/d by 2049/50. This represents a 38% reduction from the National Framework base-year value of 191.3Ml/d for 2017/18 (and includes the 14% reduction projected for AMP7).
- Approximately 11.5% (2021/22) of the water we put into supply is lost through leakage from our distribution system (133.6Ml/d - 2021/22 of DI 1156.97Ml/d).
- A further 3.4% of the water we put into supply is attributed to customers supply pipe leakage (40.17Ml/d - 2021/22).
- AWS have made significant efforts to reduce leakage and are now significantly below the previously derived sustainable economic level of leakage (SELL) - 211Ml/d.
- Smart meters are now also contributing to leakage reduction and we expect this to be enhanced over the WRMP24 planning period, as continuous flows will be identified much more rapidly and, consequently, repaired (3 days continuous night flow for identification and notification). The smart meter program for 2024/25 to 2049/50 is expected to save 7.7Ml/d of cspl (over and above that attributed to the AMP7 smart meter roll-out, which would give a 13.2Ml/d saving by 2049/50 from 2019/20).

8.3.1 The base-line leakage and preferred plan leakage projections for the revised draft WRMP24 can be shown as below (Figure 40):

Figure 40 Leakage for the base-line and preferred plan scenarios



9 Metering

In this section we will:

- Describe how we have dealt with metering policy in the demand forecast.
- Show how we have reported household metering figures in the water resources planning tables.
- Show how we have assessed the future smart meter, opting and switching programs.
- Show how we have considered the costs and benefits of compulsory metering, given that Anglian Water is designated as an area of serious water stress.
- Show how we have assessed tariffs which might be appropriate for Anglian Water as part of our options appraisal.

9.1 Overview

9.1.1 Base-line figures for measured (metered) and unmeasured (metered and un-metered) customers have been derived from our water-balance data and the metering team.

9.1.2 The metering team has produced forecasts for our Water resource zones (and PZs) for meter switcher/optant segmentation (switchers, selective, optant on 'move in'), as customers change from being unmeasured to being measured over the WRMP24 planning period.

9.1.3 Additionally, the metering team have produced revised trajectories for the AMP7 (2020-25) smart meter program along with further potential smart meter roll-out programs for AMP8 and beyond (the WRMP24 planning period). This revised assessment also includes the 'Accelerated Infrastructure Delivery' (AID) program, bringing forward the installation of 60K meters into AMP7. As part of the WRMP24 assessment we have reviewed both a 10 year and 15 year smart meter program, with the WRMP24 preferred plan being selected as a 10 year rollout between 2020 and 2030 (2AMP).

9.1.4 The Metering Team in co-ordination with the Leakage Team (water-balance) have provided base-line figures and forecast values for:

- **The Smart Meter roll-out program: number of meters per year**
  - revised assumptions have been derived for the impact of smart meters on behaviour, plumbing loss reduction and customer supply pipe leakage reduction (cspl) based upon updated smart meter data from the general rollout (>150K meters installed with continuous data from April 2021) and the long term trial data from Newmarket and Norwich (>4 years). These savings have been applied to PCC (and PHC leakage) as appropriate at PZ (WRZ) level.
- **The Meter optant program: number of meters per year**
  - note PCC has been assumed to be equal to the unmeasured value pre-switch and equal to the unmeasured value minus 15% post switch;
  - occupancy has been assumed to be equal to the average of unmeasured and the overall ONS WRZ average value.
- **The Selective metering program: number of meters per year**
  - note PCC has been assumed to be equal to the unmeasured value pre-switch and equal to the unmeasured value minus 15% post switch;
  - occupancy has been assumed to be equal to the average of unmeasured and ONS WRZ values
- **The number of 'move in optants' per year**
  - note PCC has been assumed to be equal to the unmeasured value pre-switch and equal to the unmeasured value minus 15% post switch;
  - occupancy has been assumed to be equal to the average of unmeasured and ONS WRZ values.
- New Properties (Population): the number of additional meters has been derived from the Household Property/Population

forecast (based upon Local Authority planning and strategic growth information (Oxcam1b_r_P)).

- **Meter under-registration**
  - Meter under registration is included in the forecast base-year values and forecast.

9.1.5 Anglian Water already has one of the highest meter (and measured customer) penetration rates in the industry and expects to achieve full theoretical market penetration (94.8%) during the WRMP24 planning period.

9.1.6 Thus the measured population is forecast to increase from 4.022M (2021/22) to 5.558M (2049/50) and unmeasured population is forecast to decrease from 0.816M (2021/22) to 0.341M (2049/50) over the planning period, as the population grows and customers switch.

9.2 The smart meter rollout program

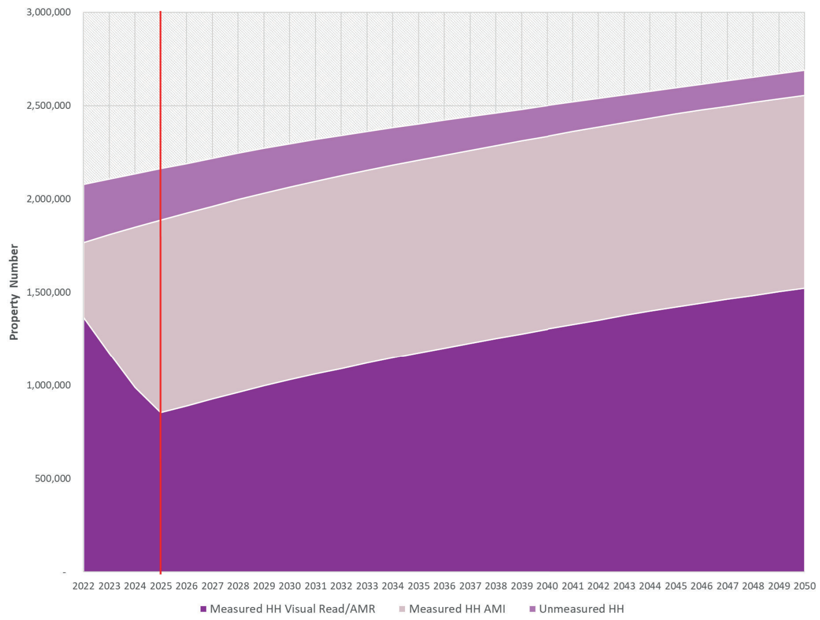
9.2.1 We are currently in the process of installing >1M smart meters across the Anglian Water region, up to 2025, in accordance with our WRMP19 demand management strategy. These smart meters are instrumental in facilitating a better understanding of household consumption and allowing us to efficiently communicate with our customers about their behaviour. Additionally, smart meters will be key to reducing customer leakage (via internal plumbing losses and customer supply pipe leaks), by early identification and remediation.

9.2.2 As part of our analysis, we have considered alternate smart meter rollout scenarios (beyond 2024/25) including 10 year, 12 year and 15 year installation programs (from 2019/20). These programs are based upon our chosen technology, the AMI (Automatic Meter Infrastructure) Fixed Network solution which facilitates hourly meter readings. All options include AMP7/8 PMX (Proactive meter exchange) and AMI upgrade of 'visual read' meters.

9.2.3 Additionally, as part of our preferred plan, we have also accounted for the 'Accelerated Infrastructure Delivery' (AID) program, which will add an additional number of smart meters to our AMP7 installation (60K). We estimate that this accelerated installation will save an additional 0.9Ml/d a day (for these 60K properties; equivalent to 0.3Ml/d for behaviour change, 0.4Mld for plumbing loss reduction and 0.2Ml/d for cspl). These savings have been included in our base-line forecast and are aligned with our revised assessments for smart meter savings implying an overall difference of >0.1l/p/d in PCC by 2024/25.

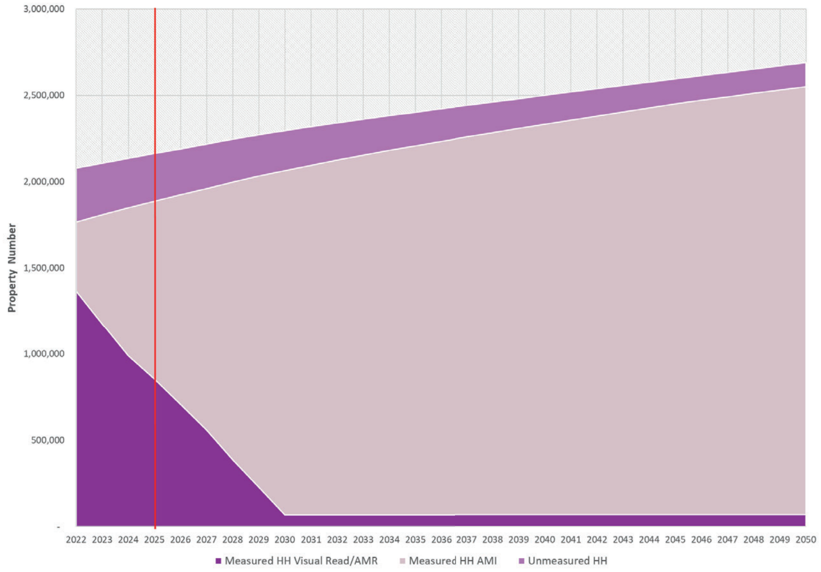
9.2.4 Our base-line plan would see smart meters being installed in line with WRMP19, with no more smart meters installed beyond that point. However, we have included the benefits of the continuing operation of the AMP7 smart meters, for the duration of the WRMP24 planning period (producing associated expected savings). This base-line meter installation program can be shown as shown (Figure 41).

Figure 41 Base-line meter installation trajectories



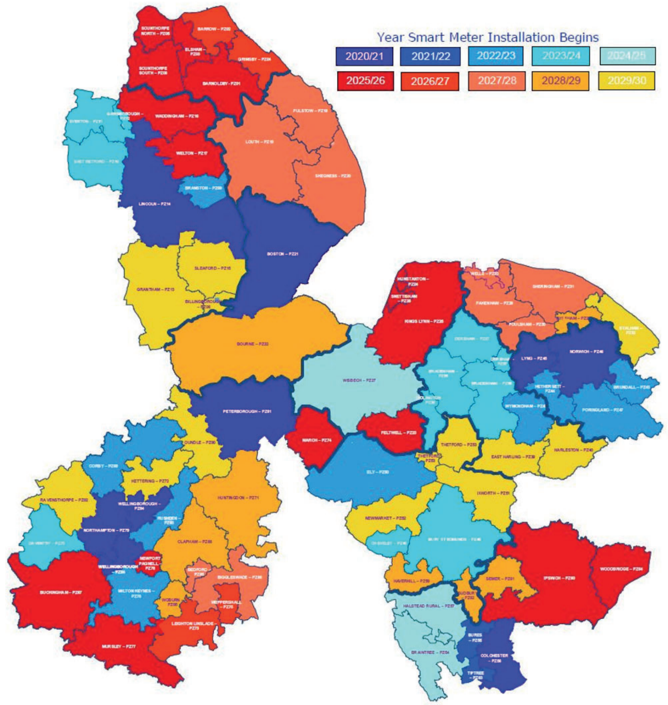
9.2.5 Our preferred plan is for full smart meter installation within 10 years, by 2029/30, achieving a household meter penetration of 94.8% by 2049/50 for the WRMP24 planning period, as shown (Figure 42).

Figure 42 Preferred Plan meter installation trajectory



9.2.6 Consideration has been given to the rollout delivery program and Supply Demand Balance (SDBI) impact, whilst effectively managing future technological change. We have, therefore chosen to install smart meters area by area (PZs) so that each area will be uniform, with respect to the type of smart meter installed (as technology advances, year by year). Planning Zones (PZs) have been sequenced, such that, areas at greater supply/demand balance risk are targeted first (Figure 43). We have also modelled scenarios with a version of universal and compulsory metering policy, leading to a household meter penetration of 95.4% by 2050.

Figure 43 Smart meter installation program - 10 year - 2AMP



9.2.7 As our metering policy progresses we expect to reach a measured/metered penetration of 94.8% by 2049/50, see table below (Table 15).

Table 15 Percent of 'billed measured' properties for the preferred plan

	2030	2035	2040	2045	2050
Measured properties	90.0%	91.9%	93.3%	94.4%	94.8%

9.2.8 Considerations regarding compulsory metering and tariffs, are dealt with in the 'Revised draft Demand management option appraisal technical support document'.

9.3 Smart metering savings: behaviour and leakage (cspl and plumbing loss)

9.3.1 As part of the revised draft WRMP24, we have re-evaluated potential savings from smart meters based upon:

- data from the full rollout of smart meters across the Anglian Water region (a cohort of approximately 150K smart metered properties with more than a full year of continuous data has been analysed, from the current installed base of >500K smart meters (2022/23)).
- along with the Newmarket and Norwich trial data (with a duration of more than 4 years) originally used for the draft WRMP24 plan.

9.3.2 Smart meters highlight customer consumption in a new dynamic fashion and enable the identification of continuous flows (after this is detected for 3 consecutive days). This data has been used in order to determine the current and future 'normal' for cspl (leakage impact), 'plumbing loss' (PCC impact), and behavioural change savings. Options have been considered which should lower the average leak duration below the current run-time, and, therefore, increase savings, beyond what can be achieved with traditional metering.

9.3.3 Current evaluation of continuous flow data has indicated that the Newmarket/Norwich trial area is not representative of the entire Anglian Water region. It does however indicate that there is still a similar volume of continuous flow to be rectified.

9.3.4 We have, therefore, concluded that current continuous flow savings attributable to smart metering should be limited to 40% of those originally estimated for the draft WRMP24 (for 2021/22) and that this should then increase, as systems become embedded (and as an indication of our ambition) on a glidepath to a value of 90% of the original estimation by 2031/32 (and beyond).

9.3.5 This revised analysis indicates that we may potentially expect continuous flow savings for cspl and plumbing loss as below (Table 16).

Table 16 Smart meter continuous flow reduction glide-path

10 year profile - 90% outcome	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
cspl saving profile (l/prop/d)	2.68	3.01	3.35	3.69	4.02	4.34	4.69	5.03	5.36	5.70	6.03
plumbing loss profile (l/prop/d)	4.84	5.45	6.05	6.66	7.26	7.87	8.47	9.08	9.68	10.23	10.89
total saving (ex. Behaviour) (l/prop/d)	**7.52**	**8.46**	**9.40**	**10.34**	**11.28**	**12.22**	**13.16**	**14.10**	**15.04**	**15.98**	**16.92**

9.3.6 Note that we still expect significant reductions in continuous flow (both for plumbing losses which impact PCC and customer supply pipe leakage (cspl) which impacts our leakage total) from the 7.5 l/prop/day, which we are currently seeing, to 16.9 l/prop/d by 2031/32.

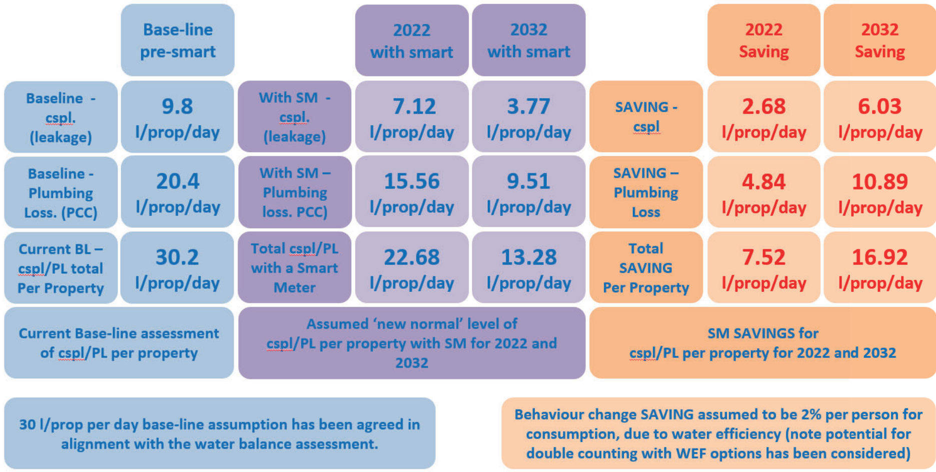
9.3.7 We will continue to analyse data to ascertain the potential final 'new normal' for household leakage/continuous flow and to realise the full smart meter benefit.

For our revised draft WRMP24 we have continued to assume a 2% impact on customer behaviour (per capita consumption). We, therefore expect to realise:

- a 2% impact on customer behaviour (per capita consumption).
- an average reduction of 10.89 l/prop/day, due to the timely identification of plumbing loss leaks and their repair by the customer, by 2031/32. This is an approximate 3% reduction in per capita consumption.
- an average reduction of 6.03 l/prop/day, due to the timely identification of customer supply pipe leaks and their repair by the customer, by 2031/32. This would be equivalent to a 2% reduction in per capita consumption.

9.3.8 This can be visualised as below (Figure 44).

Figure 44 Revised SM continuous flow saving assessment for final WRMP24



9.3.9 Note that these savings from our smart meter program are key to achieving our target of 110 l/h/d by 2050.

9.4 Base year and forecast outcomes

9.4.1 With the completion of our smart meter rollout by 2049/50, we expect additional savings from smart meters by 2029/30 to be 18.1Ml/d and by 2049/50 to be 31.9Ml/d.

9.4.2 Smart meter savings per AMP can be shown for behavioural change, cspl reduction and plumbing loss savings as per (Table 17) below.

Table 17 Smart meter savings (enhancement only) 2025 to 2050

	2030	2035	2040	2045	2050
Metering savings (behaviour Ml/d)	5.3	5.9	6.5	7.1	7.7
CSPL repair savings (Ml/d)	4.0	5.8	6.5	7.1	7.7
Plumbing Loss repair savings (Ml/d)	8.8	12.6	14.1	15.4	16.6
Total (Ml/d)	18.1	24.3	27.0	29.7	31.9

9.4.3 Note that these savings exclude those attributable to the 2019/20 to 2024/25 smart meter rollout (which are included in the base-line forecast) (Figure 45).

9.4.4 With the implementation of our smart metering program (and other associated water efficiency measures) we expect Per Capita Consumption (PCC) to decrease to a value of 109.74 l/h/d by 2049/50, for our DYAA forecast. The NYAA PCC value will be 107.59 l/h/d in line with the National Framework target of 110 l/h/d. This additional decrease in PCC, will be driven by our full smart meter rollout by 2029/30 and enhanced water efficiency options (linked with the opportunities arising from smart meters with respect to our water efficiency communications strategy). Note that achieving the 110 l/h/d target will also rely on the realization of government led interventions ('white good' / water utility labelling and mandatory standards), which will have a significant impact on PCC.

Figure 45 Smart meter savings for each AMP out-turn

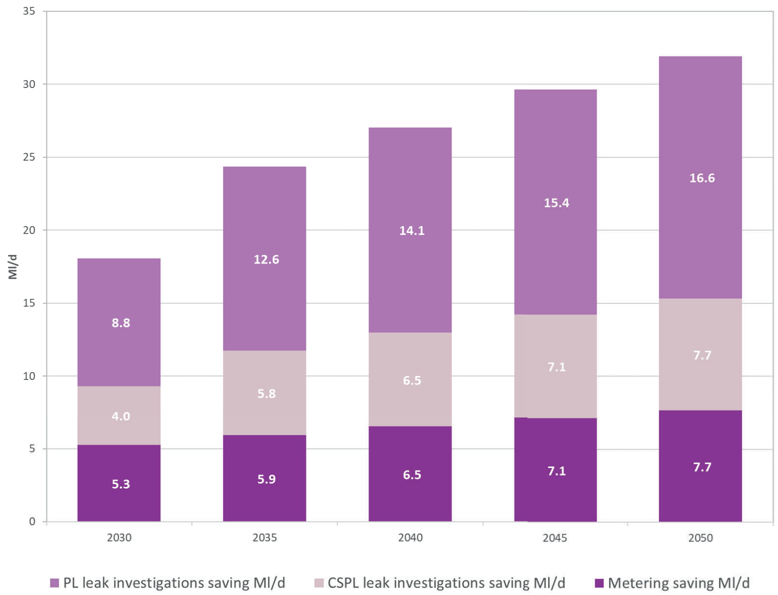
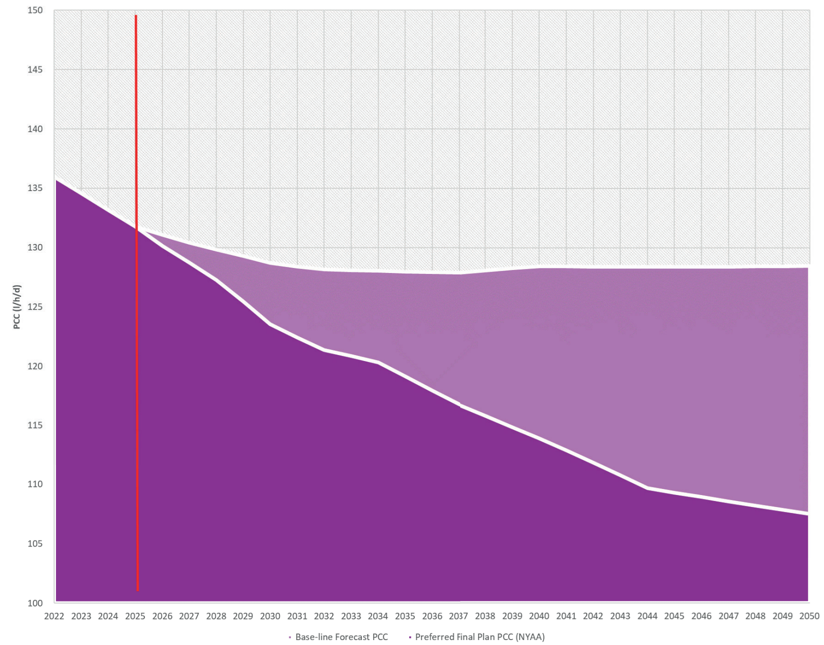


Figure 46 Per capita consumption, base-line and preferred plan



9.4.5 As can be seen below ([Figure 46](#)), in line with Water Resource Planning Guidance;

- we have excluded the impact of government led interventions ('white good' / water utility labelling and mandatory standards) in the base-line forecast.
- An assessment for government led interventions has been included in our preferred plan.

10 Water Efficiency Measures

In this section we will:

- Describe how we have included water efficiency measures in the demand forecast.
- Show how we have assessed the future water efficiency measures in our preferred program
- Discuss additional behavioural influences that have impacted our demand forecast.

10.1 Overview

10.1.1 A key element in producing our final plan demand forecast, is the understanding of customer behaviour and the quantification of savings from our water efficiency and behavioural change programmes. Demand management will form a critical part of our revised draft WRMP24 strategy, to ensure safe, sustainable and resilient water supplies into the future.

10.1.2 We are keen to build on our current momentum and the rapid deployment of smart meters across our region (we currently have >500K smart meters installed in 2022/23), while expanding our digital offering to take full advantage of our smart future.

10.1.3 Our preferred portfolio represents our most extensive and ambitious program of water efficiency and behavioural change activities to date.

10.1.4 Our ability to change customer behaviour and drive efficiency will be significantly enhanced, as it is supported by our smart metering 10 year rollout program. Smart metering is enabling innovative water efficiency interventions and allowing us to provide a platform for tailored customer engagement. Some of the options that will be enabled by smart metering include customer campaigns and reward schemes through the smart meter usage portal and smart home device retro-fitting. These options will be included in our preferred portfolio.

10.1.5 The success of smart metering will also be influenced by our water efficiency activities. We understand that smart metering is ultimately simply a technological change that needs to be accompanied by a 'behavioural change revolution' in order to unlock its full potential to help manage demand in future.

10.1.6 We are also mindful that we should utilize the wealth of information generated by smart meters to understand customer behaviours and how demographic change will shape future water consumption. The smart meter data will also be crucial in validating the efficacy of our current demand management program and in shaping future demand management option. Consequently, we are currently developing our 'Smart Meter Monitoring Framework' to study and analyse smart meter consumption data and associated demographic information.

10.1.7 We are excited by the opportunities that the provision of timely consumption data from smart metering is having on our ability to change consumer behaviour and promote the conservation of water.

10.2 Our preferred portfolio

10.2.1 For the revised draft WRMP24, we have developed our preferred plan for water efficiency, building upon our ambitious WRMP19 (AMP7) program and our ambitious smart meter rollout.

10.2.2 Our preferred water efficiency strategy includes a range of household water efficiency and behavioural change activities. Some of these are based upon the continuation of current activities and those we are developing alongside our smart meter rollout in AMP7.

10.2.3 Our preferred option also includes a significant number of new activities, such as incentives for customers to replace leaky toilets with more efficient brands and the installation of water butts. Further initiatives will draw upon insights from 'behavioural economics' and will be enabled by the availability of smart meter consumption data and our on-line platform (such as a rewards scheme that incentivizes water savings).

10.2.4 The assumptions, costs and benefits for our portfolio of options have been developed using internal analysis and external experience, whilst understanding the interconnected nature of the options (especially with respect to smart metering).

10.2.5 The selected option portfolio will include the following sub-options:

- Provision of smart water devices/sensors (shower sensors); investigating the potential to link smart sensors to 'MyAccount'; further investigation to link Smart devices to hubs, developments and communities
- Continued development of 'MyAccount' App to provide easy access to data.
- Additional community based water efficiency campaigns -hyper local and seasonal targeting.
- Development of gamification and rewards schemes, digitally accessed.
- Provision of garden advice / garden kits for outdoor usage with higher levels of engagement on discretionary/seasonal water use.
- Personalized engagement on discretionary/seasonal water use through virtual assistants.
- Enhanced scheme to assist vulnerable customers with internal leaks.
- A leaky loo campaign for traditionally metered customers.
- Development of the customer leakage journey to achieve minimum continuous flow run-time targets.
- Potential development of smart communities; link smart systems to other utilities

10.2.6 Some of these are based upon the continuation of our current activities, such as the 'Bits and Bobs' campaign (where we carry out free water saving home visits and install water saving devices), our retrofitting program and 'The Potting Shed' (where we provide water efficiency advice and free products to gardeners).

10.2.7 For the revised draft WRMP24, we have also developed a number of options designed to impact the non-household sector and will continue to investigate innovative options such as the potential for water re-use for both domestic and industrial customers.

10.2.8 Note that our base-line and preferred plan projections include water efficiency and leakage savings totalling 20Ml/d (reflecting impacts from our WRMP19 plan, from 2021/22 to 2024/25).

10.3 Forecast outcomes

10.3.1 For our preferred portfolio of water efficiency measures we expect to realize the following benefits (Table 18).

Table 18 Benefits for our preferred water efficiency portfolio

Option	AMP 8 -2030 out-turn water saving per year Ml/d	AMP 12 -2050 out-turn water saving per year Ml/d
Smart Showers	1.32	2.60
Garden Advice	0.30	1.50
WRMP24. Community Reward scheme	0.41	1.46
PL Uplift - Vulnerable Customers	0.61	0.94
PL uplift - Non-Vulnerable Customers	5.22	8.11
Leaky Loos Campaign	1.51	-
Mandatory water labelling* (Government led intervention)	3.52	84.35
Totals	12.89 Ml/d	98.96 Ml/d

10.3.2 Savings have been calculated for each of the water efficiency measures and can be shown as below (Figure 47). Note that this graph excludes the impact of government led interventions.

Figure 47 Water efficiency measure savings for the plan period

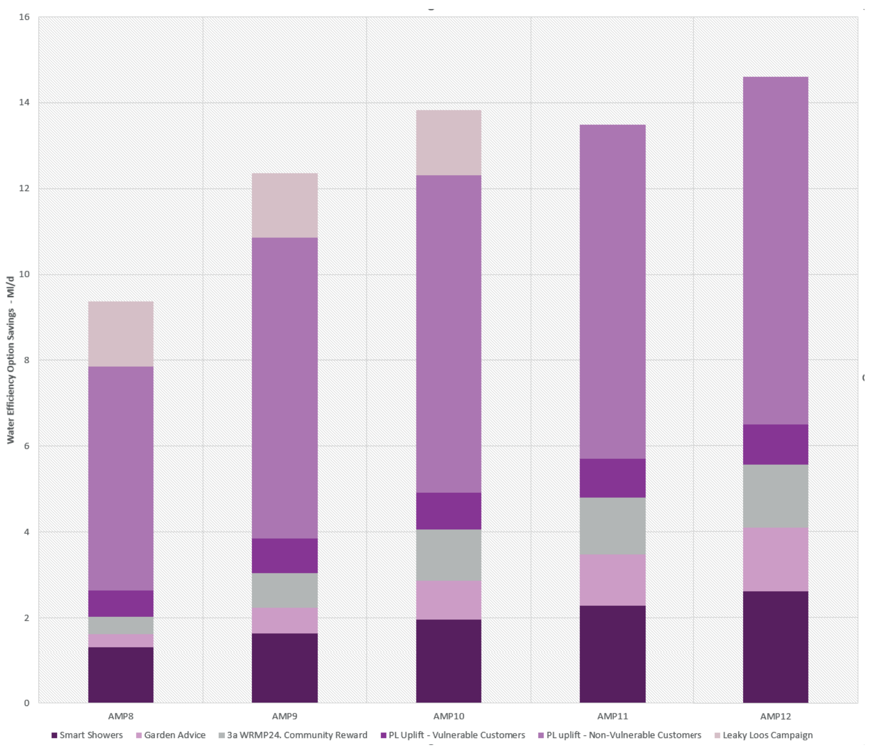
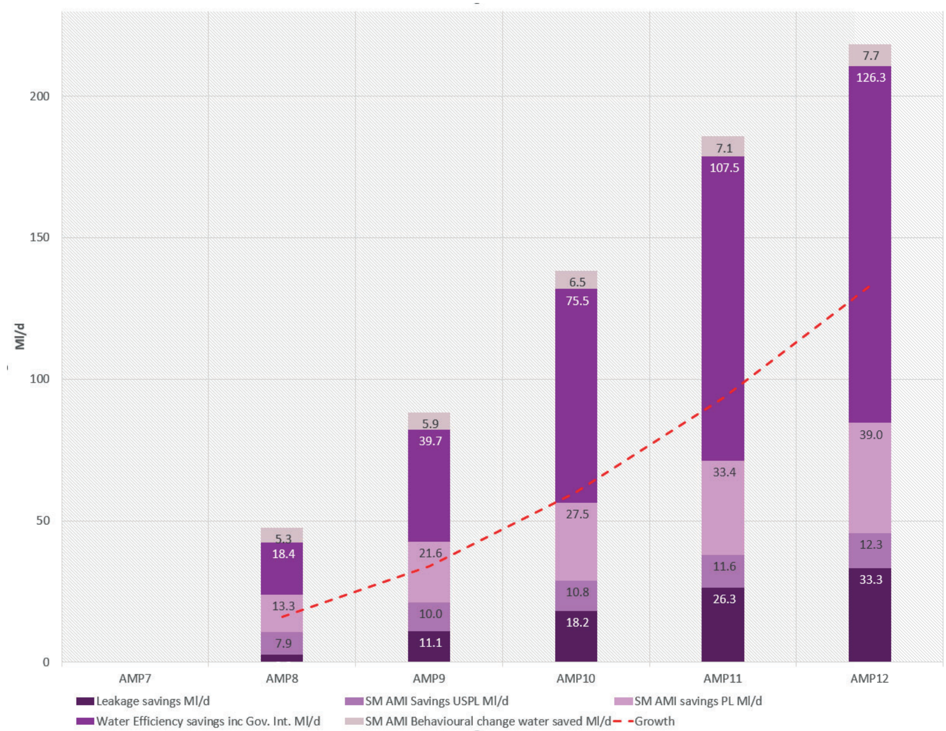


Figure 48 Total (Preferred Plan) savings including government led interventions



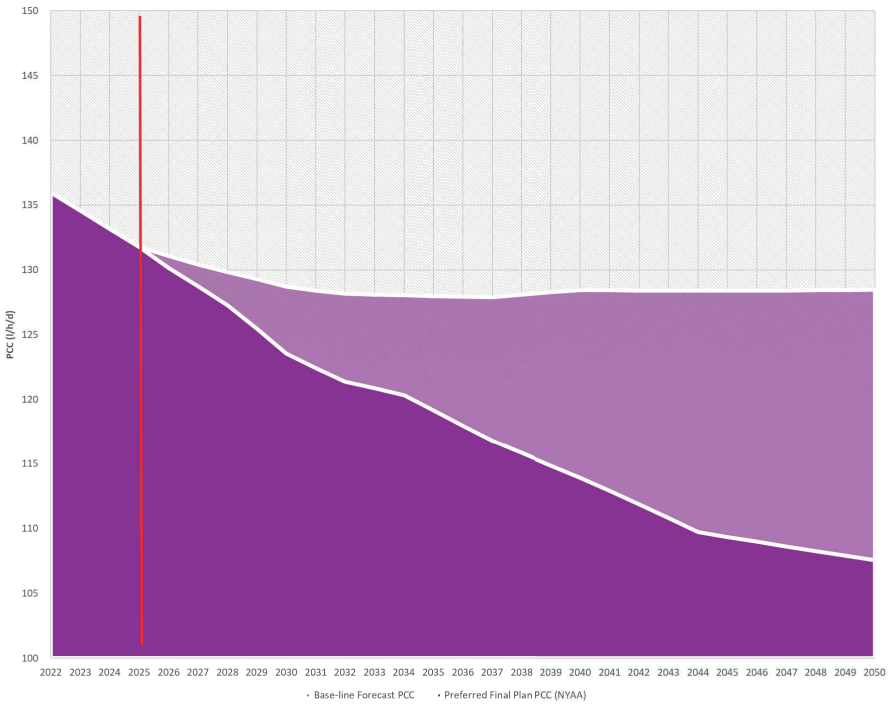
10.3.3 As already discussed, we have also modelled the potential impact of government led interventions on the demand forecast, including a conservative factor (in the final plan only, as directed by the WRPG), in alignment with the UK/Artesia report: 'Pathways to long-term PCC reduction.

10.3.4 Note that, government led interventions contribute very significantly to demand reductions in the long term (included in the water efficiency segment), saving the equivalent 84Ml/d by 2049/50 (note that this is equivalent to the 84Ml/d saved by the Anglian Water interventions for smart metering, water efficiency and leakage, excluding non-household water efficiency) (Figure 48).

10.3.5 With the implementation of our smart metering program (and other associated water efficiency measures) we expect per capita consumption (PCC) to decrease to a value of 109.7 l/h/d by 2050, for our DYAA forecast (with the NYAA PCC value being 107.6 l/h/d), which is in line with the National Framework target of 110 l/h/d. This significant decrease in PCC, will be driven by our full smart meter rollout by 2029/30, enhanced water efficiency options (linked with the opportunities arising from smart meters with respect to our water efficiency communications strategy), and the impact from government led interventions.

10.3.6 As can be seen below in (Figure 49), only the preferred plan forecast includes the impact of government led interventions ('white good' / water utility labelling and mandatory standards), which have a significant impact on PCC (approximately 14 l/h/d by 2050)

Figure 49 Per capita consumption, base-line and preferred plan



11 Additional Demand Factors

11.1 Components of demand

We have also accounted for:

Other components of demand (DSOU, WTU), including the methods we have adopted for their calculation and our source datasets.

11.1.1 Overview

11.1.1.1 Additional derivation of the remaining components, as described in the Annual Performance Review, has included,

- water taken unbilled (estimated at the regional level and disaggregated to WRZ/PZ level in proportion to DI)
- distribution system operational use (estimated at the regional level and disaggregated to WRZ/PZ level in proportion to DI)

11.1.1.2 Both of these components have been initially derived from the base-line 2021/22 water-balance data at the planning zone and water resource zone (WRZ) level, and have been assumed to remain constant throughout the forecast period with values of (Table 19).

Table 19 Additional components of demand

Component of Demand	Value included in forecast - Ml/d
Distribution system operational use	7.701
Water taken un-billed	24.63

11.2 Climate change impact

In this section we will document:

- how we have included for the impact of climate change on demand, including the assumptions on which this is based. Although our allowance is within the expected impact range (<3%), we have robustly demonstrated and justified our reasoning.

11.2.1 In order to forecast the impact of climate change on household demand, annual percentage change factors, developed by UKWIR (2013) 'CL04B impact of CC on water demand', have been used. Average factors from the two models provided have been extrapolated to 2050 and cross referenced. It is noted that, UKWIR (2013) found no consistent weather-demand relationship for non-household demand; consequently, following guidance no climate change allowances have been made.

11.2.2 The 'regional tables' provided by UKWIR (2013) detail three demand criteria: annual average, minimum deployable output, and critical period. Percentiles are provided, to demonstrate the uncertainty in the UKCP09 model (10th, 25th, 50th, 75th, 90th). The calculation of these values has involved the production of demand figures for 2030, which have then been scaled across the planning period at time of publication (2012 to 2035).

11.2.3 For our demand forecast the average of Thames Water and Severn Trent household demand and climate change relationships have been used in line with the UKWIR (2013) Guidance. The WRMP24 planning horizon is from 2019/20 to 2049/50 and as mentioned, UKWIR (2013) climate change and demand factors are scaled from 2012 to 2035; we have, therefore, produced change factors linearly extrapolated to 2049/50 and change factors have been linearly scaled back from 2049/50 to reach 0% change in the base-year.

11.2.4 The 50th percentile annual average factors have been used for the Dry Year Annual Average (DYAA) planning scenario (0.85% in the year 2049/50). The 50th percentile critical period factors were used for the Critical Period (DYCP) planning scenario (1.67% in the year 2049/50). To explore the uncertainty in the impact of climate change on demand, the 10th and 90th percentile values were modelled in the revised draft WRMP24 headroom analysis, see table below (Table 20).

11.2.5 Climate change factors have been derived for the Dry year annual average and Critical period scenarios.

Table 20 Climate change factors (%)

Factor (%)	2025	2030	2035	2040	2045	2050
DYAA	0.09	0.19	0.33	0.51	0.73	0.85
CP	0.17	0.37	0.65	1.00	1.43	1.67

11.2.6 Note that climate change factors are applied to household consumption only.

12 Risk and Uncertainty

12.1 Overview

12.1.1 Forecasting future demand for water over the long term for a region the size of Anglian Water, is fraught with uncertainty, given the number of variables involved, especially considering that key factors are human behaviour and our attitudes to water use. However, for our revised draft WRMP24 planning process we have attempted to mitigate these uncertainties, by;

- being pragmatic and conservative regarding forecast assumptions.
- making all the assumptions, driving the forecast, clearly visible and as simple as possible in their application.
- developing a scenario testing framework to explore sensitivities to different forecast assumptions.
- using Target Headroom to account for uncertainty in the revised draft WRMP24 planning submission.
- creating adaptive plan scenarios for future out-comes, such that, if forecasts (for example, demand management option savings) do not materialise as expected, we will be able to account for these differences in our plan.

12.1.2 In order to fully test our key portfolios ('Extended Low', 'Extended Plus' and 'Aspirational' (the preferred plan)), we have developed a large number of alternate scenarios. These alternates have been designed to test a range of outcomes dependent upon key influent factors, detailed in the table below (Table 21), including:

- alternate growth projections (plan, trend, strategic), including alternate non-household growth projections
- alternate demand management option portfolios (high, medium, low option packages)
- alternate demand management options outcomes (higher, lower savings)
- the inclusion or non-inclusion of other influent factors (government led interventions)

Table 21 WRMP24 Test Scenarios

Package Name	Growth Forecast	DMOs portfolio	Variable	Gov led interventions inclusion
1000REV_dWRMP_OxCam1b_Baseline_ZeroGovInt	OxCam_1b_r_P Growth	NO DMOs beyond AMP7	AMP7 Smart Metering and WEF only	Incl. Revised Gov. interventions
1001REV2022BL_OxCam1b_Extended_Low_GovCombined	OxCam_1b_r_P Growth	Low DMOs - 3AMP SM	Low DMOs	Incl. Revised Gov. interventions
1001REV2022BL_OxCam1b_Extended_Low_zeroGovInt	OxCam_1b_r_P Growth	Low DMOs - 3AMP SM	Low DMOs	Zero Gov. Interventions
1002MREV2022BL_OxCam1b_ExtPlus_GovComb_Mains	OxCam_1b_r_P Growth	Medium DMOs - 2 AMP SM - uplifted AMP8 Mains	Medium DMOs additional mains	Incl. Revised Gov. interventions
1002MREV2022BL_OxCam1b_ExtPlus_zeroGovInt_Mains	OxCam_1b_r_P Growth	Medium DMOs - 2 AMP SM - uplifted AMP8 Mains	Medium DMOs additional mains	Zero Gov. Interventions
1002REV2022BL_OxCam1b_Extended_Plus_GovCombined	OxCam_1b_r_P Growth	Medium Plan 2AMP SM	Medium DMOs	Incl. Revised Gov. interventions
1003REV2022BL_OxCam1b_Aspirational_50GovInt	OxCam_1b_r_P Growth	Preferred Plan High DMOs 2AMP SM 38% leakage	Preferred High DMOs	Incl. 50% Gov. interventions

Package Name	Growth Forecast	DMOs portfolio	Variable	Gov led interventions inclusion
1003REV2022BL_OxCam1b_Aspirational_GovCombined PREFERRED PLAN	OxCam_1b_r_P Growth	Preferred Plan High DMOs 2AMP SM 38% leakage	Preferred High DMOs	Incl. Revised Gov. interventions
1003REV2022BL_OxCam1b_Aspirational_zeroGovInt	OxCam_1b_r_P Growth	Preferred Plan High DMOs 2AMP SM 38% leakage	Preferred High DMOs	Zero Gov. Interventions
1003T_REV2022BL_OxCam1b_Extended_Plus_MaximumLeakage	OxCam_1b_r_P Growth	High DMOs 2AMP SM 50% leakage	High DMOs - 50% leakage	Incl. Revised Gov. interventions
1003REV2022BL_OxCam1b_Aspirational_zeroGovInt_10to20percentuplift	OxCam_1b_r_P Growth	Preferred Plan High DMOs 2AMP SM 38% leakage - Uplifted Non-HH 10% to 20%	Uplifted Non-HH demand	Incl. Revised Gov. interventions
1003REV_CC_P10	OxCam_1b_r_P Growth	Preferred Plan High DMOs 2AMP SM 38% leakage - CC 10% percentile	High DMOs - Climate Change P10	Incl. Revised Gov. interventions
1003REV_CC_P90	OxCam_1b_r_P Growth	Preferred Plan High DMOs 2AMP SM 38% leakage - CC 90% percentile	High DMOs - Climate Change P10	Incl. Revised Gov. interventions
2000REV_dWRMP_OxCam1b_Baseline_ZeroGovInt	OxCam_1b_r_P Growth	NO DMOs beyond AMP7	AMP7 Smart Metering and WEF only	Zero Gov. Interventions
2001REV_dWRMP_OxCam1b_Extended_Low_50GovInt	OxCam_1b_r_P Growth	Low DMOs - 3AMP SM	Low DMOs	50% Gov. intervention
2002REV_dWRMP_OxCam1b_Extended_Plus_50GovInt	OxCam_1b_r_P Growth	Medium DMOs 2AMP SM	Medium DMOs	50% Gov. intervention
2003REV_dWRMP_OxCam1b_Aspirational_50GovInt	OxCam_1b_r_P Growth	High DMOs 2AMP SM 38% leakage	Preferred High DMOs	50% Gov. intervention
3000REV_dWRMP_OxCam1b_Baseline_ZeroGovInt	OxCam_1b_r_P Growth	NO DMOs beyond AMP7	AMP7 Smart Metering and WEF only	Zero Gov. Interventions
3001REV_dWRMP_OxCam1b_Extended_Low_ZeroGovInt	OxCam_1b_r_P Growth	Low DMOs - 3AMP SM	Low DMOs	0% Gov. intervention
3002REV_dWRMP_OxCam1b_Extended_Plus_ZeroGovInt	OxCam_1b_r_P Growth	Medium DMOs 2AMP SM	Medium DMOs	0% Gov. intervention
3003REV_dWRMP_OxCam1b_Aspirational_ZeroGovInt	OxCam_1b_r_P Growth	High DMOs 2AMP SM 38% leakage	Preferred High DMOs	0% Gov. intervention
4000REV_dWRMP_HousingPlan_Baseline_ZeroGovInt	Housing_Plan_P Growth	NO DMOs beyond AMP7	AMP7 Smart Metering and WEF only	Zero Gov. Interventions
4001REV_dWRMP_HousingPlan_Extended_Low_GovComb	Housing_Plan_P Growth	Low DMOs - 3AMP SM	Low DMOs	Incl. Revised Gov. interventions
4002REV_dWRMP_HousingPlan_Extended_Plus_GovComb	Housing_Plan_P Growth	Medium DMOs 2AMP SM	Medium DMOs	Incl. Revised Gov. interventions
4003REV_dWRMP_HousingPlan_Aspirational_GovComb	Housing_Plan_P Growth	High DMOs 2AMP SM 38% leakage	Preferred High DMOs	Incl. Revised Gov. interventions
4500REV_dWRMP_HousingPlan_Baseline_zeroGovInt	Housing_Plan_P Growth	NO DMOs beyond AMP7	AMP7 Smart Metering and WEF only	Zero Gov. Interventions
4501REV_dWRMP_HousingPlan_Extended_Low_zeroGovInt	Housing_Plan_P Growth	Low DMOs - 3AMP SM	Low DMOs	Zero Gov. Interventions
4502REV_dWRMP_HousingPlan_Extended_Plus_zeroGovInt	Housing_Plan_P Growth	Medium DMOs 2AMP SM	Medium DMOs	Zero Gov. Interventions
4503REV_dWRMP_HousingPlan_Aspirational_zeroGovInt	Housing_Plan_P Growth	High DMOs 2AMP SM 38% leakage	Preferred High DMOs	Zero Gov. Interventions

Package Name	Growth Forecast	DMOs portfolio	Variable	Gov led interventions inclusion
5000REV_dWRMP_ONS_18_P_Baseline_ZeroGovInt	ONS_18_P Growth	NO DMOs beyond AMP7	AMP7 Smart Metering and WEF only	Zero Gov. Interventions
5001REV_dWRMP_ONS_18_P_Extended_Low_GovComb	ONS_18_P Growth	Low DMOs - 3AMP SM	Low DMOs	Incl. Revised Gov. interventions
5002REV_dWRMP_ONS_18_P_Extended_Plus_GovComb	ONS_18_P Growth	Medium DMOs 2AMP SM	Medium DMOs	Incl. Revised Gov. interventions
5003REV_dWRMP_ONS_18_P_Aspirational_GovComb	ONS_18_P Growth	High DMOs 2AMP SM 38% leakage	High DMOs	Incl. Revised Gov. interventions
5500REV_dWRMP_ONS_18_P_Baseline_zeroGovInt	ONS_18_P Growth	NO DMOs beyond AMP7	AMP7 Smart Metering and WEF only	Zero Gov. Interventions
5501REV_dWRMP_ONS_18_P_Extended_Low_zeroGovInt	ONS_18_P Growth	Low DMOs - 3AMP SM	Low DMOs	Zero Gov. Interventions
5502REV_dWRMP_ONS_18_P_Extended_Plus_zeroGovInt	ONS_18_P Growth	Medium DMOs 2AMP SM	Medium DMOs	Zero Gov. Interventions
5503REV_dWRMP_ONS_18_P_Aspirational_zeroGovInt	ONS_18_P Growth	High DMOs 2AMP SM 38% leakage	High DMOs	Zero Gov. Interventions
6000REV_dWRMP_ONS_18_Low_L_Baseline_ZeroGovInt	ONS_18_Low_L Growth	NO DMOs beyond AMP7	AMP7 Smart Metering and WEF only	Zero Gov. Interventions
6001REV_dWRMP_ONS_18_Low_L_Extended_Low_GovComb	ONS_18_Low_L Growth	Low DMOs - 3AMP SM	Low DMOs	Incl. Revised Gov. interventions
6002REV_dWRMP_ONS_18_Low_L_Extended_Plus_GovComb	ONS_18_Low_L Growth	Medium DMOs 2AMP SM	Medium DMOs	Incl. Revised Gov. interventions
6003REV_dWRMP_ONS_18_Low_L_Aspirational_GovComb	ONS_18_Low_L Growth	High DMOs 2AMP SM 38% leakage	Preferred High DMOs	Incl. Revised Gov. interventions
7000REV_dWRMP_OxCam2b_Baseline_ZeroGov	OxCam2b_r_P Growth	NO DMOs beyond AMP7	AMP7 Smart Metering and WEF only	Zero Gov. Interventions
7001REV_dWRMP_OxCam2b_Extended_Low_GovComb	OxCam2b_r_P Growth	Low DMOs - 3AMP SM	Low DMOs	Incl. Revised Gov. interventions
7002REV_dWRMP_OxCam2b_Extended_Plus_GovComb	OxCam2b_r_P Growth	Medium DMOs 2AMP SM	Medium DMOs	Incl. Revised Gov. interventions
7003REV_dWRMP_OxCam2b_Aspirational_GovComb	OxCam2b_r_P Growth	High DMOs 2AMP SM 38% leakage	Preferred High DMOs	Incl. Revised Gov. interventions

12.1.3 These scenarios have been used to test a range of outcomes, dependent upon;

- different growth forecasts,
- different base-line values for non-household demand,
- differing demand management option scenarios (including different smart meter rollout programs, leakage reduction and water efficiency measures)
- different out-comes for our preferred demand management options and
- the inclusion of alternate factors (government interventions, covid19 factors).

12.1.4 The alternate demand forecast outcomes can be shown (Figure 50) with the preferred WRMP24 base-line and final plan (red) out-comes):

Figure 50 Demand forecast scenarios and WRMP24 Base-line and Preferred Plan

12.1.5 Uncertainties with respect to the preferred plan forecast arise from the following areas:

12.1.1 The base-line water balance assessment of population, per capita consumption and the components of demand.

- We have continued to review of our water balance data, and have now moved from a 2019/20 to a 2021/22 base-line for the revised draft WRMP24. This has included a further detailed review of property, population and occupancy attributions at the Planning Zone Level, in order to confirm PCC values with more certainty. We also continue to review inter-year variations in order to ascertain the variability of our water balances components over time, at our WRZ geographic level, given that we are seeing significant variations due to current societal changes (the Covid19 pandemic, the new 'working from home' normal, the 'cost of living crisis'.).

12.1.2 The achievement of our WRMP19 AMP7 out-turn reductions in demand from smart metering and leakage.

- We are currently pursuing aggressive measures with regard to our per capita consumption (PCC) and leakage targets for AMP7, despite the impact of:
  - the Covid19 pandemic,
  - recent weather impacts (the driest summer in 2022 since 1976 and record temperatures),
  - supply chain issues with regard to smart meter installation (we have, however, installed >500K smart meters as of 2023) and
  - the 'cost of living' crisis.
- We have reviewed our AMP7 out-comes as part of our revised draft WRMP24.

12.1.3 The inclusion of savings from Government led interventions and their realization.

- We have reviewed the inclusion and level of impact that should be included for Government led interventions in our preferred plan (note that this factor is excluded from the base-line forecast, in line with Water Resource Planning Guidance). We have rigorously tested scenarios, as can be seen, with and without this external impact on PCC, as part of our option appraisal. It is noted that in order to achieve the goal of 110 l/h/d for PCC, this option will be required, as well as our full smart meter rollout and water efficiency program.

12.1.4 Smart meter savings and their realization over the WRMP24 period, from our 2AMP smart meter installation program.

- For our revised draft WRMP24 we have reviewed our initial understanding of smart meter savings, which were initially assessed on our long-term Newmarket and Norwich trial areas. We are now (2022/23) seeing the first evidence from our wider rollout regarding potential behavioural change savings and plumbing loss/cspl reductions (as customers are made aware of leakage). Consequently, our new assessment has been based

- upon data from our wider smart meter roll-out utilizing a cohort of approximately 150K properties (with greater than 1 year of continuous data).
- This has led us to a more conservative view of current savings from reductions in continuous flow (plumbing loss and cspl run-time reductions), which have now been included in our revised draft WRMP24.
- We are at the beginning of the process of understanding customer behaviour (how customers respond to the introduction of smart meter technology and how we need to tailor our systems in order to maximise water efficiency), so we expect that our assessments will need to adapt over time as we build a much more complete view.
- As part of our future analysis program we are now actively developing our 'Demand Management Monitoring Framework', in order to maximise our understanding of:
  - base-line consumer behaviours and attitudes to water consumption (cohort analysis)
  - the impact of current water efficiency options and communications and how we might target and tailor our program in real-time.
  - how we should scientifically trail and test our proposed demand management options and validate their efficacy.
- Further reviews of customer data and segmentation will form part of the update of the 'Demand Forecast Model' as we move forward towards WRMP29.

12.1.5 Leakage reduction over the WRMP24 planning period.

- Significant uncertainty is involved with regard to leakage reduction and the maintenance of given leakage levels.
- We are currently a frontier company with respect to our current leakage level (we recently recorded our lowest leakage value ever at 173.23Ml/d), and are significantly below our previously calculated SELL (Economic Leakage Level). Consequently, achieving lower and lower levels will prove much more challenging .
- We are also beginning to exhaust traditional methods of leakage reduction, such as pressure management, and so will need to develop innovative new methods to detect and repair leakage (noting that our smart meter installation program should have a significant impact with regard to the detection and repair of customer supply pipe leakage).
- For our revised draft we have, however, included an ambitious program for leakage of a 38% reduction by 2049/50 (relative to the National Framework base-line year of 2017/18), indicating our commitment to contributing to the achievement of the national 50% leakage reduction target.

12.1.6 The long term impacts of the Covid19 pandemic.

- The Covid19 pandemic and associated lockdowns have been seen to impact both household and non-household demand as sections of the population worked from home, segments of the business sector were forced to shut and latterly as many people 'stay-cationed' in our region.
- For our revised draft WRMP24 we have now moved the base-line for our plan to 2021/22 (post pandemic) and have consequently, reassessed the inclusion of the Covid19 impact.
- We continue to review consumption patterns, post pandemic, in order to ascertain whether we have now entered a new normal, where home-working is seen as a more usual pattern of behaviour.

12.1.7 Property and population growth over the next 25 years.

- Property and population forecasts for the next 25 years, are also an area of great uncertainty. We have, therefore, modelled a number of high (strategic growth) and low (ONS trend) property and population projections, including Local Authority property and population projections in alignment with WRMP Guidance.
- For our revised draft WRMP24, we have adopted a scenario (OxCam1b) that balances future risk from unexpected population growth in our region. This reflects an element of strategic growth, whilst balancing this with the fact that the current Government

position appears to have been revised with regard to the OxCam strategic plan development.

- The chosen scenario maintains near term Local Authority planned growth (higher than trend) beyond AMP7 (rather than returning to trend in the long term) in our identified high growth areas. This would seem to be the most pragmatic approach, given recent growth in the areas covered by the Arc, and the fact that the East of England has experienced the highest growth rates in the UK since the 2011 census (>8%). This forecast has been aligned with our WRE partners and is in accordance with WRMP24 Guidance.

12.1.8 Understanding customer cohort behaviours and the Monitoring Framework.

- Our smart meter program is facilitating a step change in our understanding of our customers and their consumption. However, we are only at the beginning of our research and analysis into;
  - how and when our customers use water;
  - how these patterns of consumption change within the family unit over time and
  - how receptive customers are to attitudinal and behavioural change.
- We are currently progressing analysis on our hourly customer consumption data and statistically analysing consumers to characterise them into meaningful cohorts (e.g. early morning users; all day users etc.) to better understand the demographics of our customer base at WRZ level. As this analysis advances we will use it to produce more sophisticated forecasts and target demand management options in a more meaningful way. This analysis will form a key element of our 'Smart meter monitoring framework'.

12.1.9 Non-household, business sector demand.

- Our non-household forecast is based upon regression analysis and estimates of future population, GVA and employment, as applied to relevant non-household segments. This simple methodology can only produce forecasts that are relatively uncertain over the WRMP24 period. As stated we have sensitivity tested our central forecast with additional variants of future non-household demand.
- Additionally, we can be called upon to supply large specific volumes of water for new local business customers, which can have direct impacts at the water resource level (WRZ). Identifying when these requirements might be called upon, can cause issues within the planning process.
- We are currently ensuring that these needs are identified and where possible, reflected in the revised draft WRMP24 plan, however we have seen significant volatility with regard to these requests in the last year.
- Whilst considering all these risks and issues we also account for uncertainty in the WRMP24 plan using the concept of Target Headroom.

12.1.10 Increasing NAV development

- We are closely monitoring the incidence of 'New appointments and variations' (NAVs) ((where alternate companies are appointed to provide a water and/or sewerage service to new development customers), which are increasing. A new appointment is made when a limited company is appointed by Ofwat to provide water and/or sewerage services for a specific geographic area. A new appointee has the same duties and responsibilities as the previous statutory water company. These companies install their own metering systems for their customers independent of our smart meter installation program, and as such might not achieve the savings we would expect. Despite the fact that these customers would not fall directly into our domain, we would still need to supply water as the regional wholesaler, which would impact our overall supply demand balance.
- Future household growth has been included in the revised draft WRMP24 (which would account for these new properties). However, if water efficiency measures implemented by the NAV company areas does match our smart meter driven water efficiency strategy, this would pose a risk for our bulk supply requirements and our overall supply/demand balance
- We are liaising with these NAV companies in order to align our water efficiency programs, and ensure that customers in these

areas also achieve the levels of water efficiency that we expect to achieve as part of our revised draft WRMP24 (110 l/h/d by 2049/50)and are in discussion regarding how smart metering benefits might be provided to these customers. (Note that for business customers we are installing smart meters despite these not being our customers, being served by Water Retailers).

12.2 The impact of Government led interventions on demand

12.2.1 As part of the WUK/Defra project Artesia developed a number of demand management scenarios, describing the potential impact of Government-led interventions on per capita consumption.

12.2.2 In particular they found that the introduction of water labelling and the slow change to more efficient white goods, along with a set of government led mandatory standards for new-build and retrofit properties, might lead to very significant savings in the long-term (up to 31 l/h/d by 2049/50)

12.2.3 Given that the government has signalled that they will introduce legislation to bring in white good labelling and promote more water efficient white goods, we have felt that it is prudent to include a demand reduction linked to this (see table below (Table 22)) in our preferred plan (in alignment with the WRPG).

12.2.4 For the revised draft WRMP24 plan, we have, included an updated savings trajectory based upon a combined view of the low, medium and high 'white good' labelling scenarios. This leads to a saving of 14.95 l/h/d by 2049/50, which would equate to a significant saving of approximately 84.35Mld by this point. It is noted that this saving is required, in order to achieve the National Framework target of 110 l/h/d, along with the savings quantified for our smart metering and water efficiency programs.

12.2.5 Additionally, note that due to the uncertainty surrounding these savings the near term impact has been minimised for AMP8.

Table 22 Government led intervention scenarios

Scenario	2030	2035	2040	2045	2050
G1. Mandatory water labelling|With minimum standards|Saving|Lower - l/h/d	2.83	8.71	16.15	20.63	23.15
G2. Mandatory water labelling|With minimum standards|Saving|Middle - l/h/d	3.33	10.25	19.00	24.27	27.23
G3. Mandatory water labelling|With minimum standards|Saving|Upper - l/h/d	3.83	11.79	21.85	27.92	31.32
G4. Mandatory water labelling|No minimum standards|Saving|Lower - l/h/d	**1.35**	4.16	7.71	9.85	11.05
G5. Mandatory water labelling|No minimum standards|Saving|Middle - l/h/d	1.59	**4.89**	**9.07**	**11.59**	13.00
G6. Mandatory water labelling|No minimum standards|Saving|Upper - l/h/d	1.83	5.63	10.43	13.33	**14.95**
Demand Saving Ml/d - (based upon Oxcam Population projection)	3.52	16.39	45.24	72.19	84.39

12.3 Covid19 pandemic impacts on demand

12.3.1 An additional consideration for the revised draft WRMP24 has been the impact the of Covid19 pandemic. The selection of the base-year, especially given the social and behavioural changes that have been experienced, has been considered, in order to remove any short term impacts that might affect the long term forecast.

12.3.2 The 2020/21 water balance, has been seen to be significantly different from previous water balances. As a result of Covid-19 pandemic related restrictions in 2020/21 we experienced changes in the spatial distribution of demand along with changes in the magnitude of consumption for both Household and Non-Household demand. Consequently, we have chosen a base-year of 2021/22 (as opposed to 2019/20 in the draft WRMP), which post-dates the main impacts of the pandemic, minimising anomalies that might arise in the water balance.

12.3.3 Covid-19 had a marked impact upon per capita consumption (PCC) values in the years 2020/21 and to a smaller extent in 2021/22. Determining the longevity of this impact and arriving at a consensus on the water balance values to be included in WRMP24 has been factored into our revised draft WRMP24 plan.

12.3.4 In order to determine the future potential impacts of Covid19, Artesia has been commissioned to review consumption data (including smart meter hourly data, through the Covid19 lockdown period) across the industry, in order to develop a number of potential future scenarios and factors. These scenarios have been designated as the 'Old Normal', 'New Normal', 'Partial Lockdown' and 'Full Lockdown'.

12.3.5 This analysis has been used to inform the near term forecast of demand, as it tends to reflect a new 'normal'.

12.4 Covid19 impacts - detailed findings

12.4.1 The closure of business premises during March 2020 and the almost overnight switch to homeworking had a significant impact on patterns of demand for both water and wastewater services across the country, and had a particular impact in those regions where commuting to London was a more dominant feature of pre-pandemic work patterns, with impacts being potentially felt due to:

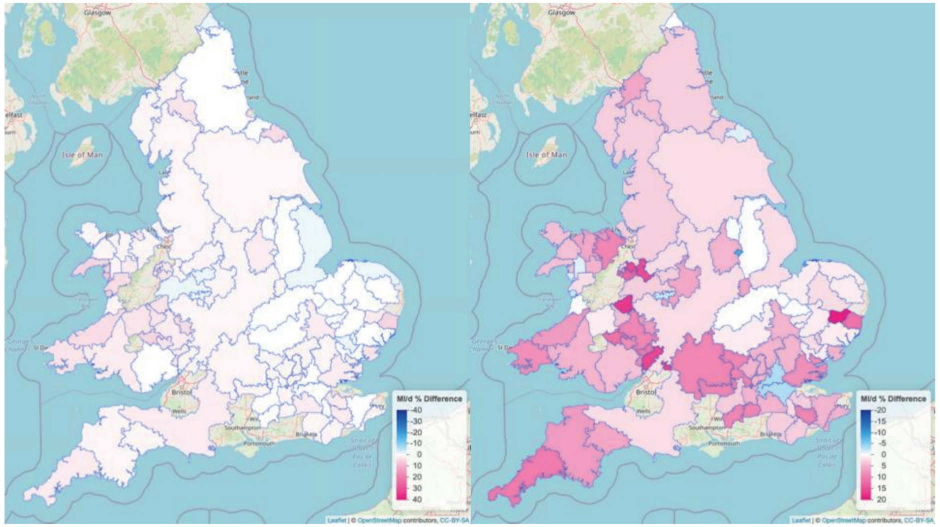
- 'Lock-down'; working from home and the transfer of consumption from the workplace to the home environment - (Noting that the transfer of consumption from the workplace to the home has not been a direct one to one transfer, for example considering the change from the usage of urinals at work to flushing toilets in the home).
- Potential changes in behaviour due to Covid-19, i.e. increased hand-washing; initial washing of groceries; increased external usage of water in gardens for recreation; increased usage due to the change resulting from using home appliances.
- The hot weather spell in the spring of 2020, whilst children were at home, as schools were closed.
- Consumers 'stay-cationing' through 2020, increasing overall home water usage in the Anglian Water Region.

12.4.2 Throughout the pandemic changes in consumption were monitored and we participated in collaborative work with Artesia to understand these impacts as reported in the '*Collaborative Study: The impact of COVID-19 on water consumption'*

12.4.3 The following describes the key findings from the Artesia report relating to the nationally picture. See map below (Figure 51).

- Water demand was observed to increase across most WRZs. This is above and beyond demand expectations due to weather.
- Total demand increased by 2.6% (beyond weather impact)
- Household consumption increased by 9% (beyond weather impact)
- Non-household decreased by 25%
- London demand was redistributed
- Peak increases of 20-30% during the hottest periods of lockdown were experienced.

Figure 51 Map shows water consumption between Feb-Oct 2020 before and after COVID-19 restrictions



12.4.4 Additionally qualitative research was conducted with Manchester University using focus groups from Newmarket and Colchester to discuss behavioural change. This identified that:

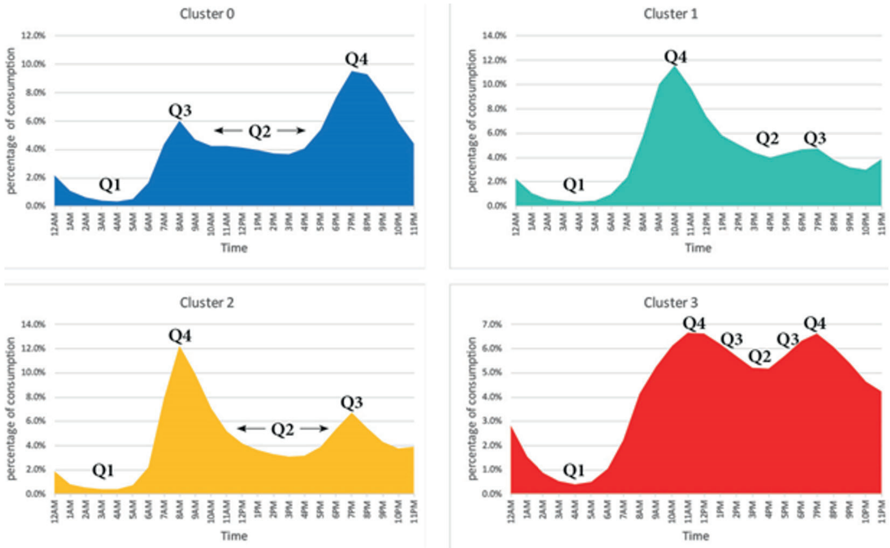
- Participants reported substantial changes in water usage throughout lockdown.
- Gardens were a particular focus of increased usage for both leisure and wellbeing.
- More time was spent preparing and cooking food, increasing water consumption.

12.4.5 With the introduction of smart metering we were also able to analyse the behaviour of different cohorts of consumers through the pandemic (using Newmarket and Norwich hourly data), characterizing groups into different usage patterns:

- Evening Peak users (EP)
- Late Morning Peak users (LM)
- Early Morning Peak users (EM)
- Multiple Peak users (MP)

12.4.6 Consumption was analysed to see how consumption varied between groups and how the percentage of customers in each group fluctuated throughout the year, see (Figure 52).

Figure 52 Indicative patterns of water usage for different cohorts of users



12.4.7 Overall consumption increased as a result of Covid-19 lockdown restrictions, with changes to how and when customers used water throughout the day. This resulted in a shift from early morning peak users (which could be assumed to be commuters) and small decline in evening peak users (Figure 53, to late morning and multiple peak users (Figure 54).

Figure 53 Change in distribution of cohorts in Pre-lockdown period

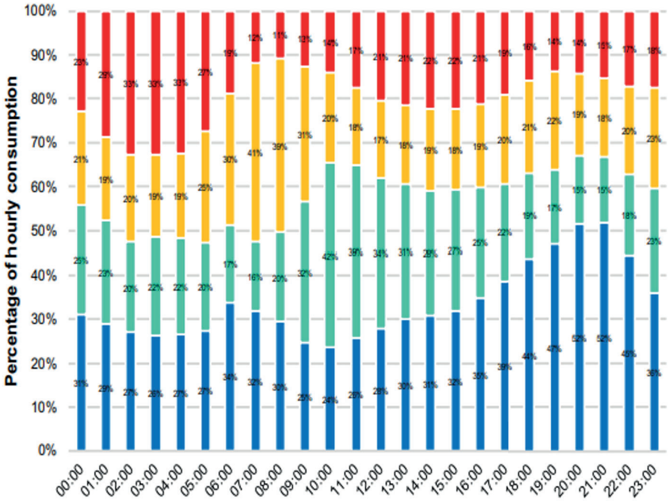
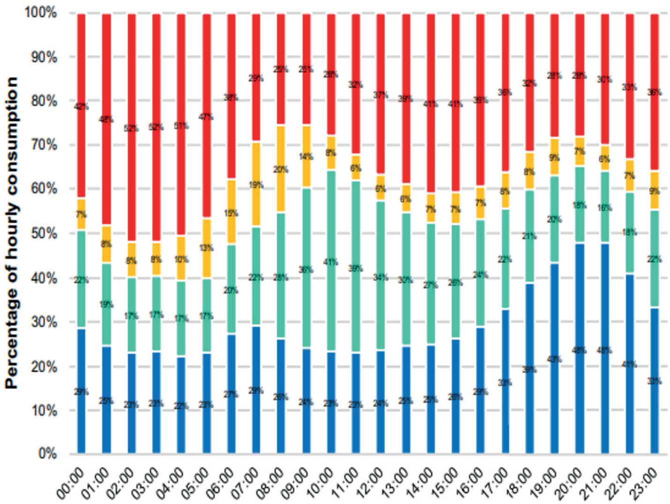


Figure 54 Change in distribution of cohorts in Post Lockdown period



12.4.8 As the pandemic subsided, we observed demand returning to a similar level to that previously experienced. However, it appeared that consumption was still approximately 2.5% higher than previous levels in 2021/22 (once weather related changes are accounted for), potentially reflecting the fact that home-working for a sector of the population appears to have become a new normal.

12.4.9 For the draft WRMP24 we included the following uplift factors for household consumption, declining from the peak seen in 2021 to a 1% uplift from 2030 onwards, reflecting new working practices going forward. See below table (Table 23).

12.4.10 For the revised draft WRMP24, we have now moved the forecast base-line to 2021/22, and have, therefore produced a revised impact assessment, assuming that the 2.56% uplift would be reflected in the base-year values. Maintaining logical consistency with the draft plan has led to an updated set of 'down-lift' factors, as we expect the impacts of the pandemic to subside. (Note the 2.56% uplift previously included for 2021/22 is now assumed to included in the 2021/22 base-line (Table 24). Consequently we expect this demand factor now to become a negative impact).

12.4.11 We have currently not included a factor for non-household consumption as this was seen to return to relatively normal levels through 2021. However, we are seeing some volatility in non-household demand currently, but believe that this is not directly due to the pandemic, being potentially caused by international geopolitics (supply chain changes and the 'cost of living crisis')

12.4.12 Note these factors for 2021/22 to 2029/50 have been included in the modelling to reflect Covid19, given that we have base-lined the model to 2021/22 as a normal year.

12.4.13 Original Draft WRMP24 Covid19 factors: (Table 23).

Table 23 Original draft WRMP24 Covid uplift factor for household consumption

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Covid19 Factor	0.00	10.2%	2.56%	2.56%	2.56%	2.56%	2.25%	1.94%	1.63%	1.31%	1.00%

12.4.14 Updated Revised draft WRMP24 Covid19 factors: (Table 24).

Table 24 Revised draft WRMP24 Covid uplift factor for household consumption

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Covid19 Factor	0.00	0.00	0.00	-0.31%	-0.63%	-0.94%	-1.25%	-1.56%	-1.87%	-2.18%	-2.47	-2.56%

12.5 Target Headroom

12.5.1 As part of our forecast process, for our preferred plan projections we must consider uncertainty. One method of dealing with this, is the calculation of Target Headroom, in which an additional contingency volume of water that might be required, is derived for each Water Resource Zone (WRZ). This Target Headroom is added to our preferred projections for both the base-line and final plan forecasts, for our final calculations of supply-demand balance.

12.5.2 For the purposes of calculating Target Headroom, we use 'Monte Carlo' simulation. This process uses a number of demand (and supply) variables (with pre-defined distributions), which are used as parameters (producing high and low variants), so that when combined many scenario outputs can be generated. This process is described more fully in the 'Planning Factors' report.

12.5.3 The demand parameters included in the model can be listed, as below (Table 25).

Table 25 Component parameters used in Target Headroom analysis

Component Code	Component description	Distribution Type
D1-1	Accuracy of sub-component data - Overall HH (base year)	Normal/Alt
D1-2	Accuracy of sub-component data - Overall NHH (base year)	Normal/Alt
D1-3	Accuracy of sub-component data - Leakage (base year)	Normal/Alt
D2-1	Demand forecast variation - HH population	Triangular
D2-2	Demand forecast variation - HH PCC growth	Triangular
D2-3	Demand forecast variation - Overall NHH (subsequent years)	Triangular
D2-4	Demand forecast variation - Leakage (subsequent years)	Triangular
D3	Impact of climate change on demand	Triangular

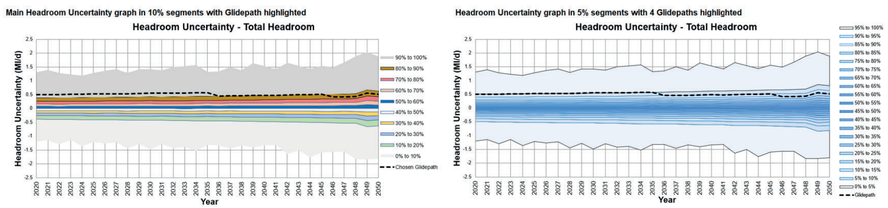
12.5.4 Each of the parameters is generated in the following way:

- D1-1: This is the base-line assessment of household demand derived from the company water-balance.
- D1-2: This is the base-line assessment of non-household demand derived from the company water-balance.
- D1-3: This is the base-line assessment of leakage derived from the company water-balance.

- D2-1: This is the variation of demand (DI) due to high or low population projections, generated using scenarios based upon low and high growth (i.e. ONS_Low_L and OxCam2b_r_P).
- D2-2: This is the variation of demand (DI) due to forecast high or low per capita consumption (PCC), generated using scenarios based upon low/no demand management and the highest demand management.
- D2-3: This is the variation of demand (DI) due to high or low forecasts for non-household demand.
- D2-4: This is the variation of demand (DI) due to high or low forecasts for leakage reduction.
- D3: This is the variation of demand (DI) due to high or low impacts of climate change.

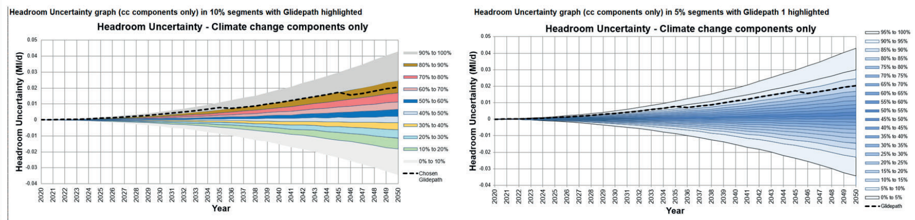
12.5.5 Using 'Oracle Crystal Ball'™ software, we have generated 30,000 scenarios per water resource zone. These have been used to generate a probability distribution of potential future outcomes, from which a glidepath has been selected. Modelled, glide-path outputs for a hypothetical WR, for all the parameters can be shown as in (Figure 55).

Figure 55 Target Headroom modelled glidepaths



12.5.6 Additionally, the climate change parameter trajectories can be visualized as below (Figure 56).

Figure 56 Target Headroom: climate change projections and glidepath



12.5.7 This analysis has generated the following demand contingency at WRZ level (expressed as a percentage of DI uplift). As part of our WRE liaison, we have agreed preferred glidepaths, in order to align with our neighbouring PWCs.

12.5.8 These factors have been reviewed prior to our revised draft WRMP24 submission.(Table 26).

Table 26 Target Headroom Factors for each WRZ

Water Resource Zone	2025/26	2029/30	20334/5	2039/40	2044/45	2049/50
Essex Central	3.68%	3.72%	3.93%	2.46%	3.20%	2.50%
Essex South	4.55%	4.72%	5.57%	1.64%	2.44%	1.91%
Fenland	5.24%	6.29%	7.31%	0.69%	1.66%	1.38%
Hartlepool	3.91%	4.42%	4.97%	2.69%	3.02%	2.35%
Lincolnshire Bourne	3.14%	4.43%	5.55%	3.97%	4.66%	4.86%
Lincolnshire Central	4.54%	5.16%	5.93%	3.61%	4.33%	4.09%
Lincolnshire East	4.73%	5.96%	7.19%	5.35%	6.49%	6.26%
Lincolnshire Retford and Gainsborough	3.67%	3.74%	3.89%	2.51%	3.25%	2.76%
Norfolk Aylsham	3.56%	5.54%	7.02%	5.52%	6.56%	5.93%
Norfolk Bradenham	3.47%	3.65%	3.96%	2.97%	3.93%	3.40%
Norfolk East Dereham	4.18%	4.24%	4.35%	5.49%	6.51%	7.31%
Norfolk East Harling	3.86%	4.87%	4.66%	3.28%	3.68%	3.07%
Norfolk Happisburgh	1.76%	3.32%	4.31%	3.50%	3.67%	2.99%
Norfolk Harleston	2.95%	4.31%	9.06%	8.50%	9.20%	8.46%
Norfolk North Coast	3.64%	5.22%	6.42%	5.35%	6.10%	5.61%
Norfolk Norwich & the Broads	3.61%	3.74%	4.06%	3.21%	4.14%	3.87%
Norfolk Wymondham	3.31%	3.40%	4.12%	3.05%	3.83%	3.33%
Ruthamford Central	2.06%	2.20%	3.19%	2.94%	3.59%	3.18%
Ruthamford North	3.81%	4.24%	5.23%	7.78%	8.70%	7.83%
Ruthamford South	5.80%	7.84%	9.12%	12.93%	13.38%	11.29%
Ruthamford West	2.95%	4.03%	5.12%	4.81%	6.05%	5.51%
Suffolk East	3.06%	4.56%	5.82%	3.73%	4.89%	4.47%
Suffolk Ixworth	2.85%	4.31%	5.49%	4.36%	5.13%	4.60%
Suffolk Sudbury	4.52%	5.91%	7.12%	4.73%	5.54%	4.88%
Suffolk Thetford	3.74%	5.07%	6.12%	3.93%	4.70%	4.24%
Suffolk West & Cambs	6.05%	7.54%	9.39%	7.52%	9.26%	9.11%

12.5.9 The full derivation of Target Headroom is described in more detail in the 'Revised draft WRMP24 Planning factor technical supporting document'.

12.6 Risk mitigation

12.6.1 Whilst being keenly aware of the risks and uncertainties associated with forecasting future demand and with implementing such an ambitious demand management strategy, we intend to mitigate these risks by:

- setting up clear, continuous monitoring strategies with regard to out-comes and especially with respect to the efficacy of our demand management strategy. This 'smart meter monitoring framework' will be described in more detail in our Revised draft WRMP24 'Demand management preferred plan' technical supporting document'.
- adopting 'Adaptive Planning Strategies' dependent upon these outcomes:

12.6.2 Risks will be mitigated by proposing relatively conservative AMP8 targets with continuous review processes.

- Meaningful metrics are being identified for all aspects of the demand management strategy, in order to ensure that we meet our targets for technical rollout, customer engagement and the benefits we have identified and expect to see.
- Trigger points and 'signposts' will be defined, as our demand management programs are implemented to track performance and indicate whether additional supply side options will be required or whether additional demand options should be considered.

12.6.3 Adaptive planning will play a key role in delivering our revised draft WRMP24 demand management plan.

13 Conclusion

13.0.1 We have detailed all aspects of our preferred plan in our three demand related reports:

- 'Demand forecast technical supporting document' - this details the modelling processes that have generated our preferred plan.
- 'Demand management preferred plan technical supporting document' - this details our preferred plan and the reasoning that has informed our preferred demand management strategy.
- 'Demand management option appraisal technical supporting document' - this details our option appraisal process for the selection of our preferred plan.

13.0.2 Our demand forecast and preferred plan has been based upon robust and systematic demand forecast modelling and options assessments applied at a granular level (cohort by cohort and resource zone by resource zone).

13.0.3 In deriving our plan we have been mindful of and taken into consideration:

- our baseline position with respect to leakage, PCC, non-household demand
- projected growth for both household and non-household properties, population and demand,
- realistic / feasible assessments of demand management option impacts.
- Defra/EA targets and policy,

13.0.4 This has led us to generate out-turn values for PCC, leakage, non-household demand and demand per person, that are based upon realistic assumptions and pragmatic assessments.

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