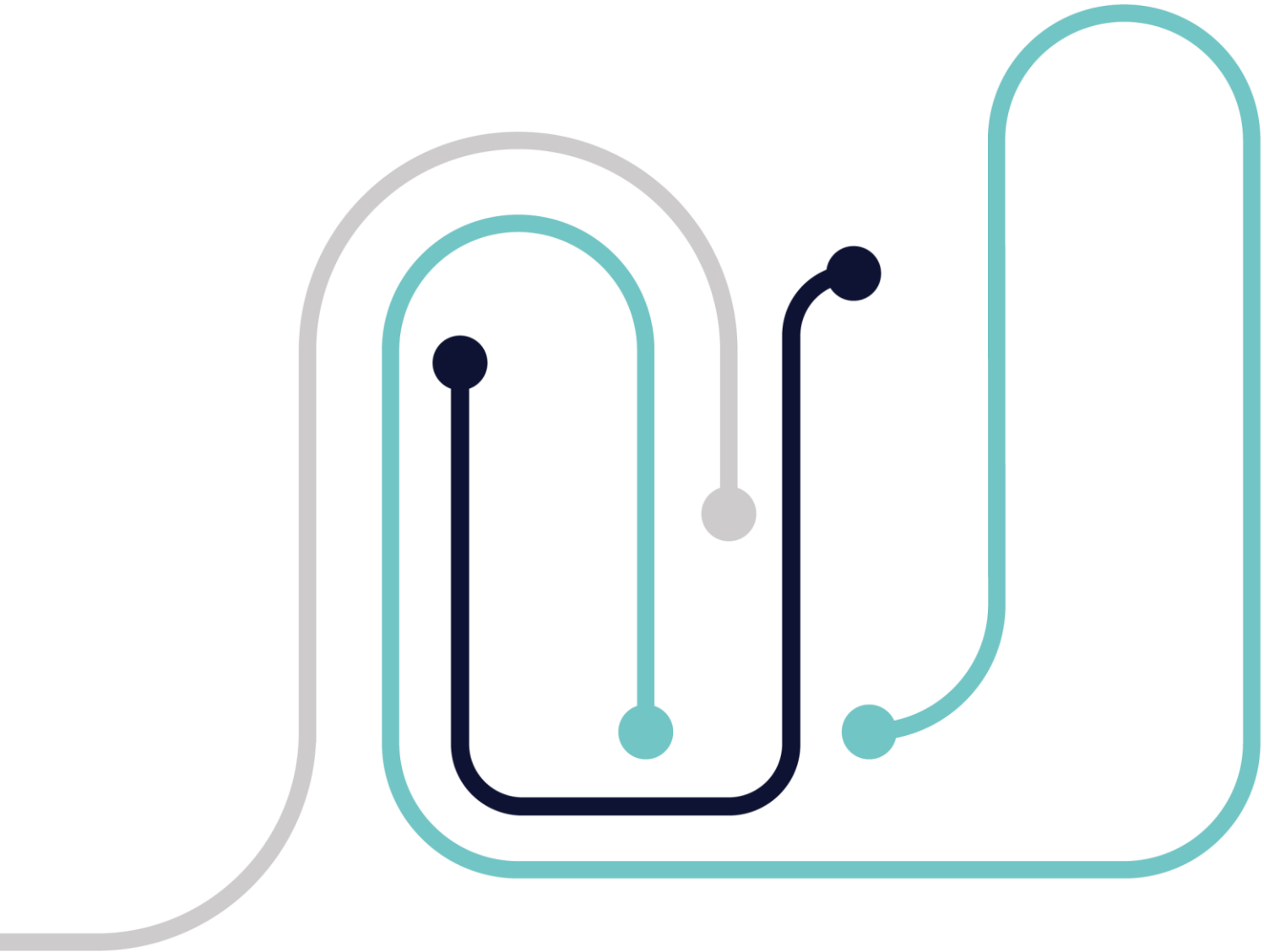
ICS

Anglian Water

Valuation Completion PR24: 2nd iteration

Report FINAL

September 2023



Contents

Part 1

1 Introduction

1.1 Objectives

The purpose of this report is to provide recommended societal values for use in the Anglian Water valuation framework.

The AWS valuation framework has multiple purposes informing both day to day and strategic decision making (through social cost benefit appraisal) and underpinning reporting in line with the Anglian Water six capitals value framework (see Figure 1-1).

The societal values are values for economic, social and environmental impacts that are not captured as part of the financial (private) values that Anglian Water incur as a business. Including the societal values in the value framework allows Anglian Water to drive and demonstrate best value planning and decisions for PR24, BAU and in reporting.

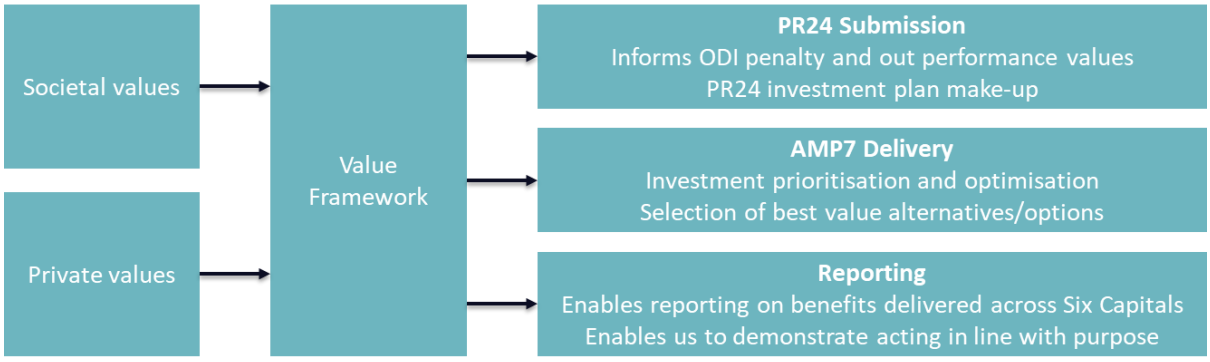


Figure 1-1: Overview of the inputs purposes of the AWS value framework

See 2.1 for further information on why values are required and the AWS value framework.

1.2 Overview

Triangulation was first introduced as a formal requirement of business planning in PR19.

Triangulation is the use of multiple, independent data sources and research methods to produce a common perspective or understanding. It is a means for cross-checking, validating and providing confidence in research results and findings.

Anglian Water has used a range of deliberative, qualitative and quantitative research methods to develop the customer evidence base to support the development of the PR24 business plan and day to day decision making.

The process of triangulation can be thought of as two components:

- Triangulation of values that are used in the value framework as an input into decision making
- Triangulation of plans and day to day investment decisions (e.g. levels of service, pace of change, prioritisation, optioneering, etc)

This report is concerned with the first components the triangulation of societal valuations to feed into the value framework which are an input supporting investment appraisal for changes in risk and performance.

The process of triangulation of values brings together the breadth of customer insight from the AWS PR24 valuation programme and wider engagement programme with evidence from previous price reviews and wider external evidence via a process of interpretation and validation to present the common understanding of customers' and other stakeholder requirements and priorities.

A more diverse range of valuation methods and approaches were tested and used by water companies, including AWS, for PR19 than ever before, in part as a response to Ofwat's reflections on PR14 that companies could improve their customer engagement by widening the scope of customer evidence. This extensive evidence set has be leveraged and built on for PR24.

In developing the approach to triangulation to meet the valuation framework requirements we have reviewed and challenged the well-received AWS PR19 triangulation approach to ensure it is consistent with the latest guidance and updated framework from CCWater.

This report summarises the process of triangulating values and presents the second iteration of the societal valuation set for the valuation framework. As part of PR24 planning these values feed into a wider triangulation process that will integrate further customer data, research and analysis as part of the business planning process.

The report focuses on collating the available valuation evidence to produce a recommended set of values. It does not include testing the valuations in the decision support tools, which is also part of the triangulation process and has been completed separately by Anglian Water.

1.3 Report Structure

The report is structured in two parts. Part 1 of the report contains:

- Section 2 summarises the principles of triangulation.
- Section 3 summarises the triangulation process, as applied to Anglian Water and the alignment with the updated CCWater framework.
- Section 4 contains the key information on the valuation sources.

Part 2 of the report contains:

- Sections 5 to 20 contain the triangulated gain findings and associated assumptions for service measure areas, such as flooding, interruptions, carbon and bathing water quality.
- Section 21 summarises the loss values, using the same assumptions.
- Section 22 summarises segmentation analysis.
- Section 23 contains the summary and conclusions.

2 Triangulation principles

2.1 Why are values needed?

Unlike many goods and services, the benefits and wider impacts of investments in water, wastewater and environmental services either cannot be inferred from the price that customers pay for the service (e.g. the water and wastewater bill) or the impacts are indirect and not priced (e.g. environmental services).

The AWS value framework – structured by the six capitals - provides a mechanism for taking account of these values (see section 1.1 on objectives).

The value framework is made up of a series of metrics that allow the impact of investments to be quantified, measured and reported. An overview of the types of metrics covered by the value framework is shown in the figure below.

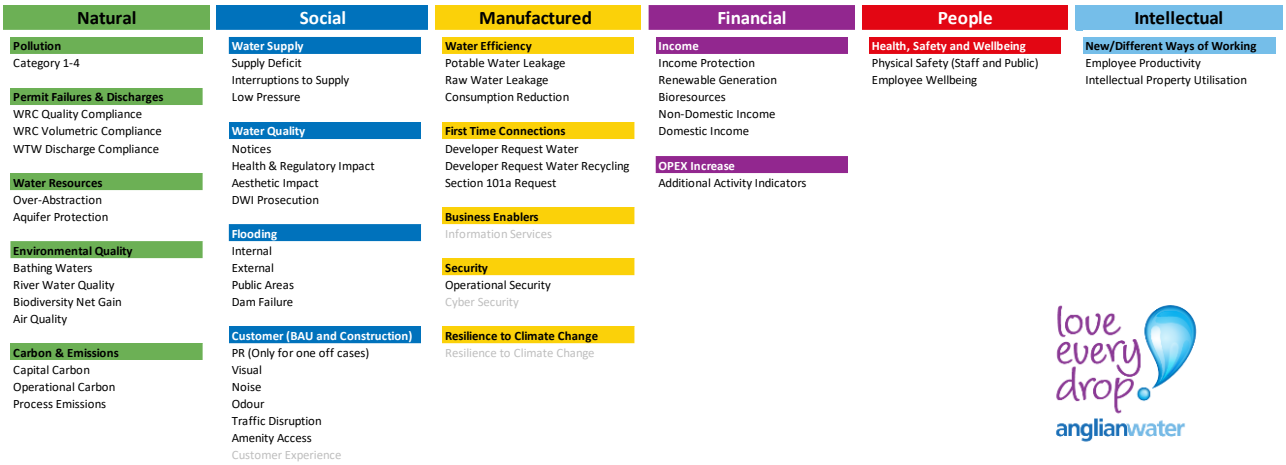


Figure 2-1: AWS Value framework overview

Each of the categories shown in the summary figure have a larger number of metrics sitting behind them. Through the Societal Valuation Strategy refresh project[1] AWS has identified around 240 measures that have an impact that is not captured by the private costs to Anglian Water alone. If these impacts are to be fully taken into account in decision making, they require a value, to ensure customers preferences are appropriately considered in investment decisions.

The value framework provides a mechanism for AWS to identify and target best value interventions in the planning process.

2.2 Objectives of triangulating values

The objective of a robust valuation triangulation process is to increase the reliability and acceptability of valuations used in decision making by incorporating the range of available evidence (both quantitative and qualitative). This in turn will increase the acceptability and legitimacy of the decisions themselves.

Drawing upon the HMT Greenbook guidance the approach we apply is to produce a central value with a range based on the available data. This approach explicitly takes account of the inherent

[1] AWS Societal Valuation Strategy Refresh,2022

uncertainties in the valuation information both within a single source and across multiple sources. Using this range to stress test plans and decisions allows Anglian Water to identify where uncertainty materially effects plans and decisions. This in turn allows efforts to be focused on refining evidence where it matters.

2.3 PR19 approach and feedback

Triangulation was first introduced as a formal requirement in PR19.

Ofwat's Final PR19 Methodology set out the context for their requirement for increased triangulation linked to their view that 'Companies should use a broad evidence base on customer preferences to challenge the degree of stretch in their proposals' (page 42).

In response AWS developed a multi-stage iterative approach to triangulating values (Figure 2-2). Over 600 quantitative valuation evidence data points were collected across a range of services and performance levels.

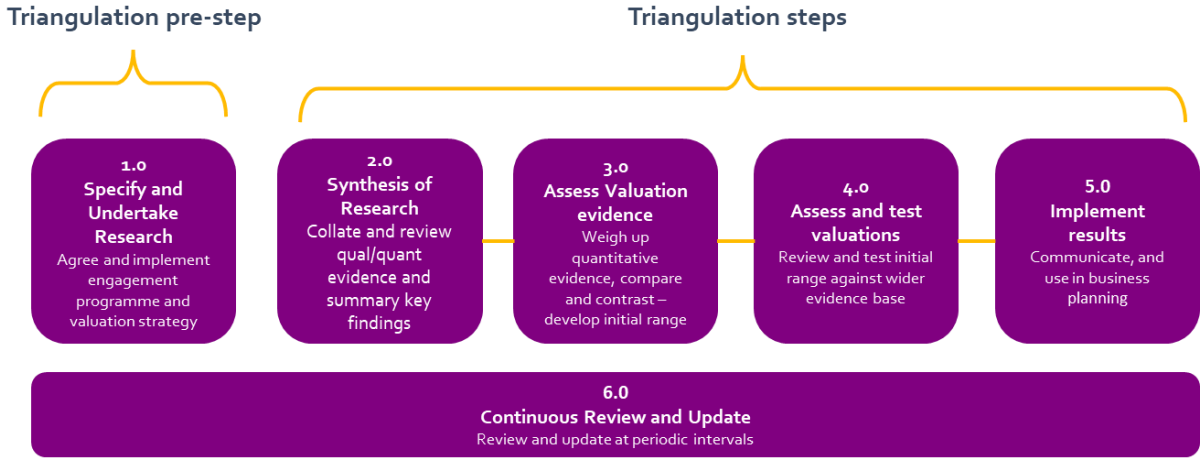


Figure 2-2: AWS PR19 triangulation process

Following PR19 Anglian Water has developed their six-capital value framework and embedded it in day-to-day decision making. To support this, a further exercise was undertaken in 2020 to ensure coverage of the six capitals. This focussed on the addition of measures and values for a number of values, including social capital impacts[2].

FEEDBACK ON THE PR19 APPROACH

To ensure that the approach going forward is fit for purpose the feedback from PR19 has been reviewed.

The approach was well received by both the Anglian Water Customer Engagement Forum and Ofwat, with AWS receiving an A rating for Customer Engagement. The 2021 CCWater review of triangulation best practice[3] also identified several aspects of the AWS approach as examples of good practice.

[2] ICS undertook a project to develop values for social capital measures and AWS separately developed further measures.

[3] Sia Partners on behalf of CCWater, 2021, Triangulation- A review of its use at PR19 and good practice

Further minor detailed points of feedback and how the approach has been adapted are captured in section 3.

Customer Engagement Forum report:
"Anglian Water has, in virtually all cases, adopted a very structured and transparent approach to triangulation, based on a series of logic steps comparing latest valuations with Anglian Water PR14 results, uprated for inflation and customer base dimensions, with a conservative bias to produce a recommended value range."

Ofwat IAP feedback:
"The company provides convincing evidence of the effective use of a wide range of customer engagement techniques, (both on triangulation and segmentation) including innovative multi-stage willingness to pay research for which assurance was provided. The business plan provides convincing evidence to demonstrate the very detailed triangulation process it has undertaken as part of its valuation research and that the triangulation approach was mapped to the CCWater guidance. External assurance of the triangulation process found no major shortcomings."

In their price determination the CMA also highlight the importance of understanding differences in values where the uncertainty range is large, or there are large differences between different sources of values[4].

2.4 CC Water review and guidance

The 2021 review of triangulation use and good practice by CCWater sets out the recommendations to enable good practice triangulation for PR24 (Figure 2-3). These recommendations have been taken into account in refining, evolving and developing the AWS PR19 approach for PR24.

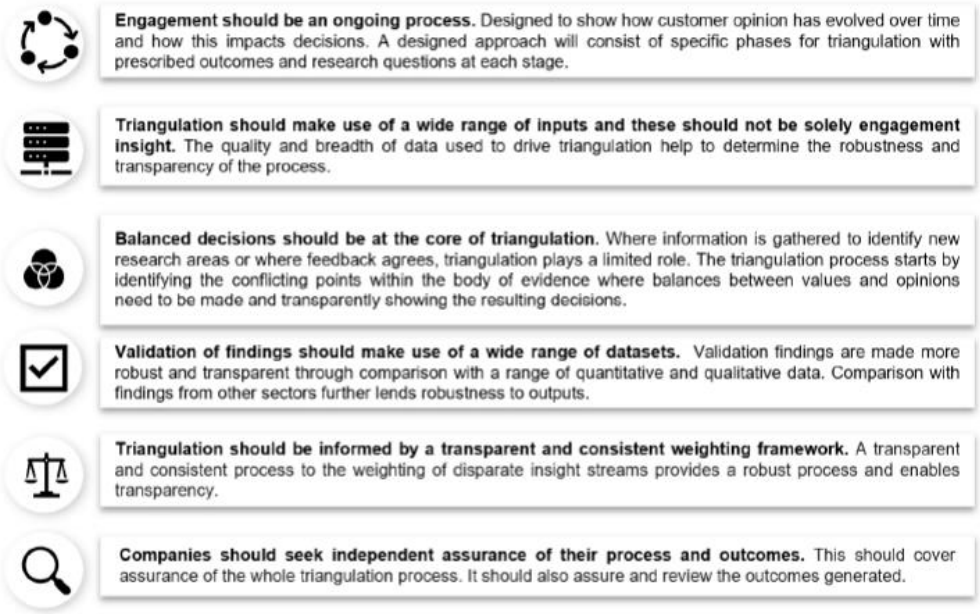


Figure 2-3 CCWater recommendations for triangulation at PR24

Source: CCWater and SIA Partners, Triangulation - A review of its use at PR19 and good practice (2021) P.5

[4] CMA, 2021, *Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: Final report*

Overall, CCWater highlight that a multi-staged approach to research and triangulation gives confidence in results. They also state there should be a transparent approach to triangulation with a clear decision framework and external challenge.

To aid this the CCWater guidance also proposes an updated framework. This is designed to be non-prescriptive but provide enough detail for companies to benchmark their approaches (Figure 2-4). The updated CCW framework is used to benchmark the AWS PR24 approach that is outlined in Section 3.

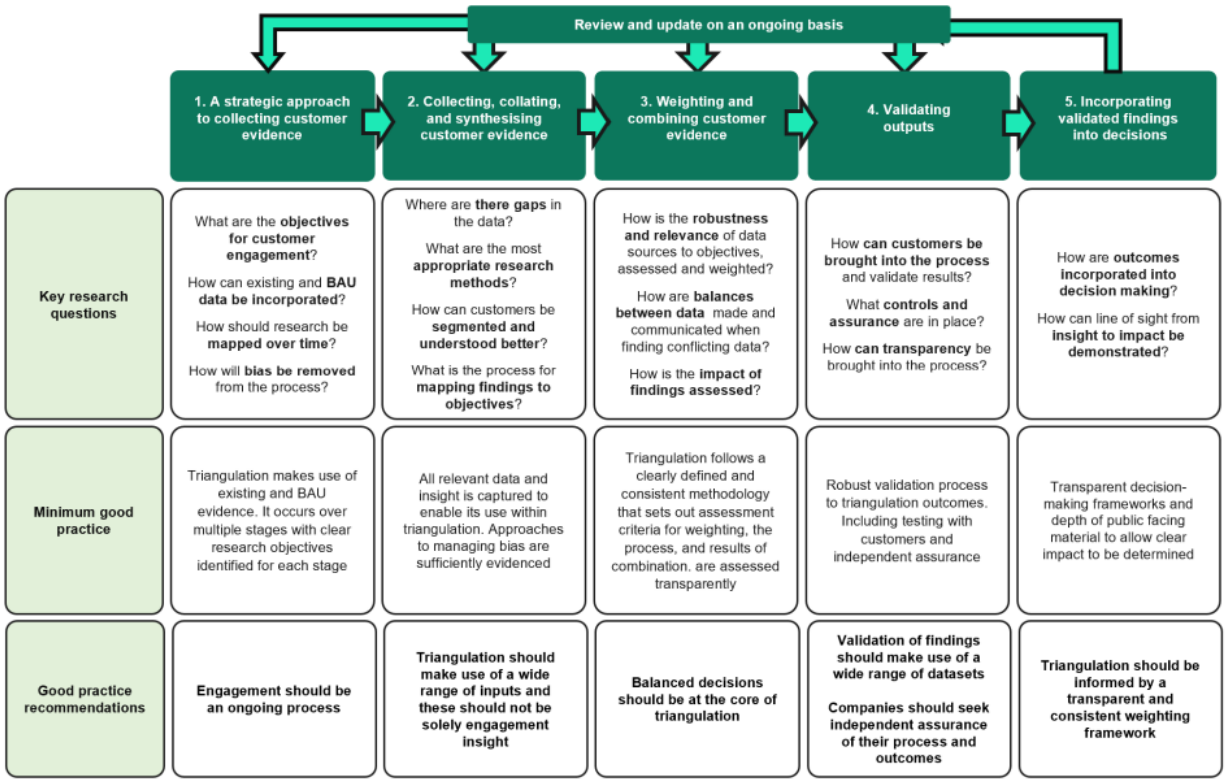


Figure 2-4 CCWater triangulation updated framework

Source: CCWater and SIA Partners, Triangulation - A review of its use at PR19 and good practice

3 Triangulation process

3.1 Overview

We have reviewed feedback and the latest guidance in detail to inform how to develop the AWS approach to triangulating values. A key step in this process has been to compare the AWS PR19 framework to the CCWater framework (Figure 3-1).

This mapping shows that the Anglian Water process is consistent with the CCWater framework. As a result, and reflecting the positive feedback, we have used AWS PR19 framework as basis for development.

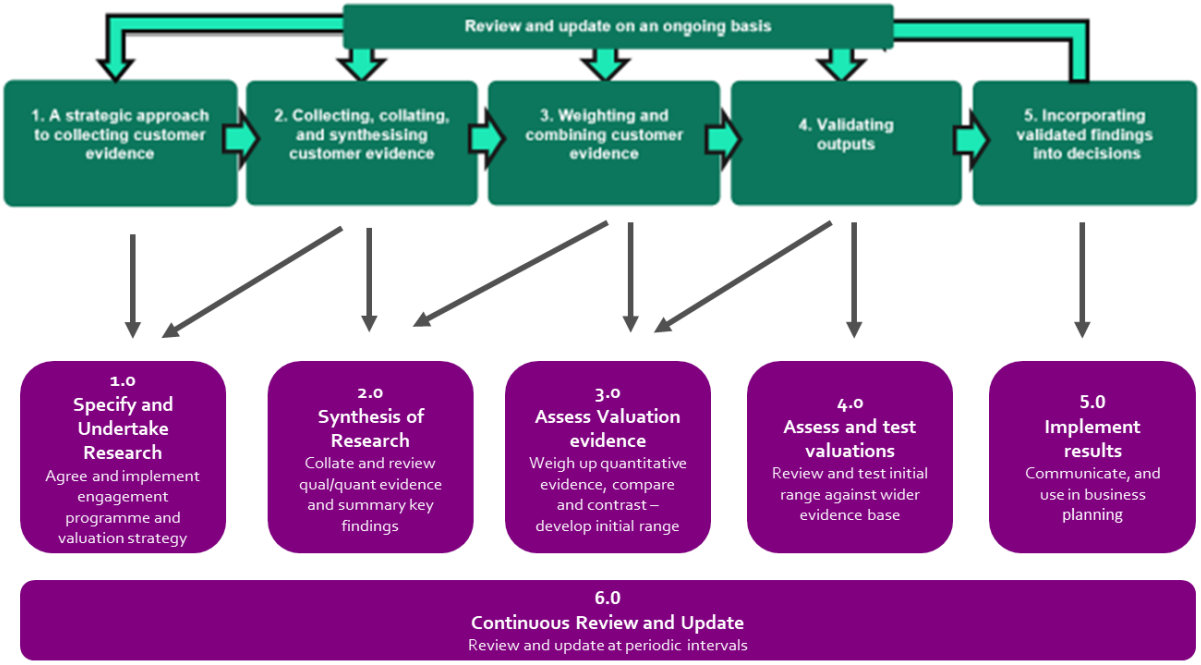


Figure 3-1: Mapping to CCWater Framework

The process steps for the AWS triangulation framework are outlined in the rest of this section. In each section we highlight how the approach maps to the CCWater framework, including meeting the minimum requirements and good practice.

Note – this report covers the triangulation of values that feed into planning and day-to day decision making. As a result, it focuses on undertaking Steps 2.0 and 3.0 for the available evidence. It also includes the assessment of the qualitative evidence under Step 4.0. It does not include triangulation of the business plan activities, such as testing the valuations in the business planning process/decision support tools and any subsequent testing that may occur (e.g. acceptability testing), which is also part of Step 4.0.

3.2 Step 1.0 Specify and Undertake Research (Pre-Step)

SOCIETAL VALUATION STRATEGY AND RESEARCH PROGRAMME

The research has been undertaken by Anglian Water in accordance with its customer engagement programme, which includes the Societal Valuation Strategy (SVS).

The societal valuation strategy explores the potential role of valuation methods to populate AWS' societal valuation framework and sets out a programme of valuation research to inform the update of the values.

In early 2022 Anglian Water commissioned ICS Consulting and eftec to inform the development of a Societal Valuation Strategy refresh[5]. The strategy built upon an earlier one developed in 2016-17 by NERA which included a detailed assessment of the range of customer valuation techniques that could be deployed to deliver the societal valuations required by the business. The PR19 strategy subsequently led to an extensive research programme that has provided a good base to build on and leverage for this iteration.

Key steps of the 2022 Societal Valuation Strategy refresh included:

- **Phase 1: Discovery** – Identifying the business and wider valuation needs including regulatory expectations and review of feedback. Collecting information on the existing approaches to form a baseline view including:
    - Review of the evolution of methods relative to PR19 to identify further opportunities for valuation and evidence.
    - Review of the six capitals framework approach to identify potential gaps and best practice through a comparison to external evidence.
    - Review of the development of the AWS value framework to identify new or updated list of service measures to value (the Service Measure Framework (SMF)).
    - Review of existing triangulated values and sources.
- **Phase 2: Development** - Utilised the information from the discovery phase to build a strategy. It covered:
    - Prioritisation of service areas for refresh through combining an assessment of materiality, customer priority and the ability of values to influence decisions with the assessment of the existing triangulated values.
    - Identification of options/recommendations through mapping methods to each service measure.
- **Phase 3: Roadmap** - Defined work packages and timetable for proposed updates to the societal valuation strategy.

[5] NERA "Developing a PR19 Societal Valuation Strategy", prepared for Anglian Water, February 2017.

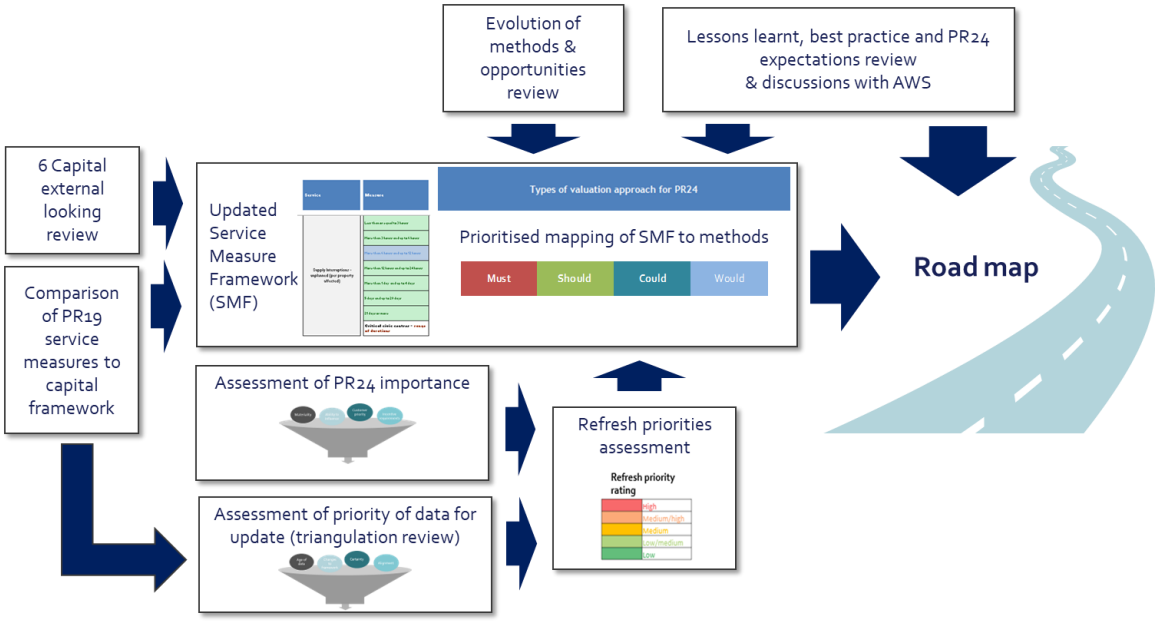


Figure 3-2: The PR24 Societal Valuation Strategy process

The SVS sets outs the approaches to sourcing and estimating customer, wider societal and environmental valuations. It includes:

- Strategic Objectives
- Suitable methods to be used for primary direct & indirect valuation for each Service Measures that makes up the Service Measure Framework
- A series of research studies, including how they fit together into one coherent overall valuation programme within the overall customer engagement/understanding strategy
- Priority PCs/SMs

The SVS outlines that customer insight to inform the triangulation of values can broadly be considered under three categories:

1. **Customer preferences** – priorities and valuations for the provision of services, used in strategic business planning and investment appraisals;
2. **Customer behaviour and actions** – in response to service levels and service issues, used in design of solutions and delivery and can provide an input to valuation; and
3. **Customer experience** – measured and reported through contact and tracker-type data, used as metrics of company performance.

Customer preference evidence and in particular valuations for changes in service levels and associated social and environmental impacts are a key input into the triangulation. However, additional layers of evidence can be provided through observing the actions customers undertake and examining how these change with varying levels of performance/service and overlaying customer experience data on top of valuation data to validate results.

The SVS identifies the range of evidence which aligns to each aspect of service, as shown below. This includes identifying softer engagement, customer contacts, deliberative research, etc. Further details on the types of evidence used in the triangulation process are outlined in Section 4.

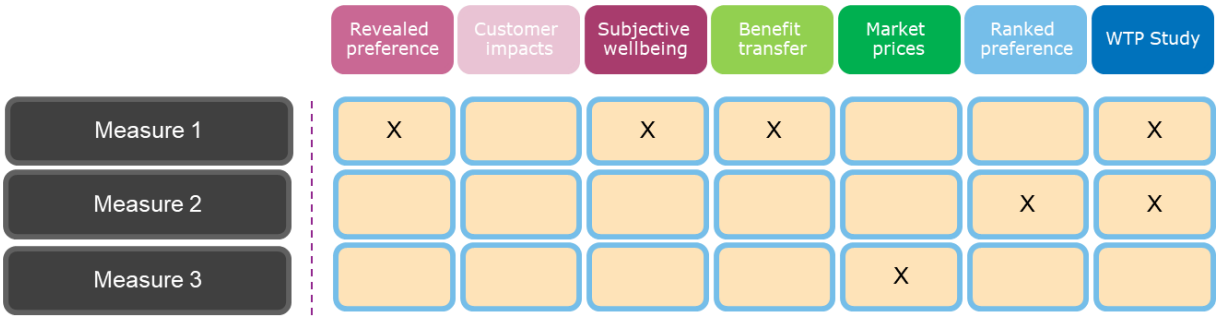


Figure 3-3: Range of Evidence - illustrative

Alignment with the CCWater framework

Good practice

- **The good practice recommendation is that engagement should be part of an ongoing process.** The valuation programme has been developed to be iterative and build upon the previous information collated at PR19 and in 2020 to prioritise evidence collection where it can have the greatest impact.

Minimum good practice

- **To meet minimum good practice, it is recommended to make use of existing and BAU evidence. The triangulation is also expected to occur over multiple stages with clear research objectives identified for each stage.** AWS societal valuation strategy and the wider engagement programme and synthesis has been developed with clear objectives. They consider of the role of both business-as-usual data and existing evidence and how this can be used within the triangulation of values. The incorporation of BAU data into the process is an area where the CCWater review highlights AWS for good practice.

> **Anglian Water: Incorporating BAU data into the process**
>
> Anglian water mapped each source of evidence including BAU data against service measures and outcomes, they also looked at each specific service measure and identified where information would be useful, determined if there was sufficient range of existing information and highlighted any gaps.
>
> They collated relevant studies, research, and customer insight, through a Synthesis report, written by an independent author, and updated on a monthly basis as further engagement was added to the evidence base. This included BAU data from customer complaints and enquiries, and call centre data.

- **A further recommendation is to consider how to remove bias from the process.** The potential for bias has been considered upfront. In addition, to the AWS sampling strategy clearly defining the representative population and segments to consider, the valuation programme has been developed to cover a range of methods (thereby accounting for differences due to methods) and views from both uninformed and informed customers.

Coverage of CCWater framework step 2

- **In step 2 CCW recommends that the most appropriate research methods are identified and findings are mapped to objectives to identify gaps.** This step identifies the most appropriate research methods upfront and includes an assessment of the mapping of both the existing and potential research and identification of gaps in

3.3 Step 2.0 – Synthesis of research

The aim of this step is to:

- Collate relevant studies, research and customer insight
  - Record descriptive & factual information that is available from the study in database, e.g. study date, methodology and type of use and non-use values captured, researcher, sample size, geographic area – national or regional, purpose/primary aim of data collection etc.
- Document the results of the research and capture in a database
  - WTP point estimates and ranges by e.g. households (mean/median) and businesses. These need to be by unit, especially where the units of service are not uniform across studies (e.g. properties v. contacts; internal flooding v all flooding; etc). Similarly starting service levels should documented as well as the changes in service levels that the values are being elicited for.
  - Other customer insight e.g. priorities, rankings etc.
  - Qualitative findings or research.
- Synthesise the findings
  - Assess each source for robustness and relevance.
  - It is important to stress that both quantitative and qualitative data are important in the triangulation process and need to be collected. In this step it is important to identity where the qualitative and wider research (i.e. not direct valuation research) feeds into the process (e.g. Step 4, plan balancing, etc).

The evidence should be mapped to the service measures in the SMF and PCs to confirm there is coverage of each measure.

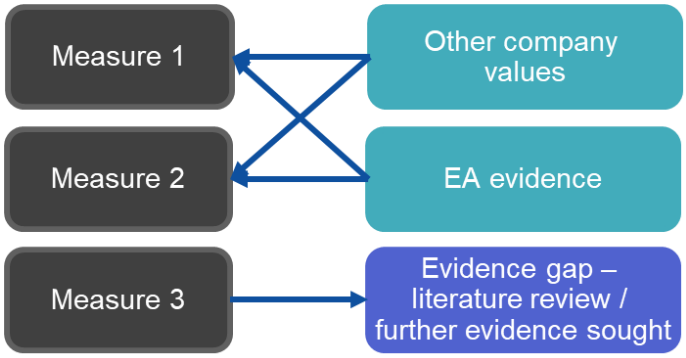


Figure 3-4: Mapping data sources

There should be sufficient coverage for each service aspect in terms of application of valuation methods, proportionate to its importance in the business planning process:

- Stated preference and revealed preference
- Other PR24 and previous price review quantitative and qualitative studies
- Operational and business as usual data
- Value transfer including other companies' data, EA valuations, govt valuations, etc.
- Subjective wellbeing

- Market data and macroeconomic analysis

We note that Anglian Water has a long-established process of synthesising all research into a single report[6]. This is a key input into the triangulation process. The mapping of the evidence also includes identifying the appropriate step in the AWS triangulation process (see step 3 and 4 for further details).

WEIGHTING OR FAVOURING EVIDENCE

The extent to which each source is favoured or weighted is a key part of this step.

The HMT Magenta Book (supplementary book to the HMT Green Book) provides critical questions that provide guidance on how to appraise evidence sources that can be used to develop business cases and business plans as to its robustness and relevance. This has been combined with information from the CCWater triangulation process and the Defra benefit transfer guidance to provide an overall set of critical questions against which each valuation evidence source can be assessed.

The final set of critical questions used to appraise evidence are outlined in the table overleaf.

[6] Anglian Water Customer Research & Engagement Synthesis report. For PR24 the report is being updated quarterly.

Table 3-1: Questions to assess robustness and relevance of individual valuation studies

Area	Criteria	Questions	Interpretation **(Applicable depending on study and information available)**
Robustness	**Methodology**	• Is the methodology employed robust?	• What method was used? • What types of use and non-use values are captured? • If stated preference, how was the survey undertaken e.g. online, face-to-face. • Is this an established or innovative method? • Was the study peer reviewed, if necessary?
	Sampling/ Representativeness	• Is the sample representative of the population? • Is the sample size adequate?	• Are any selection biases in the achieved sample effectively accounted for? Were quotas applied and, if applicable, were the results weighted? • Are customer subgroups and segments identified and studied? • What was the sample size and is this sufficient for the type of study?
	Estimation	• Is there a robust statistical approach to analysing responses? • Are the results robust?	• Were appropriate statistical tests used to analyse responses? • Were those conducting the analysis suitably qualified/competent to apply these tests? • Are the results statistically significant according to best practice tests (applicable to methodology)?
	Evaluation	• Is there a formal assessment of validity? • Are any weaknesses and issues made clear – and effectively dealt with? • Is the research part of a set of repeat studies?	• What is the scope of any validity testing? Does it include a) assessment against prior expectations; b) comparisons with other studies, methods, data sources, etc; c) content validity (bias testing - behavioural economics, qualitative testing, understanding of respondents). • If study is part of a set of repeat studies how have earlier versions been considered and weighted? Does this approach improve robustness? Are these considered in the study &/or weighted or are they assumed to be separate results within the triangulation process?
Relevance	**Definition**	• Is the definition of the service/good in the study consistent with the definition of the good being assessed?	• Does the definition match? • Is any interpretation required to ensure the study/source is comparable? • Are there any critical assumptions for translating the values into the appropriate units for use?

	Level & range	• Are the status quo and changes in service levels consistent?	• Is the current level of service similar? • What range does the study cover and is this an improvement or avoiding a deterioration? • Are there different values over different ranges?
	Customer base and context	• Is the customer base consistent? • Is the wider context consistent? Are there key factors that could affect the values?	• Comparison for socio-economic structure, business customer base? • Are there significant geographic or contextual differences that could affect the value? For example, availability of substitutes, distance from good?
	Age of research	• How old is the research and does this impact on consistency?	• Have there been any changes that could affect value? E.g. was the research undertaken following an event that could cause bias?

Applying these critical questions to each evidence source allows a transparent assessment of how much each evidence should be favoured in the triangulation process. Each data source is assessed separately for robustness and relevance on a five-point scale:

- High (H)
- Medium/High (M/H)
- Medium (M)
- Low/Medium (L/M)
- Low (L)

Whilst the assessments are generally consistent across a study, they can vary for different values within a study, e.g. due to relevance of definitions. Overall Anglian Water research values are the most relevant and most robust valuations since these studies are designed to deliver values linked to the service measures including levels of service, meet the AWS customer segmentation strategy and provide the most up-to-date evidence on customer values. These are the 'core' or 'primary' values. Other sources of data – such as other companies' values – are typically less favoured and as such are more appropriate as a cross check and are 'secondary' values.

Note – there are exclusions to this. For example, where the value transfer is from a government source such as carbon or health and safety.

Alignment with the CCWater framework

Good practice

- **The good practice recommendation is all relevant data and insight is captured to enable its use within triangulation. Approaches to managing bias are sufficiently evidenced.** The AWS process provides a systematic process for identifying and capturing data from multiple sources. The robustness and relevance assessment criteria have been developed to ensure that the relevant data is assessed to enable appropriate use within the subsequent triangulation steps. This process is designed to identify the suitability and potential bias within evidence. It includes capturing any difference found for segments.

> **Anglian Water and South West Water** made use of a weighting matrix based on an assessment of sources robustness and relevance (as related to the assessment purpose). The higher the degree of robustness and relevance, the higher the weighting the evidence receives. Robustness was assessed by taking account of the research method used to generate the primary data and its suitability for triangulation. Relevance was determined by reviewing the relevance of the evidence to the service area being triangulated.

Minimum good practice

- **The minimum good practice recommendation is that triangulation should make use of a wide range of inputs and these should not be solely engagement insight.** The evidence collected covers input from a range of sources and not solely engagement insight. This includes the prioritised and targeted valuation programme, the wider synthesis of AWS evidence including operational data such as complaints and the collation of external sources of evidence from both other companies, standardised sources and other published sources.
- **A further recommendation is that the process for mapping the findings to objectives is developed and that gaps are identified**. The mapping of the findings to the service measure framework allows a check on the coverage of the evidence after the research has completed (this provides a useful check on the upfront mapping covered by step 1 and allows additional evidence to be taken into account).
- **The framework also questions how can customers be segmented and understood better.** The robustness assessment includes a review of how representative the study and findings are as well as whether differences have been found by segment.

Coverage of CCWater framework step 3

- **A recommendation in CCW step 3 is that robustness and relevance of data sources to objectives is assessed and weighted.** This step provides a systematic approach to assessing robustness and relevance of data source to objectives that is routed in best practice guidance e.g. HMT Magenta Book, Defra Benefit transfer guidance.

3.4 Step 3.0 Assess valuation evidence (to produce recommendations)

The aim of this step is:

- Understand the units of measurement for the service measures for which valuations are needed – either adjusting valuations as needed to ensure consistency of the definitions, or recognising any differences.

- Inflating all values to a common price base so all valuations are consistent.
- Aggregating values (e.g. from per household value) given the size of the customer base.
- Comparing different types of valuation and evidence sources e.g. for differences and similarities.
- Use of confidence intervals where available to identify conflicting evidence.
- Developing an appropriate recommended range that reflects the valuations scope, taking into account how robust and relevant each source is.

SERVICE MEASURES VERSUS PERFORMANCE COMMITMENTS (PC)

The business plan is presented to customers and stakeholders summarised by Outcomes and PCs. However, the detailed investment planning process involves understanding risks and the impacts on customers and other stakeholders at a greater level of detail.

For example, consider internal flooding. The list of service measures to inform the value framework (the Service Measure Framework (SMF)) contains a range of severity categories – property type. Whilst all flooding is unpleasant the impact on customers varies according to property type and the SMF is designed to capture that. Differentiating between these impacts is therefore an important part of integrating customers' views into the business planning and prioritisation process.

The service measures that make up the SMF are individually valued. These aggregate to give the average valuation for all property types.

AGGREGATING VALUES

Values collected at per household and per business need to be converted to aggregate values (i.e. aggregate across the customer base given its size and composition[7]). They can then be compared to other aggregated values.

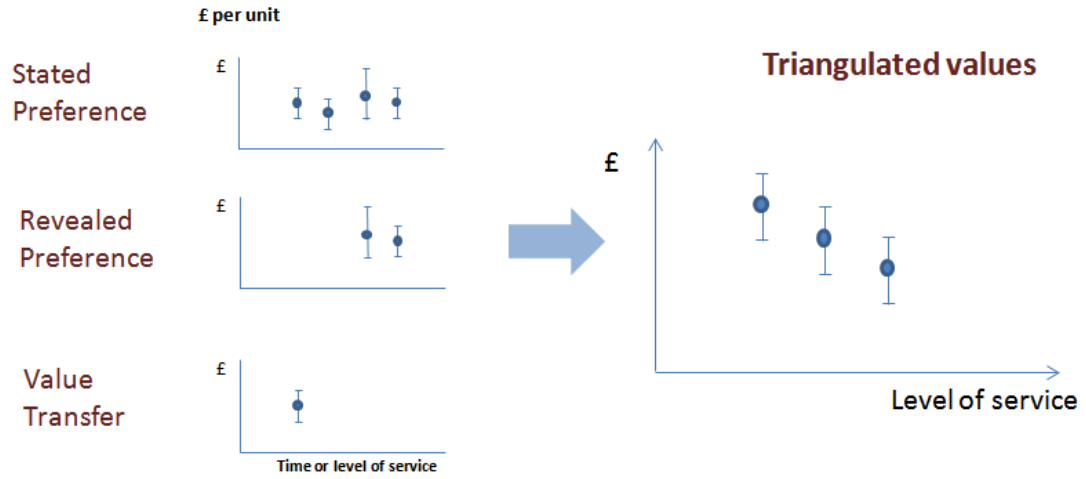


Figure 3-5: Values from multiple sources aggregated to one set of values

[7] The assessment in this report uses the following AW customer base (including Hartlepool) figures: Household customers – water = 2,077,374, wastewater = 2,681,851; Non-household customers – water = 105,259, wastewater = 105,046. Figures provided by Anglian Water.

To do this requires valuations that are comparable. This means comparing values in the same units of measure, the same price base, same customer base and following good practice guidance for using value transfer.

STRUCTURE OF APPROACH

The application of Step 3.0 of the process is outlined in the figure below. It allows for the following:

- Data comes from one of two sources - primary/core (AW customer data) or secondary /crosscheck evidence (other company/area data).
- Valuation data tends to be more widely available for a number of key measures (referred to as anchor measures).

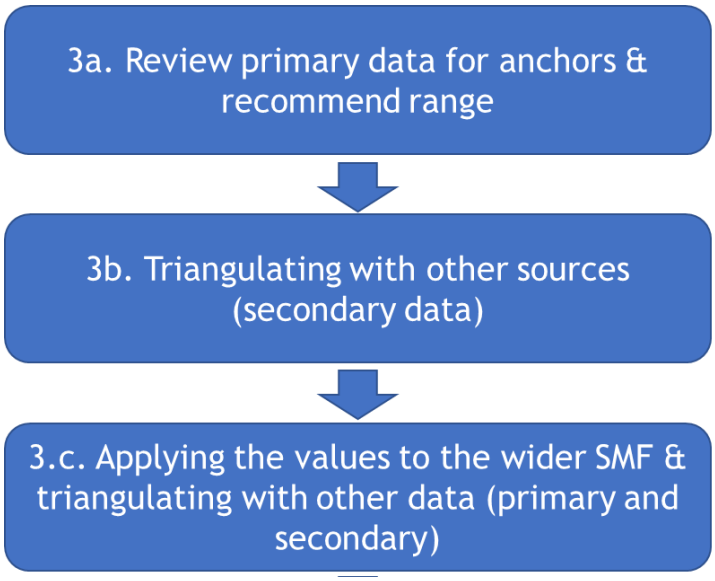


Figure 3-6: Step 3.0 sub-steps

A summary of each sub-step:

- Step 3a - Primary data & initial recommended range: This step focuses on the primary data available for the anchor measure being triangulated. These are measures where the majority of the valuation information lies e.g. 6 to 12-hour interruption. The approach recognises that valuation data is usually available for different customer types in line with the AWS customer segmentation strategy - household, non-household and combined (all) customers. The data including confidence intervals are compared at these levels to produce a recommended range.

  Part of Step 3a also includes reviewing how customer preferences and WTP value vary by key customer segments within the core primary valuation studies. This provides an important part of the triangulation process as it can inform the extent to which specific customer segments may hold different WTP compared to the average WTP values that underpin the recommended values.
- Step 3b - Triangulating against other sources (secondary data) involves comparing the recommended ranges from Step 3a to the available secondary data. This step is also split by customer type as outlined in Step 3a to reflect that types of secondary data that are available. This allows observations as to whether the ranges from Step 3a are in line, higher or lower than the available secondary data. The reasons for this can be explored. For example, differences in definition, area or valuation type. Understanding the likely reasons for the differences helps

inform a view on whether the range from Step 3a is likely to be appropriate or whether further evidence should be sought.

- Step 3c - Applying the values to the wider service measure framework and triangulating against other data (primary and secondary). In this step the recommended values for the anchor are mapped to the wider SMF measures using available customer preference data (second stage studies that provide valuation weights to link to anchor values). The figure below provides an example of the SMF for supply interruptions. The anchor is an interruption of 6 to 12 hours and is shown in dark blue.

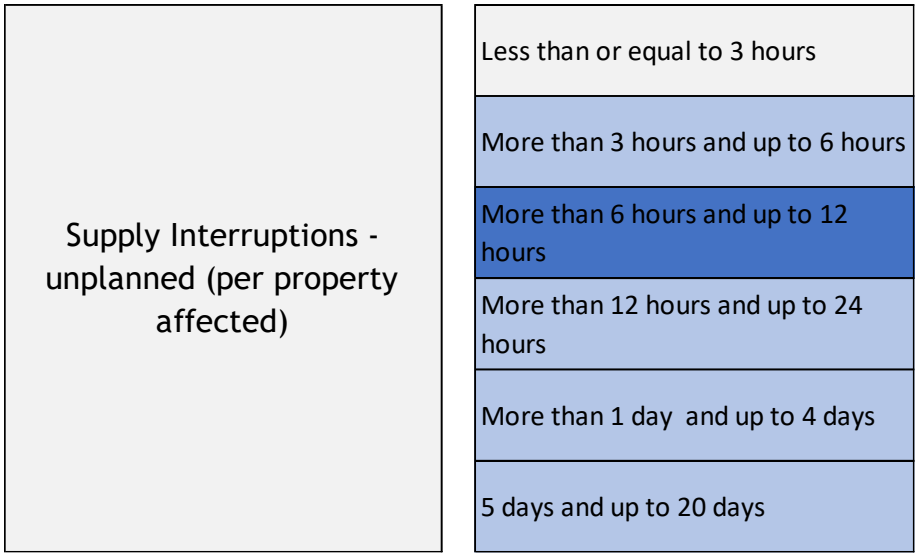


Figure 3-7: Step 3c example

Other primary & secondary data is then linked to the wider measures and compared to the weighted values. This comparison reflects the customer type (household, non-household or combined). The figure above shows that other primary and secondary data is not available for all the measures. In the example, data is available for interruptions lasting greater than 3 hours. For the less than 3 our durations only customer preference weights are available at this stage.

- The outputs of this step are recommended values that will be compared to wider evidence in step 4.0. This step highlights areas where evidence is strong or where further evidence or research should be sought.

Measures that do not link to an anchor from the primary valuation studies are also covered in this report and the assumptions that have been made or updated outlined.

Further points to note are:

- The approach to identifying conflicting evidence is explored further in section 4.6. This is an area highlighted in the CCW 2021 review.
- A review of the previous Customer Engagement Forum comments from PR19 identified areas for development. These include:
    - The approach to transferring and comparing other company values. This is addressed in more detail in Section 4.
    - Challenges on the application of specific value data for leakage and sewer flooding. These points are addressed under the relevant sections in part 2 of this report.

- The PR19 CEF also discussed the segmentation of values for low-income groups. This included different approaches to applying the findings such as adjusting the central values, the trade off with the more conservative scaled value approach (see section 4.3) and whether covered by the ranges. This is addressed in more detail in Section 4.

Alignment with the CCWater framework

Good practice

- **The good practice recommendation is that balanced decisions should be at the core of triangulation.** The rationale behind the assessment criteria and being rooted in established assessment guidance helps ensure a balanced approach to weighting. The development of a centralised value with a range allows for a systematic approach to identifying conflicting data.

Minimum good practice

- **The minimum good practice recommendation is that triangulation follows a clearly defined and consistent methodology that sets out assessment criteria for weighting, the process, and results of combination are assessed transparently.** The process sets out a detailed, step by step approach to triangulating values that builds on the assessment in step 2. Part 2 of this report details the outcomes of the assessment criteria and the approach to calculating both the central values and the ranges, including identifying where conflicting data is identified.
- **A further research question identified is how are balances between data made and communicated when finding conflicting data?** The approach of identifying ranges and uncertainty whilst using multiple methods where available provides a transparent approach to identifying and provide clarity around conflicting data (See section 4). The assessment of robustness and relevance is a transparent approach to identify reasons for whether this is genuine conflict or whether there are underlying differences/biases. The iterative approach provides a mechanism to communicate and explore the impact of the conflict (See step 4 for further details).

Coverage of CCWater framework step 4

- **The CCW step 4 good practice recommends that validation of findings should make use of a wide range of datasets.** The AWS process step 3 includes the validation of the triangulated values using external sources and wider evidence that can be used to directly inform the values.

Other

- **The CCW step 3 recommends that the impact of findings is assessed.** This is covered in the AWS step 4.

3.5 Step 4.0 Assess and test valuations

This step covers a number of different assessment and testing processes, namely first, a comparison with the wider evidence from stakeholders and customers, and second, a comparison of the implications of the triangulated values on the investment plan with the wider evidence on service levels.

The former has been collated by Anglian Water in their Customer Research & Engagement Synthesis report for the main service areas that have been valued in this report. The latter part arises as the wider evidence is likely to be in different (not directly comparable) formats and so to make meaningful comparison it is important to compare the implications of the different evidence. This means that some evidence can only be compared once the values have been applied in cost benefit analysis.

To review and test the proposed valuation range against wider evidence base involves the following tasks:

- Understand if the initial recommended range is consistent with wider evidence.
- Understand the impact of the range of values on the business plan – mean, upper and lower levels.
- Understand the implications if the proposed valuations are not consistent with wider evidence or expected impacts on the business plan – i.e. whether this will mean selecting another point in the range due to further evidence, or undertaking further research as part of a review and challenge of the range.

THE WIDER EVIDENCE BASE

The wider evidence base consists of customers, stakeholders, other quantitative research (e.g. priorities research, acceptability research, etc.) as well as other qualitative research. All of this should be used to test the valuations. The evidence can be divided into two groups:

- Evidence that is compared prior to cost benefit analysis and feeds into the economic level of service assessment: This tends to include quantitative and qualitative information on priorities, relative preferences, relative impacts and/or levels of service where there may a change in perception[8].
- Evidence that can be compared post cost benefit analysis and is used to crosscheck and validate the findings from CBA: This would include information such as acceptability research, affordability/social tariffs, GIS problem analysis. This step could also include priority studies.

THE IMPLICATIONS OF THE VALUES

Understanding the implications of the values is important. For example:

- If customers say in qualitative or priority studies that they want to see improvements in one aspect of service, do the PCs that result from the valuations reflect that? And if not, why not?[9]
- If the economic level of service is the same as the current level of service, what part of the range of valuations justifies maintaining service. If not, what value would justify maintaining the current service level and what service levels do the valuation range being used produce?
- Are there any key findings from the wider evidence that contradicts the valuation findings and/or societal values and ranges? What might be driving the difference i.e. different set of customers, type of engagement activity etc?

[8] An example is a threshold where interruptions below a certain duration are not considered a problem but there is a certain duration where customers report a step change in the impact.

[9] This data could be consistent as although customers value improvements costs could be high enough to outweigh the perceived benefits.

Example:

Consider the situation where a valuation for a given service measure that is found to be in the region of £1600 to £1800 per unit, and the mid-value of £1700 is selected. The impact of a value of £1700, and other values from the uncertainty range are considered in the optimisation:

- Does the expected value (i.e. £1700) result in a business plan/investment strategy with an economic level of service that is significantly different to the current level of service? Or does it change how we should deliver service to customers (i.e. the mix of solutions are different to those selected in the past)?
- Do values at the lower and higher end of the range (i.e. £1600 and £1800) change the results significantly or are the results largely unchanged?
- What is the value required to meet a given target (e.g. maintain service, meeting a new standard, etc.) and is that value in the valuation range?

This step involves using valuations and cost information to understand the potential level of service that is cost beneficial under a range of circumstances. To understand this requires running optimisation scenarios, and checking sensitivity and materiality.

The implication of this step is that the proposed valuation selected from the range can be amended or revisited once the evidence that has been compared post cost benefit analysis has been taken into account.

Alignment with the CCWater framework

Good practice

- **A good practice recommendation is that validation of findings should make use of a wide range of datasets.** The AWS process uses a multistage validation process that draws upon a wide range of datasets:
    - Integration of secondary values and preference evidence in step 3 (including other company data, standardised values and wider published data).
    - Validation check for consistency with wider customer evidence collated through the AWS synthesis process in step 4.
    - Internal review and sense check of the relative values through workshops with AWS.
    - The iterative approach allows for AWS to test the implications of the triangulated values, including sensitivity testing which identifies scope for further testing with customers.
- **A further good practice recommendation is that companies should seek independent assurance of their process and outcomes.** The approach is subject to independent assurance by Jacobs and through the Independent Challenge Group.

Minimum good practice

- **The minimum good practice recommendation is to have a robust validation process to triangulation outcomes including testing with customers and independent assurance.** Robust validation process as evidenced above that includes independent assurance.
- **A further recommendation is that customers are brought into the process to validate the results.** The process builds on the findings from PR19 which included playback sessions with customers to validate the triangulated values. This process involved customers reviewing the relative values between service measures and provide further clarity where conflicting evidence was observed. The PR24 valuation programme has been focused to target higher priority areas, including where there is uncertainty, to provide new evidence as well as validation of the existing evidence base. Further customer validation is planned as part of the of triangulation process.

3.6 Step 5.0 Communicate and implement results

This step involves documenting and communicating the results. These can then be used in business plan development and business as usual decision making.

Alignment with the CCWater framework

A large part of this step covers the triangulation of plan outcomes and the documentation of the line of sight for decision making. Whilst the triangulation of values is a key part of this process it only covers part of the CCW framework requirements:

Good practice

- **The good practice recommendation is that triangulation should be informed by a transparent and consistent weighting framework.** The triangulation of values in this report provides a transparent and consistent weighting approach to combine evidence with an audit trail and line of sight from the customer evidence to the development of the recommended triangulated values.
- **A further recommendation is that a line of sight from insight to impact is demonstrated to show how outcomes are incorporated into decision making.** AWS will apply the recommended values in this report as part of their decision-making process alongside wider evidence to triangulate their plan and investment decision outcomes.
- The iterative approach to triangulating values allows for the inclusion of outputs in the business plan particularly in the development of scenarios and strategies in a phased approach therefore providing insight where decisions are sensitive to the valuation inputs. This is an area that the PR19 approach was highlighted for good practice.

> **Anglian Water- an iterative approach to including outputs in the business plan**
>
> The impact of triangulated customer valuations on the business plan were assessed in stage 3 of Anglian's five stage approach. The company made use of optimisation scenarios, and materiality impact assessments to understand the impact of the valuations on the business plan and proposed service levels. The use of valuation data in developing the business plan was an iterative approach and updated as additional data became available from continued customer interactions. The triangulation results directly impacted on performance commitments, ODIs and investment cases, as well as the WRMP.

Minimum good practice

- **The minimum good practice recommendation is that transparent decision-making frameworks and depth of public facing material to allow clear impact to be determined.** The transparent framework is evidenced in this report.

3.7 Step 6.0 Continuous review and update

The final step of the triangulation process is to revisit the results throughout the business planning and delivery processes as new data becomes available and customer engagement continues, and to make periodic updates as appropriate.

As the plan continues to be developed and implemented new evidence should be captured and put into the triangulation process for the next iteration of the valuation set.

4 Key information on valuation data

The data and recommended ranges in this report are the first iteration of this process. The ranges are based on the:

- Full set of valuation data and study results available as of 31st October 2022.
- SMF definitions and categories, with associated assumptions for applying valuations to the SMF, up to 31st October 2022.

This section sets out key information ahead of the results being presented in subsequent chapters.

4.1 Types of data

Previously in section 3.1 we set out three general types of evidence that could be used:

1. **Customer preferences** – priorities and valuations for the provision of services, used in strategic business planning and investment appraisals;
2. **Customer behaviour and actions** – in response to service levels and service issues, used in design of solutions and delivery and can provide an input to valuation; and
3. **Customer experience** – measured and reported through contact and tracker-type data, used as metrics of company performance.

CUSTOMER PREFERENCE AND WILLINGNESS TO PAY

Section 2.1 outlines that the benefits and wider impacts of investments in water, wastewater and environmental services either cannot be inferred from the price that customers pay or the impacts are indirect and not priced. These types of values are called non-market values and they are estimated through economic valuation methods.

HM Treasury's Green Book summaries the hierarchy of main techniques for valuing impacts without a market price. These approaches have strengths and weaknesses that need to be considered when they are used for Social CBA.

The compilation of valuation evidence draws on various sources that employ a range of methodologies for estimating values associated with the provision of water and wastewater services. These are summarised in Table 4-1..

Table 4-1: Range of methods and approaches featured in valuation evidence base

Methods/approaches	Basis	Uses
Market impacts/values and macroeconomic analysis	Includes a range of valuations types, based on: ▪ Actual customer choices from observed behaviour: - Expenditure values, e.g. in response to service failures ▪ Resource costs from market impacts: - Damages and clean-up costs (repair/replacement), e.g. from flooding - Disruption costs, e.g. productivity impacts from service interruptions (such as restrictions) ▪ Market values of goods: E.g. shellfish values	Service issues that result in customers incurring: (i) some expenditure either to mitigate the problem or in relation to damages/clean-up; and/or (ii) a productivity loss. Likely to be a partial valuation of the service issue as this will not incorporate the inconvenience or suffering experienced (e.g. anxiety). Market data is limited to observed datasets but these can also be used to forecast future impacts using assumptions e.g. macroeconomic analysis of water restriction impacts.
Generic prices	Use of Green Book approved and other standardised sources transferable values.	These values are useful benchmarks. As generic values they are dependent on suitable studies being available that align with the definition or can be robustly 'transferred'.
Revealed preference methods (RP)	Assess customer preferences based on observed behaviour. Specific methods include: ▪ Avertive behaviour – examines how market expenditures vary with differing levels of company performance. ▪ Hedonic pricing – examines how demand for market goods varies with various factors (which could include water and wastewater services). ▪ Recreation demand models – examines how use of recreational site varies with various factors, including environmental quality.	Fairly limited scope, since the application of RP methods is dependent on specific complementary or substitute markets relationships. For example: ▪ Expenditure on products that that help improve service quality (e.g. tap water filters) or avoid poor service (e.g. water softeners) ▪ Outcomes that are dependent on service level/quality (e.g. recreation site visits).
Stated preference methods (SP)	Assess customer preferences through survey-based 'choice' methods. Specific methods include: ▪ Discrete choice experiment (DCE) ▪ Dichotomous choice contingent valuation (DCCV) ▪ Paired comparison (PC) ▪ Best-worst scaling (BWS)	Wide scope due to the flexibility of the SP methodology that allows customer choices to be simulated for the breadth of water and wastewater service areas. Can capture both use and non-use values.
Subjective wellbeing analysis (SWB)	Measures how customer wellbeing is impacted by quality of life factors (incl. water and wastewater services).	SWB is mainly applicable to persistent and 'readily' experienced service levels. It can be captured through surveys.
Value transfer	Use of results from previous market, RP, SP and/or SWB sources, subject to assessing the appropriateness of 'transferring' these valuations based on established value transfer principles.	Wide scope – but dependent on suitable studies being available (with robust results that can be 'transferred').

The sources included in Step 3 of this iteration of customer valuations can be grouped into four main components (specific datasets):

- Main WTP stated preference studies: customer valuations from the main WTP Customer Preference Studies conducted by Anglian Water, dating from 2012 (PR14) through to 2022. This also includes multiple studies from PR19. Due to the nature of the water industry (lack of direct markets) stated preference methods remain a vital technique to understand the values of the non-market aspects of AWS services.
- 'Second stage' stated preference studies: customer preference utility weights for: (i) differing severities, frequency and duration of service failure; and (ii) different investment solutions (e.g. water resources options). These results are sourced from four rounds of Stage 2 Customer Preference Studies in 2008, 2012, 2017 and 2022 that provide the basis for valuing the full set of service measures in the SMF.
- 'Other sources' primary datasets: compiling valuations from revealed preference (insurance and avertive behaviour), subjective wellbeing (interruptions and flooding), macroeconomic analysis (water restrictions impacts), preference data from an AWS survey on investment priorities and values and relative preference weights from the PR24 Ofwat and CC Water centralised research.
    - This includes an innovative AWS study with customers that have experienced service failures to provide valuation data using three methods simultaneously (stated preference, avertive behaviour and subjective wellbeing).
- 'Other sources' secondary dataset: compiling valuations from market data, revealed preference, and value transfer sources. This mainly captures valuation evidence from external sources, such as UK Government appraisal guidance values (e.g. flooding) and other companies that are available in the public domain (e.g. 'benchmark' values from PR19).

WIDER SOURCES

The triangulation of values can also draw upon Anglian Water's wide programme of research and operational data and insight. Examples of this type of information are listed below.

Customer behaviour and actions

- Customer contacts
- Social media and contact sentiment analysis to understand the relative severity and impact of service issues.
- Information on customer actions taken in response to service issues.
- Key findings from incentive schemes and pilot schemes (e.g. incentivising customers to reduce consumption, smart meters, etc)
- Trend analyses to identify how customers may respond or be affected over time, such as:
    - Impact and efficiency of investment; e.g. such as impact of metering on consumption, meter switching and switch back rates; uptake of water audits; impact of communication campaigns; etc.
    - Operational contacts resolved first time – which service areas or operational regions incur the most repeat contacts

Customer experience and other sources

- Geographic information systems (GIS) / System level analyses to understand service levels and service provision.

- Customer tracking research
- Customer segmentation analyses
- Customer priorities research
- Deliberative and qualitative methods (e.g. focus groups, workshops)
- Quantitative methods (e.g. customer surveys)
- Acceptability testing surveys
- Stakeholder engagement sessions

4.2 General adjustments to source values

The general adjustments are:

- Inflating the values to a common price base:
    - Previous studies have been updated to September 2022 using CPI as the measure of inflation. AWS PR14 values assumed to be 2012 and PR19 are assumed to be 2017 (indexes for the years applied).
    - AWS 2022 studies are not adjusted as they are based on 2022/23 bill levels, which is consistent with AWS cost models.
- Adjusting primary sources for the AWS customer base. Many of the values used are per household or per non-household customer values. Where this is the case, these values have been multiplied by the current number of AWS customers (including Hartlepool) to allow comparison on a like for like basis. This means that previous AWS data from PR19 and PR14 will be different to the inflated value alone as it has also been adjusted for customer numbers.

4.3 Stated preference studies

Stated preference values are available for all of the anchor values. Stated preference studies can produce different types of values:

- Linear vs Gains/losses
    - Linear: This is one £/unit value that covers the whole range covered by the study
    - Gains-losses: This explores whether the £/unit value for improvements from the current situation differs to the value of avoiding a loss (deterioration in service).
    - In general gains values have been used in preference to linear values for service improvements, where results indicate lower values for the mean per unit value of an improvement. This is a more conservative approach that was supported by the AWS CEF at PR19. Linear and gains values are shown in primary data graphs.
- Both scaled and unscaled values have been assessed. These values address the effects that are observed when large improvements to service are implemented - 'package effects'[10]. In the stated preference studies significant package effects were observed for valuations associated with large improvements to multiple water and wastewater services. As such, aggregate benefit estimates have been produced as scaled (i.e., taking into account the package effects) and unscaled.
    - The use of scaled values may be more appropriate where the application of CBA may result in 'large' improvements across multiple service attributes and thus exceeds the maximum package of improvements customers have indicated they are willing to pay

[10] Package effects are where the sum of estimated willingness to pay amounts for service measures or policies that are independently valued may be different when summed to the willingness to pay estimated for the combined projects when valued as a package. This is also referred to as part-whole bias.

as measured in terms of the impact on the bill. Here it is likely that simply summing the unscaled marginal WTP values for service improvements will over-estimate overall benefits since they do not fully account for substitution effects between attributes valued. However, the use of scaled values as a 'default' is likely to under-estimate the benefits of service improvements for individual attributes, especially if these are 'small' in total.

- At PR19 the peer review demonstrated there are no fixed rules for applying scaling or not; this needs to be agreed using expert judgement based on the study approach and findings. The peer review indicated support for the preferred approach of testing the scaled values first and then to test the unscaled values as part of the business plan testing or sensitivity testing process.

- Testing for differences by customer segment. Building on the approach at PR19, the stated preference WTP values from the integrated WTP study have been tested for differences across the segments outlined in the AWS sampling strategy. The analysis found that lower income segments were observed to be more cost sensitive than higher income segments for wastewater services. The same trend was observed in socioeconomic groups. Greater cost sensitivity was also observed for the digitally disengaged sample, although the differences are minor. Other segments for age and gender did not show significant differences.

4.4 Primary data approach

Based on the section above, this report produces two sets of ranges – one unscaled and one scaled. The findings in part 2 focus on presenting the scaled values. Unscaled values are also included for completeness. This follows significant discussion at PR19 on the values to use. At PR19 AWS used the scaled values in their assessment of plans.

In line with the PR19 peer review, the preferred approach is to use the scaled values as the starting approach for business plan testing. This also provides continuity with PR19. The unscaled values can be used as part of the business plan testing or sensitivity testing process, should it be required.

The approach to identifying the ranges varies for each anchor depending on the information available. Factors that are common to the approach for setting values and ranges can be summarised as:

- Using confidence intervals to inform the low to high range.
- Mainly basing the values on the evidence across all three price reviews taking into account the type of value each source covers – is it likely to be a full or partial value.
- Checking the PR24 values against PR19 and PR14 sources. Where values are consistent, PR14 and PR19 values are used to inform the range. In some cases, either PR19 range or PR14 range is different a lower weight is used. This is particular the case for PR19 where a greater number of sources has the potential to influence the recommended value. If this is the case, then similar studies are treated collectively to avoid undue weight being placed on outliers.
- Further analysis to compare the ranges observed for lower socioeconomic groups with the triangulated value range.

Table 4-2 shows the anchor measures from the service measures framework and the units in which the values are expressed in this report.

Table 4-2: Service measure framework – anchor valuations

Performance measure / OPM	Metric/unit	Severity / level
Supply interruptions	Per property affected	6-12 hours unplanned interruption
Severe water restrictions	Per expected day/ Per expected day per property affected	Rota cut & standpipe
Leakage	Per Ml/d	Leakage
Internal sewer flooding	Per property affected	Inside the living space at a property
Pollution incidents	Per incident	Category 3
River water quality	Per km of river length improved	Change to good status
Bathing water quality	Per site	Change from good to excellent status
Repeated customer contacts	Per customer contact	Repeated contact

4.5 Secondary data

The secondary data presented in this report is data that is available through the public domain plus industry collaborative studies to collate data from PR14 and PR19. This is used as a cross check to understand if the AWS values look high or low. The details of the secondary sources used are covered in the subsequent chapters and Annex 1 which sets out the detailed assessments of robustness and relevance.

A key study that has provided cross check information for a majority of the anchors is the Accent and PJM Economics study of PR19 values[11].

The Accent study provides information on a number of companies' values from PR19. In the report companies are anonymised, and values are presented as regional values (i.e. the £/unit value multiplied by the number of customers). To produce the report the Accent study team worked with water companies to collate values and present the data using a common definition where appropriate. Where this is not the case all the definitions are provided.

Where possible we have identified companies from public domain information.

A challenge raised at PR19 related to the approach taken to transfer these other water company values to compare to AWS values. The challenge was that the regional values for each company as set out in the Accent report did not require adjustment for relative size of the company. The rationale for this is that customers would take into account the level of risk in their decision making therefore values do not need to be adjusted for size.

We have hypothesised that whilst it can be expected that some customers may do this, many would not and the extent of this will be partially determined by the approach and information provided in the source WTP studies.

Recognising these different perspectives, in response, we have used a dual approach to transferring the other water company values to test the validity from multiple points of view:

- Approach 1: using the values from the Accent study in line with the CEF challenge from PR19 i.e. not adjusted for size of region

[11] Accent (2014) Comparative Review of Willingness to Pay Results. Final Report.

- However, a minor adjustment was required so the values are consistent with the AWS source values. When collating the values Accent recognised that companies had undertaken their studies from one of two perspectives. This resulted in either: a) values per household or non-household affected or b) values per property in the region affected. When aggregating values, the former can be proportionally weighted. The latter can be summed. Accent made an adjustment, so all values in their report are presented in line with (a).
- The adjustment made adjusts the values, so they align with (b). This adjustment uses the proportion of either household or non-household properties out of the total number of properties.

- Approach 2: applying a benefit transfer function approach to the PR19 values. This tests the relationship between the values and potential regional explanatory characteristics using regression analysis. A traditional benefit transfer function approach uses the relationship developed to transfer values from one context to another, rather than transferring absolute values, it is the explanation of the values that is transferred enabling values to be generated in the second context. The full suite of likely explanatory variables was not available through the Accent report or public domain information (e.g. the status quo level of service and the change in level of service offered in each study) and so the results of this analysis are likely to have a lower confidence level than full benefit transfer but provide a useful additional triangulation data source.
  - The approach uses the values from the Accent report plus other water company published values where these could be identified to be consistent.
  - This approach draws upon the Defra guidance on benefit transfer[12].
  - Explanatory factors tested for include company size (connections, network length), service risk, bill level (water or sewerage), service levels (absolute and normalised), density, customer income (both before and after housing costs), whether a company's findings were scaled or unscaled. This allows values to be produced that are based on the characteristics of the AWS region and their customer base.

4.6 PR24 Ofwat and CCWater research

The PR24 Ofwat and CCWater collaborative research findings have been included in the part 2 of this report where feasible. The research comprises two sets of information – marginal benefit values and relative preference weights.

The marginal benefit values are included in the report for comparison but have not been used within the triangulation calculations.

To ensure full transparency the collaborative research values for the Anglian Water region have been included in graphs alongside other primary values and the collaborative research values for England and Wales have been included within the secondary dataset.

The relative preference weights have been compared to the equivalent AWS weights as a sense check on the results.

We note that Ofwat has now replaced the collaborative bottom-up values with the indicative top-down marginal benefit values.

[12] eftec (2009) Valuing Environmental Impacts: Practical Guidelines for the use of value transfer in policy and project appraisal. Report submitted to Defra.

4.7 Process for identifying and addressing conflicting data

The CCWater framework highlights that use of conflicting evidence is a strong indicator of the strength of companies' triangulation approaches. They note that only a few examples of processes for dealing with conflicting evidence were found across the industry.

A key part of the AWS process is to take uncertainty and confidence intervals into account where they are available. This allows conflicts to be identified once the assessments for robustness and relevance are also taken into account.

For example, in the illustrative data below study A can be considered consistent with study D and Study B is consistent with study C. The confidence bands for study A and B do not overlap so could be considered inconsistent. In this case the difference may be due to a factor such as a change in service level or that the method used to produce a value only captures a partial value. Where these differences cannot be explained further evidence should be sought.

An example of addressing conflicting data at PR19 is when the pollution value was identified as high relative to external benchmarks and PR14 value and this led to further research with the AWS online community.

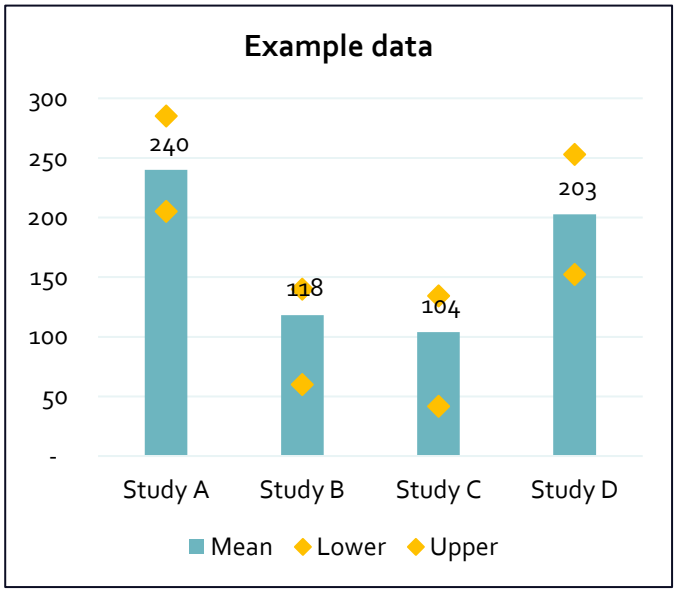


Figure 4-1: Example of conflicting data

As the AWS process of triangulating values is built around producing a central value with an uncertainty range this also provides a mechanism to include the conflicting values within the recommended range for AWS. This approach allows the sensitivity of cost benefit analysis to the range to be tested and can help target where further evidence is required to support decisions.

Part 2

5 Drinking water supply

This section covers supply interruptions, and other measures that are linked to this namely drinking water notices, pressure, discolouration, taste and odour and hard water.

Low pressure, drinking water quality notices and aesthetic water quality are included as evidence shows that customers can relate interruptions to these measures and relative preference information is available to allow the values to be compared.

STEP 1.0 – SPECIFY AND UNDERTAKE RESEARCH

The evidence base for drinking water supply is given below. The anchor measure is an interruption of 6 to 12 hours duration (highlighted in blue). The wider framework covers interruptions lasting a range of other duration bands, water pressure and water quality notices. It also covers the discolouration, taste and odour as well as hardness.

Service	Measure/Severity	Types of valuation approach for PR24				
Supply Interruptions - unplanned (per property affected)	Less than or equal to 3 hours More than 3 hours and up to 6 hours More than 6 hours and up to 12 hours More than 12 hours and up to 24 hours More than 1 day and up to 4 days 5 days and up to 20 days Critical civic centres e.g. school - range of durations	PR09 Water Services Study Update PR19 FG on weightings PR24 mapping	AW PR14 and PR19 Benefits Transfer	PR24 Impact weights (integrated study)	PR24 Post Event Survey (Stated preference, avertive behaviour and subjective wellbeing) Operational data (Macro/Insurance Study) No water - 1 week	PR24 integrated WTP study 6-12 hours
Water Pressure (per property affected)	Persistent One-off	PR19 FG on weightings	AW PR14 and PR19 Benefits Transfer	PR24 Impact weights (integrated study)	Operational data (Sentiment analysis)	
Water quality notices (arising from water quality failures), number of properties affected	Boil notice Do not drink/use notice	PR09 Water Services Study Update PR19 FG on weightings	AW PR14 and PR19 Benefits Transfer	PR24 Impact weights (integrated study)	PR24 integrated WTP study Boil water notice 2 days	
Discolouration (number of properties affected)	Persistent events One-off	PR19 FG on weightings	AW PR14 and PR19 Benefits Transfer AW PR19 Benefits Transfer	PR24 Impact weights (integrated study)	Operational data (Sentiment analysis)	Household value for tap water (Revealed preference)
Taste and Odour (number of properties affected)	Persistent and one-off events One-off	PR19 FG on weightings	AW PR14 and PR19 Benefits Transfer	Household value for tap water (Revealed preference) PR24 Impact weights (integrated study)	Operational data (Sentiment analysis)	
Hardness (number of properties affected)	Persistent (reductions by increment: e.g. very hard to hard)	PR19 FG on weightings	AW PR19 Benefits Transfer	Household value for tap water (Revealed preference)	Operational data (Sentiment analysis)	

Figure 5-1 : Drinking water supply SMF and valuation evidence

STEP 2.0 SYNTHESIS OF RESEARCH

Table 5-1 presents a summary of primary data. The table includes a range of valuation types covering a range of approaches:

- Stated preference studies
- Revealed preference - avertive behaviour studies
- Subjective wellbeing
- AWS compensation claims
- Qualitative focus group review of relative preferences
- Sentiment analysis of operational call centre data

The AWS compensation claims and avertive behaviour datasets are expected to be lower than the stated preference and subjective wellbeing values as they reflect a partial valuation and do not capture public good or inconvenience values.

The stated preference datasets differentiate between studies capturing the values direct to a household and studies focusing on wider societal values.

A key study is the AWS post event study that captures values of customers who have experienced service disruption using three methods which allows direct comparison. This innovative approach allows the methodological differences to be compared whilst the sample, location, severity of the event and timings are kept constant.

The Ofwat and CCWater PR24 collaborative research values have been included for comparison purposes. The interruptions to supply values presented in the graphs align with the duration range of 6 to 12 hours and have been calculated from the 6 hour and 24 hour values produced by the study. The weights for wider service measures have also been reviewed as part of validity testing.

Table 5-1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR24 integrated WTP study	Stated preference – valuation	Supply interruption 6 to 12 hours	Household Non-household	H Good sample size DCE & DCCV methodology	H Definition relevant, new study
PR24 integrated WTP study	Stated preference – customer preference weights	Weights for supply interruption durations, water quality notices and one-off and persistent low pressure and aesthetic impacts.	Household Non-household	H Good sample size BWS methodology	H Definition relevant, new study

PR24 Post event study	Stated preference – contingent valuation (compensation), subjective wellbeing, revealed preference (Avertive behaviour)	Values for a range of supply interruption durations	Household Customers with experience of water supply issues	M/H SWB and compensation values capture full impact on customers who have experienced event. Values do not include altruism. Sample size acceptable. M Avertive behaviour values are partial	H Definition relevant, new study
PR24 Ofwat & CCWater centralised research – AWS region	Stated preference – (compensation)	Values and customer preference weights for interruptions of 6 hours and 24 hours, water notices and 24 hour aesthetic impacts	Household Non-household	M/H Good sample size for AWS region, BWS and compensation methods, excludes altruism	H Definition relevant, new study.
PR24 Sentiment analysis	N/a Insight on relative severity	Discolouration, Pressure, taste and odour	Household	L Not valuation data	H Definition relevant, recent data
PR19 main stage study	Stated preference – valuation	Supply interruption 6 to 12 hours	Household Non-household	H Large sample DCE & DCCV methodology	M/H Definition relevant, PR19 study
PR19 Best-worst scaling	Stated preference – valuation	Supply interruption 6 to 12 hours	Household	H Good sample size, BWS methodology	M/H Definition relevant, PR19 study

PR19 triangulated value	Stated preference – valuation	Discolouration	Household Non-household	H Based on PR19 DCE DCCV and BWS sources	M/H Definition relevant, PR19 evidence
PR19 Macro economic analysis of drought impacts	AWS compensation claims (insurance data analysis)	Supply interruption 5 to 20 days	Non-household	L Assumptions required, partial value	L/M AWS data, based on interruptions due to flooding
PR19 relative preference focus group	Qualitative review of customer preference weights from PR09 water services 2nd stage study	All supply interruption, Water quality notices in the Anglian Water SMF, pressure, aesthetics.	Household	M/L Qualitative, Small sample size	M/H Definition relevant, PR19 research
PR19 2nd stage water restrictions survey	Stated Preference – valuation	Supply interruption greater than 3 hours	Household Non-household	H Good sample size, CV methodology followed by allocation exercise	M Definition different severity to anchor but relevant for wider SMF - compared to 3-6 hour measure, new study
PR14 main stage study	Stated preference – valuation	Supply interruption 6 to 12 hours, Persistent pressure, Boil water notice, taste and odour	Household Non-household	H Very large sample DCE & DCCV methodology	M/H Definition relevant, PR14 study

PR14 Industry avertive behaviour study	Revealed preference valuation	Discolouration Taste & odour Hardness	Household	M/H Good sample size, robust estimation, partial value as excludes damage costs.	L (Discolouration & T&O) Evidence suggests covers much less severe problems M/H for hardness
PR09 Water services 2nd stage study	Stated Preference – customer preference weights	Weights for all supply interruption durations plus water quality notices, discolouration and T&O.	Household	M	M Definition relevant, PR09 study

Table 5-2 presents a compilation of the secondary data that has been utilised in the triangulation. These 'other studies' are used as sense checks on the core valuation evidence provided by the primary data. It covers a range of other company stated preference surveys from PR19 and some PR14 average values covering multiple companies.

Table 5-2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR24 Ofwat & CCWater centralised research – England and Wales	Stated Preference valuation	Values and customer preference weights for interruptions of 6 hours and 24 hours, water notices and 24 hour aesthetics	Household Non-household	M/H Very large sample size, BWS and compensation methods, excludes altruism	M/H Definition relevant, new study National values not AWS region.
Accent WTP comparison study (2018)	Stated Preference valuation	Unexpected interruption values for 9 companies; Discolouration for 8 companies; Occasional pressure for 1 company; Persistent pressure for 3 companies; T&O for 9 companies.	Household Non-household	M/H Mixed surveys, limited published information for majority of studies	M PR19 studies, definitions clearly set out, other regions.
Accent WTP comparison study (2018) - AWS benefit transfer value	Stated Preference valuation	Unexpected interruption 6 – 12 hours	Household	M Based on additional calculations	M/H Uses a benefit transfer function so more relevant to AWS region than individual data points.
Accent joint study – Unknown companies (2013)	Stated Preference valuation	Unexpected interruption 3 to 6 hours & 6 to 12 hours (2 & 4 studies), pressure (3 studies), Discolouration (6 studies)	Household Non-household	M Mixed surveys, limited published information	L/M Relevant definitions, PR14 study, unknown areas

5.1 Supply interruptions (6-12 hours)

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

Step 3a: Primary data & initial recommended range

This section presents the primary data for households, non-household and the combined customer base.

Households

The primary data for AWS household customers is shown in Figure 5-2. The recommended range is shown both in the graph below and in Table 5-3. The recommended central value is lower than the PR19 inflated value reflecting more recent evidence and the increase in the range of methods.

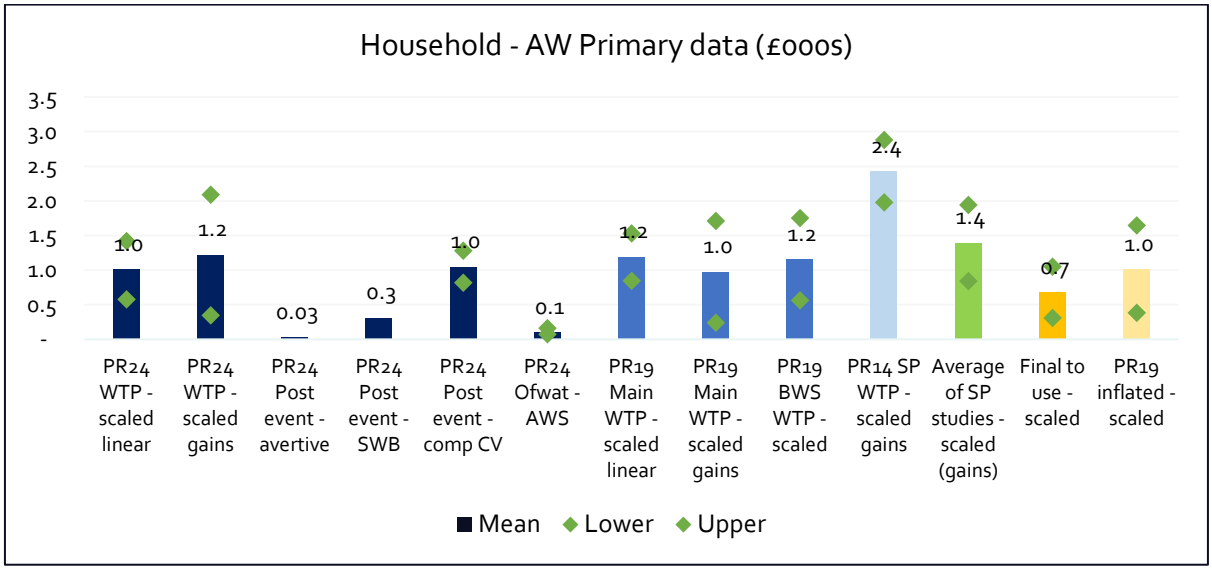


Figure 5-2: Household primary data – supply interruptions (6 – 12 hours), £ per property

Our approach to setting the central value and range takes the differences in values across methods into account. The central value is the average of the upper and lower values.

We have set the upper value in line with the stated preference study results. These are aligned and consistent over both PR24 and PR19. The PR24 linear value is used in preference to the PR24 gains value as it is lower and has a narrower confidence interval. The PR24 linear value is also in line with the PR19 main study gains value. We have not included the PR14 value in the calculation as it is outlier. The PR24 post event stated preference compensation value is based on the study findings for 3 to 24 hours where the average duration is 9 hours. This study found varying values across seasons. The higher value is set at the study average across all events sampled and the lower value excludes the summer events. The average is the midpoint of this range.

The lower value is based on the post event subjective wellbeing value.

The Ofwat and CCWater PR24 collaborative research range for the Anglian Water region lower than the recommended range for households. Whilst this complies with theoretical expectations as the Ofwat and CCWater PR24 collaborative research values does not include altruism, it is similar magnitude to the avertive behaviour value and lower than the subjective wellbeing value.

Note the PR19 Water Resources study value for interruptions greater than 3 hours is excluded from the above due to the open-ended nature of the definition being less aligned with the other evidence. It is instead included for consideration as part of wider evidence.

Table 5-3: Scaled household values (6- 12 hours), £k per property

Lower	Central	Upper
0.3	0.7	1.1

Non-households

The primary data for AWS non-household customers is shown in Figure 5-3. The recommended range is shown both in the graph below and in Table 5-4. The central value has increased relative to the inflated PR19 value reflecting the increase in value non-household customers place on this service failure for PR24.

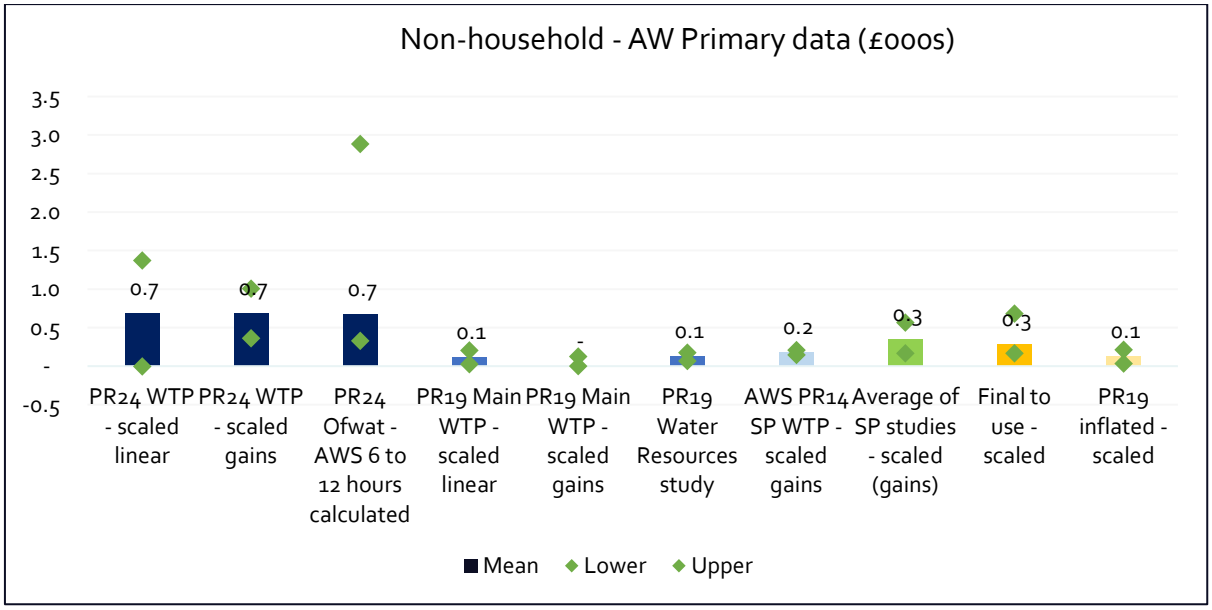


Figure 5-3: Non Household primary data – supply interruptions (6 – 12 hours), £ per property

The central and lower values are based on a long run average of PR24 scaled gains value, the PR19 scaled gains value and the PR14 scaled gains value.

The upper value of the range has been set equal to the central estimate for the PR24 gains value, reflecting that this estimate is both higher but more uncertain.

The Ofwat and CCWater PR24 collaborative research range for the Anglian Water region is aligned with the AWS PR24 WTP study values.

Table 5-4: Scaled non-household values (6- 12 hours), £k per property

Lower	Central	Upper
0.17	0.29	0.69

Combined (households and non-households)

The primary data for AWS combined customers is shown in Figure 5-4. The recommended range is shown both in the graph below and in Table 5-5.

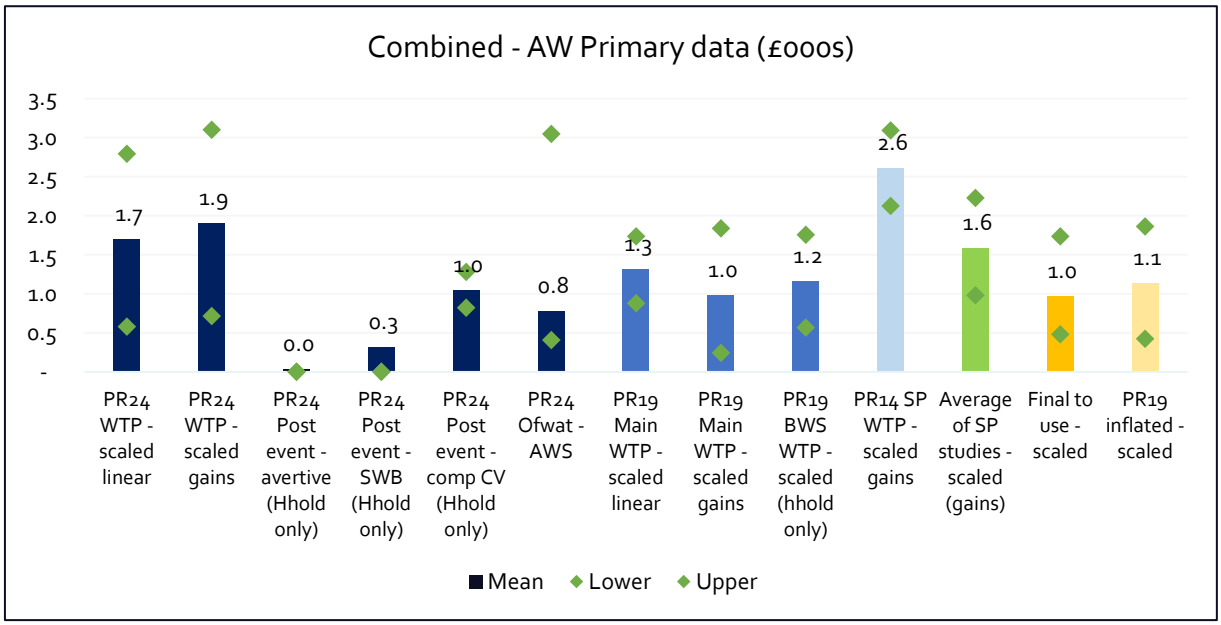


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Figure 5-4: Combined primary data – supply interruptions (6 – 12 hours), £ per property

The values presented are the household range plus non-household range. The recommended values are slightly lower but aligned with the PR19 range of values providing a conservative but consistent approach. The recommended value is slightly higher but aligned with the PR24 collaborative research value for the Anglian Water region. This complies with theoretical expectations as the Ofwat and CCWater PR24 collaborative research values does not include altruism.

Table 5-5: Initial recommended range – combined (6-12 hours), £k per property

Lower	Central	Upper
0.5	1.0	1.7

Step 3b: Triangulating against other sources (secondary data)

Figure 5-5 to Figure 5-7 show how the ranges compare to the secondary data sources available. The recommended AWS values align with the values in the middle of the range from other studies.

The values shown are aligned with the 6 to 12 hours duration band. The sources of the values included are:

- the Accent WTP comparison study from 2018
- an average WTP value from the PR14 equivalent Accent study
- the Ofwat and CCWater PR24 collaborative research values for England and Wales

For comparison a majority of the values are thought to be scaled. The Thames Water, South West Water and South Staffs Water values are thought to be unscaled.

The AWS value transfer study value is derived from the values collated in the 2018 Accent study and uses regression analysis combined with characteristics of the companies to create a value transfer function. The approach to the regression analysis draws upon the Defra guidance on benefit transfer[13]. Prior to interrogating the data potential explanatory factors were identified based on both economic theory and a previous meta-analysis of stated preference data completed by UKWIR in 2010[14].

Full details are included in Appendix 3. The interruptions to supply model uses four explanatory factors. The explanatory factors are household income before housing costs, density (connected properties divided by length of mains) and service levels from 2017-18 (current levels when the studies were undertaken) plus a variable to indicate whether the study is based on scaled or unscaled values. The resulting value is aligned with Anglian Water's stated preference values which are used to set the upper range of the recommended value.

The Ofwat and CCWater PR24 collaborative research range for England and Wales is aligned with the recommended range for the combined findings. The collaborative research values are lower than the recommended range for households and higher for non-households.

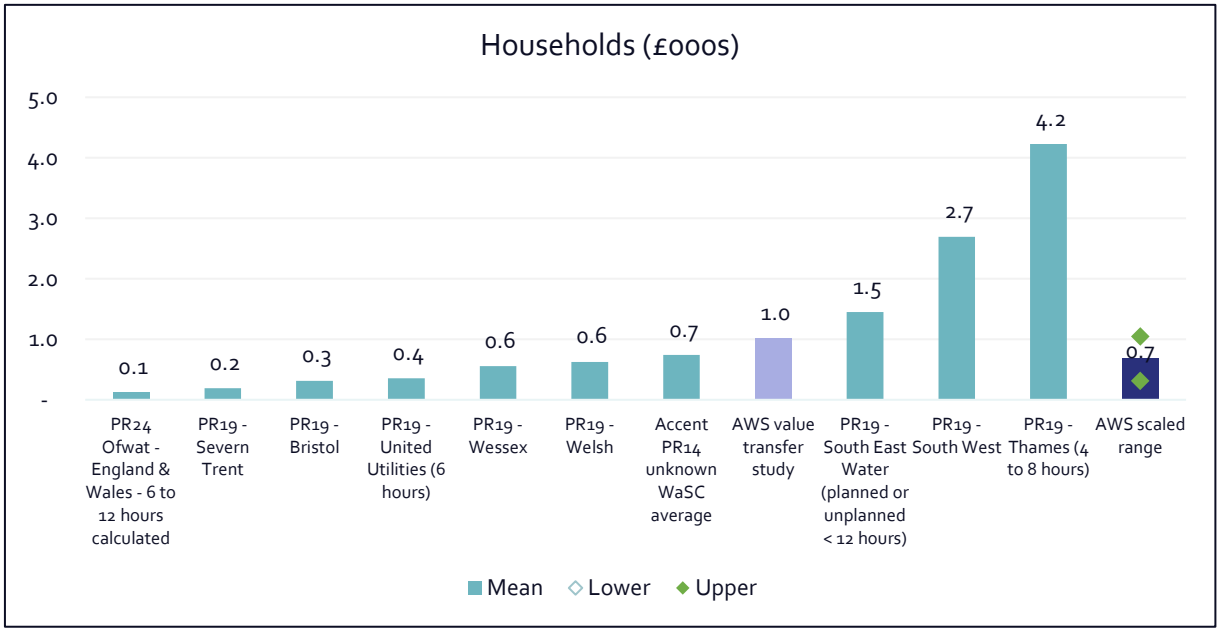

Figure 5-5: Comparing to household secondary data – interruptions (6- 12 hours), £k per property

[13] eftec (2009) Valuing Environmental Impacts: Practical Guidelines for the use of value transfer in policy and project appraisal. Report submitted to Defra.

[14] UKWIR (2010) Review of Cost-benefit analysis and benefit valuation (RG07). Milestone D (Quantitative Analysis Working paper. Authors Carlo Fezzi, Ken Willis, Allan Provins, Chelsea Thomson (Cascade, eftec and ICS Consulting)

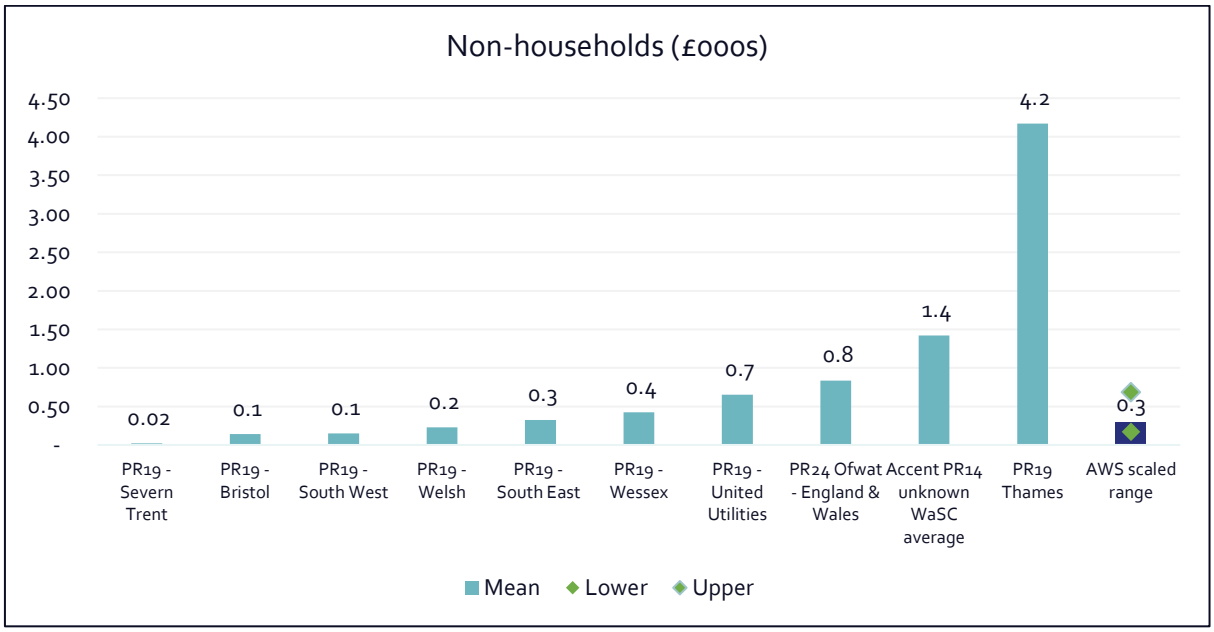

Figure 5-6: Comparing to non-household secondary data – interruptions (6- 12 hours), £k per property

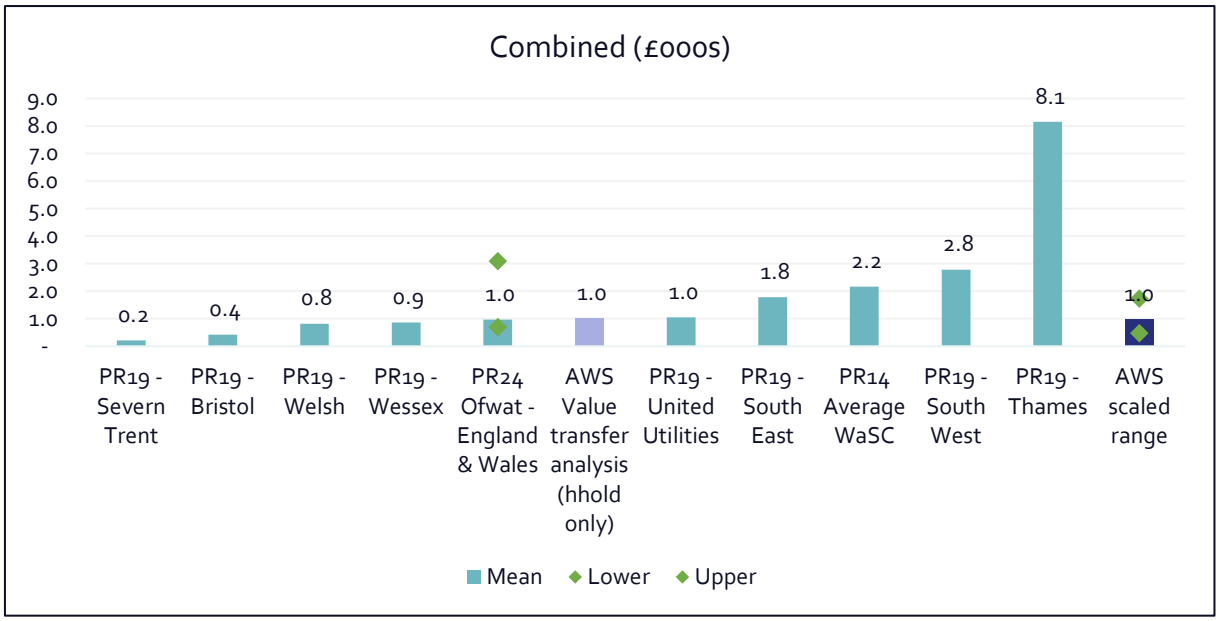

Figure 5-7: Comparing to combined secondary data – interruptions (6- 12 hours), £k per property

Step 3c: Applying the values to the wider service measure framework and triangulating against other data (primary and secondary)

The scaled values for a 6 to 12 hours interruption have been mapped to the other durations using preference weights and compared with wider primary sources. The final results are presented in the table below.

For the interruption weights we have applied the PR24 weights from the integrated WTP study. This has involved using the weight for the midpoint of the duration band relative to the 6 to 12 hour duration. For some measures we have adjusted the weights and/or resulting values to account for the wider evidence.

To test the validity of the integrated WTP study PR24 weights we have compared them to the PR09 weights which were re-tested in the PR19 relative preference focus groups and the PR24 Ofwat and CCWater collaborative study weights (6 hours and 24 hours only). The PR19 relative preference focus groups found that customers generally supported weightings between categories from PR09.

The two sets of PR24 weights (collaborative research and AWS) are aligned. The main difference to the PR09 weights is that the PR24 weights produce larger values for the two shorter duration bands and a lower value for the 1 to 4 day band. For the shorter duration bands, the integrated WTP PR24 weights have been used in preference to the older weights due to the age of the research (c.15 years) as these also align with the collaborative research data. For the 1 to 4 day duration, where no Ofwat and CCWater PR24 collaborative research weights are available, an average of the PR24 AWS and PR09 weights have been applied. The resulting relative weight aligns with the wider evidence from the post event PR24 study – see below.

Comparing the results to wider triangulation evidence is a further validity check on the weights and the anchor value (6 to 12 hour interruption).

Three further primary sources are used to compare:

- Post event PR24 study: The subjective wellbeing values for 3 days has been compared to the 1 to 4 day duration band. The value aligns with the lower end of the range for this duration band which is consistent with the approach to the 6 to 12 hour anchor value.
- Water Resources SP study 2017: The PR19 WR study measured a value for interruptions greater than 3 hours. It has been compared to the 3 to 6 hour value as customers are expected to have focused on the 3 hour duration. The 3 to 6 hour value is found to be consistent with this study.
- AWS compensation claims data (NERA, 2017). This is a business only value with a relatively low robustness score due to the assumptions required. It is also a partial valuation as it will not cover inconvenience. The value is slightly lower than the upper part of the non-household scaled value range.

The values for interruptions at civic centres (Schools, hospitals, prisons, and care homes) is based on interruption values of same duration with a weight applied. The weight is based on the average population for each institution type weighted for frequency, time occupied and adjusted to be equivalent per property. See Appendix 3 for more details.

Table 5-6: Scaled – interruption duration bands, £

SMF duration	Unit	Lower	Central	Upper	Notes on values
Less than or equal to 3 hours	£/property	109	218	396	PR09 weights produce a value consistent with the lower to central range – 57 to 204.
More than 3 hours and up to 6 hours	£/property	282	561	1,029	PR09 weights produce a value consistent with the range – 218 to 788. The PR19 Water Resources study is consistent with the lower to central value – 361 to 639.
More than 6 hours and up to 12 hours	£/property	480	968	1,736	Anchor value
More than 12 hours and up to 24 hours	£/property	624	1,270	2,240	Consistent with the PR09 weights – 585 to 2,113.
More than 1 day and up to 4 days	£/property	955	1,933	3,440	Based on average of PR24 and PR09 weight. Lower value aligned with Post event subjective wellbeing value - £999.
5 days and up to 20 days	£/property	1,381	2,854	4,897	Consistent with the PR09 weights – 1,562 to 5,644. AWS Business claims value £1,121 for midpoint but limited data and partial value. Claims value is within the non-household recommended range and lower than the combined household and non-household range.
Critical civic centres e.g. school Less than or equal to 3 hours	£/civic centre	1,461	2,920	5,312	
Critical civic centres e.g. school More than 3 hours and up to 6 hours	£/civic centre	3,782	7,522	13,791	
Critical civic centres e.g. school More than 6 hours and up to 12 hours	£/civic centre	6,437	12,972	23,259	

Critical civic centres e.g. school More than 12 hours and up to 24 hours	£/civic centre	8,364	17,018	30,012
Critical civic centres e.g. school More than 1 day and up to 4 days	£/civic centre	10,103	20,583	36,218
Critical civic centres e.g. school 5 days and up to 20 days	£/civic centre	18,501	38,244	65,617

STEP 4.0 ASSESS AND TEST VALUATIONS

The wider customer evidence for interruptions to supply has been reviewed for interruptions to supply. This review has found unplanned supply interruptions are an important service issue to customers.

The AWS synthesis report shows that providing a constant supply of clean drinking water is seen as fundamental for a water company. This aligns with the Ofwat and CCWater customer priorities research[15] which finds that water interruptions and water quality (taste/smell/ appearance and no boil notices) were ranked in the highest importance category, along with flooding.

At PR19 the online community research suggested the relative weights may be higher for longer duration interruptions. This is reflected in the AWS PR24 weightings which show a higher value for events lasting 1 to 4 days. Testing the relative values of differing duration interruptions was also a key objective of the valuation focus groups undertaken at PR19. These groups found that customers expect to adapt to longer events. This will cause the relative values to flatten as the event becomes more severe. This is what is observed in both sets of relative weights that have been used to produce the recommended values. PR19 research also suggests that interruptions lasting up to 12 or even 24 hours are generally manageable, although this depends on the time/day of the week, and customers are concerned about the impact on those with young children, with disabilities, the elderly, and local businesses.

Overall, given the balance of the evidence no changes have been made to the recommended value.

5.2 Low pressure, drinking water notices, water quality attributes and developer requests for water

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

As outlined in Step 1, the values for below are linked to the anchor value for interruptions.

- Low pressure
- Water notices
- Discolouration

[15] Ofwat & CCW Customer Preferences Research April 2022. Research by Yonder.

- Taste and Odour
- Whitewater
- Hardness

This is applied in Step 3c below prior to comparing the results to the available primary and secondary data.

Step 3c: Applying the values to the wider service measure framework and triangulating against other data (primary and secondary)

The scaled values for a 6 to 12 hours interruption have been mapped to the wider service measures and the results are presented in Table 5-7 for short term service measures and Table 5-8 for persistent measures.

The main source of the mapping is the set of PR24 weights from the integrated WTP study relative to the interruption 6-12 hour weight (i.e. the mid-point of the band). For some measures we have adjusted the weights and/or resulting values to account for the wider evidence. Evidence from the range of primary sources and notes on the calculations and adjustments due to the wider evidence are shown in the final column of the tables.

Further key evidence used in this section includes:

- Preference weights from the Ofwat and CC Water PR24 collaborative research. These weights cover drinking water notices and one-off (24 hour) impacts for pressure, taste and odour and discolouration.
- PR09 preference weights from a specific water supply study. The validity of these relative preference weights were tested with customers at PR19 in focus groups which has provided further evidence for this session.
- PR14 weights derived from the PR14 main WTP study. As well as including the anchor of 6 to 12 hour interruption this study also included persistent low pressure, boil water notices and persistent taste and odour. The PR14 relative preference weight has been applied in preference to inflating the PR14 value for two reasons a) preference weights are more likely to be stable over time compared to values; and b) the interruptions values have changed over time.
- PR14 avertive behaviour study. The study was a general survey of customers and did not target problem areas. It has produced values for persistent taste and odour and hard water. It did not produce a value for discolouration and concludes that there is likely to be limited experience of persistent service failures.

Short term service measures

For the short-term service measures the AWS PR24 weights have been applied with limited adjustments. The values for one-off pressure, discolouration and taste and odour service impacts are based on the AWS PR24 weights alone. An adjustment has been made to the values for drinking water notices.

For one-off pressure the findings are aligned with the 3 to 6 hour interruption value. In the PR19 relative preference focus groups customers told us that one off pressure was not considered a serious issue, and was ranked lower than instances of discolouration or interruptions to supply. The AWS

weightings from PR24 align with this and the PR24 collaborative weights are comparable relative to an interruption of 6 to 12 hours. There is limited secondary data to compare.

The AWS PR24 and Ofwat and CC Water collaborative research PR24 weights give similar values for one-off discolouration and taste and odour events relative to the 6 to 12 hour anchor value. The resulting values for discolouration and taste and odour are also consistent with wider evidence including the PR19 assessment of discolouration (discolouration was included in a number of PR19 studies) and other company values from PR19 and PR14. In the PR19 focus groups customers said that if they experienced a one-off discolouration issue, they would not be likely to drink it as they would be unsure if it were safe, and they would buy bottled water.

For boil water notices the recommended value is the average of AWS PR24 weight and PR09 weight. The value has been increased from PR24 weight alone based on feedback from PR19 relative preference focus groups sessions that impact of a boil water notice is similar to a moderate interruption (such as 6 to 12 hours). The PR09 weight also reflects this. The Ofwat and CCWater PR24 collaborative research study weights align with the PR09 weight for households and the AWS PR24 weight relative to a 6 to 12 hour interruption for non-households suggesting that this average approach is appropriate. The PR14 weight from the main stated preference study is higher still suggesting this value could be increased further.

The do not drink value is linked to the boil water notice value using relative weights between the two service measures. These weights are similar for both PR09 and AWS PR24 and an average has been applied. The values recommended should be considered a minimum as the PR19 focus groups indicated that the 'do not use' notice was considered to be the most serious of failings with long term impacts on confidence in water quality. It is noted that the Ofwat and CCWater PR24 weights relative to a boil water notice are lower for both household and non-household customers.

Persistent service measures

The evidence for persistent events is more variable. The PR24 weights show a similar value for discolouration and taste and odour issues with a lower value for persistent pressure. This information conflicts with wider evidence.

In the PR19 focus groups nearly all customers agreed that an unpleasant taste and odour is considered worse than discolouration. Only one person thought that discolouration and taste and odour were the same; overall people were emphatic that taste and odour is worse.

Although customers said that if it were a one-off discolouration issue they would not be likely to drink it they also stated that if a persistent issue was known to be safe, they would drink it. Both the PR14 weights and the other company sources also suggest that the value could be higher for taste and odour. To explore this issue further Anglian Water has undertaken sentiment analysis of operational data from their call centre. This approach involves analysing customers calls for operational issues to identify positive and negative sentiment during the call. The findings show that the negative sentiment is much higher for taste and odour issues relative to discolouration.

As a result, an average of the AWS evidence from PR24 and PR14 has been applied for persistent taste and odour values.

The taste and odour value has been further compared to the industry PR14 results from the avertive behaviour study. Unlike discolouration, the study did produce a value for changes in taste and odour. It aimed to correlate respondent categorisation of quality (on a score of 1 to 5) with expenditure on

substitute products. A value for a change in score of 3 is equivalent to £125 per household[16]. To make this comparable this figure can be increased to reflect the proportion of households stating that they are affected by water quality issues in the survey (38.7%). This produces a value of £324, which is still much lower than the stated preference value.

Some of the reasons for this include that:

- The study was a general survey of customers that did not target problem areas. It concludes that there is likely to be limited experience of persistent service failures. It is therefore not considered to capture the severity of failure that this value is intending to cover. Evidence for this is that in the survey, 38.7% of customers stated they were undertaking avertive behaviour and 27.6% stating avertive expenditure. The actual number of customers affected by the measure in the SMF, given the severity it aims to capture, is approximately 0.1%.
- The value shown is a linear value for changes in the quality score. The report notes that the relationship was found to be non-linear with higher values for higher scoring problems.
- An RP value is expected to be a lower estimate of the total economic value as it will not include values associated with water as a public good or non-use values.

All together it is expected that the avertive behaviour value does not capture the same level of problem.

Hardness value is calculated from the household avertive expenditure (RP) study and the taste and odour persistent value. The hardness central value and range are calculated by applying the percentage difference between the taste and odour RP and hardness RP mean values to the taste and odour value.

The hardness RP value is based on a movement of 1 in the customer score of hard water quality. This has been chosen to represent the movement from very hard to hard. Further analysis is available to link the value to actual changes in calcium carbonate levels in the water. The avertive behaviour study found a strong relationship between customer reported level of hardness and actual levels of calcium carbonate. It is therefore considered a robust estimation of the avertive behaviour expenditure for hard water. The value is, however, a partial value. It only captures expenditure on softening the water or using alternative sources. It does not cover the damage cost to appliances (e.g. kettles, washing machines, pipes, boilers) and it does not cover public good or non-use values. The additional damage cost element is expected to be significant.

The PR19 relative preferences focus groups found that the impact of hard water would be lower than taste and odour. Customers said they would not drink water with taste and odour issues, but do not mind the taste of hard water. But overall, they do think hardwater is a significant problem.

The pressure value is a value for a persistent problem that is expected to occur throughout the year. The PR19 focus groups showed that customers consider pressure to be an issue, but it is not necessarily valued higher than other persistent issues (when considered on a like for like basis). The PR14 weight gives a significantly higher value than the PR24 weight.

Evidence from the Anglian Water sentiment analysis of operational data from their call centre shows that that the negative sentiment is higher for persistent pressure issues relative to discolouration.

The secondary data evidence for persistent pressure is also variable and a review of this data suggests that the values are sensitive to definition and context.

We have set the value at the average of the PR24 and PR14 weights.

[16] Value quoted is the Anglian Water specific number provided in the company specific annex (inflated to 2022 prices). The value therefore differs to the main report which presents the national average value.

Table 5-7: One-off events - pressure, water notices and water quality attributes scaled, £

SMF duration	Unit	Lower	Central	Upper	Notes on values
Water pressure: One-off	£/property	177	350	650	Based on PR24 weight. PR19 FG compared to instances of discolouration & interruptions. Value overlaps the 3 to 6 hour interruption range (£0.3k to £1.1k).
Discolouration: One-off	£/property	291	577	1,061	Based on PR24 weight. PR19 triangulation evidence is consistent (£0.3k to £0.9k). Secondary evidence is consistent and shows a wide range but durations not always clear.
Taste and odour: One-off	£/property	280	558	1,019	Based on PR24 weight. Secondary evidence is consistent. Median is £0.4k.
Whitewater	£/property	291	577	1,061	Set equal to discolouration value.
Boil notice	£/property	397	799	1,435	Value average of PR24 weight (£0.25k to £0.9k) and PR09 weight (£0.5k to 1.9k). Value increased from PR24 weight alone based on feedback from PR19 playback sessions that impact similar to a moderate interruption – comparable value for 6 to 12 hour is £0.5k to £1.7k. The PR14 weight is higher still suggesting this could be increased further.
Do not drink/use notice	£/property	1,032	2,085	3,725	Weights relative to a boil water notice from both PR09 and PR24 are similar (2.3 and 2.8). An average is used.

Table 5-8: Persistent pressure and water quality attributes scaled, £

SMF duration	Unit	Lower	Central	Upper	Notes on values
Low water pressure: persistent	£/property	3,764	7,586	13,600	Value average of PR24 weight (£0.4k to £1.4k) and PR14 weight (£7.1k to £25.8k). Secondary sources from PR19 and PR14 show large range from £0.6k to one at 40£k, with a median of £10.5k.
Discolouration: Persistent events	£/property	526	1,073	1,881	Limited wider evidence from PR19. Range from £1.6k to £10.0k although definition severity not always clear.
Taste and odour: Persistent events	£/property	1,154	2,334	4,159	Value average of PR24 weight (£0.5k to £1.8k) and PR14 weight (£1.8k to £6.5k). Household value (£0.8k to £2.8k) is higher than RP study value (£324). Secondary evidence shows a wide range from £2.1 to £103k – median is £18.2k.
Hardness: Persistent (reductions by increment: e.g. very hard to hard)	£/property	155	318	554	Value is based on the taste and odour value adjusted for the proportional difference between the hardness and taste and odour RP values . Note value is for an incremental change. When aggregated to a value for changing water to very soft the central value is £1.6k and more consistent with discolouration.

STEP 4.0 ASSESS AND TEST VALUATIONS

The wider customer evidence for drinking water quality has been reviewed. The Anglian Water synthesis report shows that customers consistently view clean, potable water coming directly through the tap as a baseline necessity. In the Ofwat and CCWater customer priorities research[17] good quality drinking water is seen as a similar priority to avoiding interruptions to supply and flooding.

The synthesis report highlights that most of the research conducted conflates water quality (in terms of safety) with aesthetics (taste, odour and appearance). Where research has specifically split out the two areas, it appears it is safety that drives the high priority ranking in the insight.

[17] Ofwat & CCW Customer Preferences Research April 2022. Research by Yonder.

Hardness is an area where customers are dissatisfied. Recent CCW research shows only 46% of customers are satisfied, but it is not an area that is particularly highlighted in other insight.

6 Water restrictions

This section covers severe water restrictions (rota cuts and standpipes), hosepipe bans and non-essential use bans. It also covers the supply deficit, aquifer protection, developer requests for water and water recycling. The results presented below are based on the most up-to-date triangulation of values. The section provides a high-level summary, focusing on the gains values. It should be noted that a set of values were developed in July 2022 to underpin the development of the draft WRMP.

STEP 1.0 SPECIFY AND UNDERTAKE WORK

The evidence base for water restrictions is given below. The anchor measures are rota cuts and standpipes (highlighted in blue). The wider framework also covers hosepipe bans, non-essential use bans and supply deficit.

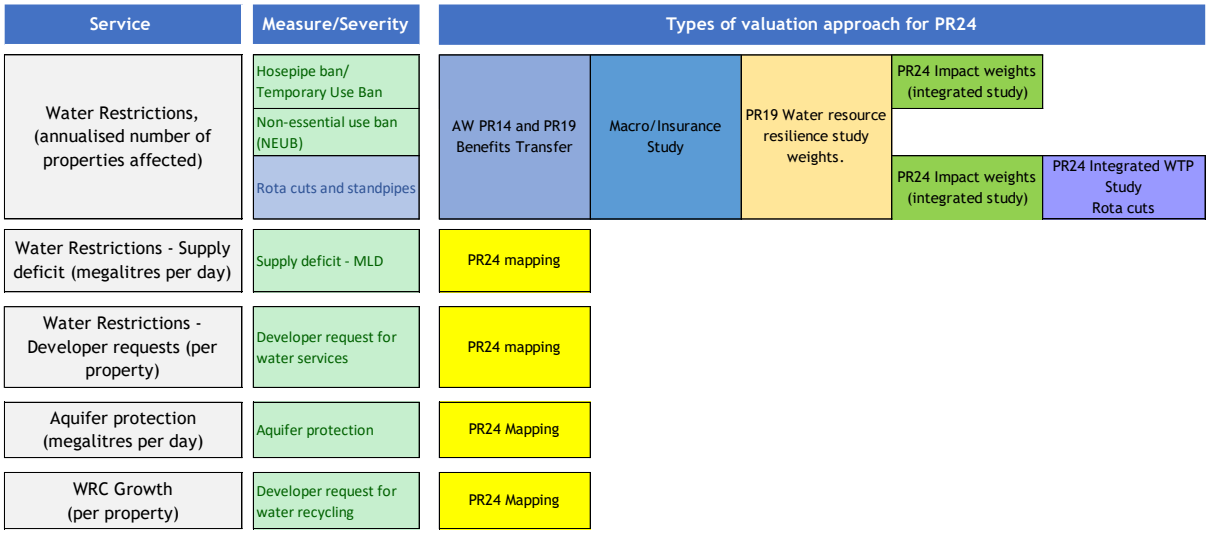

Figure 6-1 Water restrictions SMF and valuation evidence

STEP 2.0 SYNTHESIS OF RESEARCH

Table 6-1 presents a summary of primary data. The table includes a range of valuation types covering two categories: Stated Preference and Macro-economic assessment.

- Stated Preference: this information is drawn from five surveys. The valuation data from these surveys covers two measures (hosepipe bans and rota cuts). The PR19 2nd stage water resources study also provides additional customer preference weights that show how customers view the relative value of the different restriction types.
- Macro-economic assessment: This information is taken from a study for Anglian Water (NERA, 2017) that uses the UK regional Gross Value Added (GVA) dataset published by the Office for National Statistics (ONS). This dataset provides the historical output data by industry and region. Assumptions on the average percentage of output that may be lost in an event were applied to estimate the GVA lost per day during an event. These assumptions were based on previous studies. The study findings have been adjusted for PR24 using changes in GVA data.

These studies are based on contrasting data and methods. The macroeconomic methodology attempts to estimate the economic losses (measuring in terms of lost output) to non-household customers arising from drought restrictions.

The SP methodology applies to both household and non-household customers. More particularly, the SP approach estimates the dis-utility of the customer impacts arising from restrictions. The convergence between the two approaches will be in part determined by the extent to which the market price of outputs is reflective of utility. A prior expectation is that combined SP valuations (household plus non-household) would be above the macro-economic assessment valuation.

The SP derived valuations are based on samples of actual AW customers. The macroeconomic analysis in contrast constructs assumptions for the percentage loss and the AW customer share of regional GVA.

Table 6-1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR24 integrated WTP study	Stated preference – valuation	Rota cuts	Household Non-household	H Good sample size DCE & DCCV methodology	H Definition relevant, new study
PR24 integrated WTP study	Stated preference – customer preference weights	Hosepipe ban Rota cuts	Household Non-household	H Good sample size BWS methodology	H Definition relevant, new study
PR24 Ofwat centralised research – AWS region	Stated preference – (compensation)	Values and customer preference weights for rota cuts and hosepipe bans	Household Non-household	M/H Good sample size, BWS and compensation methods, excludes altruism	H Definition relevant, new study, AWS region.
PR19 2nd Water resources survey	Stated Preference valuation	Rota cuts Hosepipe ban	Household Non-household	H Good sample size, CV methodology	M/H Definition relevant, PR19 study
PR19 2nd Water Resources survey – resilience	Stated Preference customer preference weights	Hosepipe ban Non-essential use ban Rota cuts Standpipes	Household Non-household	H Good sample size, DCE/pairwise comparison methodology	H Definition relevant, PR19 study

PR19 main stage study	Stated preference – valuation	Rota cuts	Household	H DCE methodology, large sample	M/H Definition relevant, PR19 study
PR19 Best-worst scaling	Stated preference – valuation	Rota cuts	Household	H BWS methodology, good sample size	M/H Definition relevant, PR19 study
Macroeconomic analysis of drought Impacts	Macroeconomic assessment	Hosepipe ban Non-essential use ban Rota cuts & Standpipes	Non-household	H Analysis of economic data from ONS. Assumptions to calculate impact drawn from a range of studies	M/H Definition relevant, PR19 study using PR19 and 2014 data.
Anglian Water PR14 WTP Main Stage (2012)	Stated Preference – valuation	Hosepipe ban	Household Non household	H DCE & CV package methodology, good sample size	M/H PR14 study, Generally consistent definitions
Anglian Water PR14 Water Resources study (2013)	Stated Preference – customer preference weights	Hosepipe ban, Non-essential use ban	Household Non household	H DCE methodology, good sample size	M/H PR14 study, Generally consistent definitions

Table 6-2 presents a compilation of the secondary data that has been utilised in the triangulation. These 'other studies' are used as sense checks on the core valuation evidence provided by the primary data.

Table 6-2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR24 Ofwat centralised research – England and Wales	Stated Preference valuation - compensation	Values and customer preference weights for rota cuts and hosepipe bans	Household Non-household	M/H Very large sample size, BWS and compensation methods, excludes altruism.	M/H Definition relevant, new study National values not AWS region.
Accent WTP comparison study (2018)	Stated Preference valuation	Rota cuts Hosepipe for 8 companies	Household Non-household	M/H Mixed surveys, limited published information for majority of studies	M PR19 studies, definitions clearly set out, other company values
Accent WTP comparison study (2018) - AWS benefit transfer value	Stated Preference valuation	Rota cuts	Household	M Based on additional calculations	M/H Uses a benefit transfer function so more relevant to AWS region than individual data points.
Water UK - Resilience meta study	Meta study collating study ranges	Hosepipe ban, Severe Water Restriction (rota cut and standpipe combined)	Household	H Meta study that has combined company data using information not in public domain	M Based on PR14 studies, Meta study covering England and Wales

6.1 Water restrictions due to drought

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

Step 3a: Primary data & initial recommended range

This section presents the primary data for households, non-household and the combined customer base. Severe water restriction values are the values for rota cuts & standpipes added together[18].

Households

The primary data for AWS household customers is shown in Figure 6-2. The recommended range is shown both in the graph below and in Table 6-3.

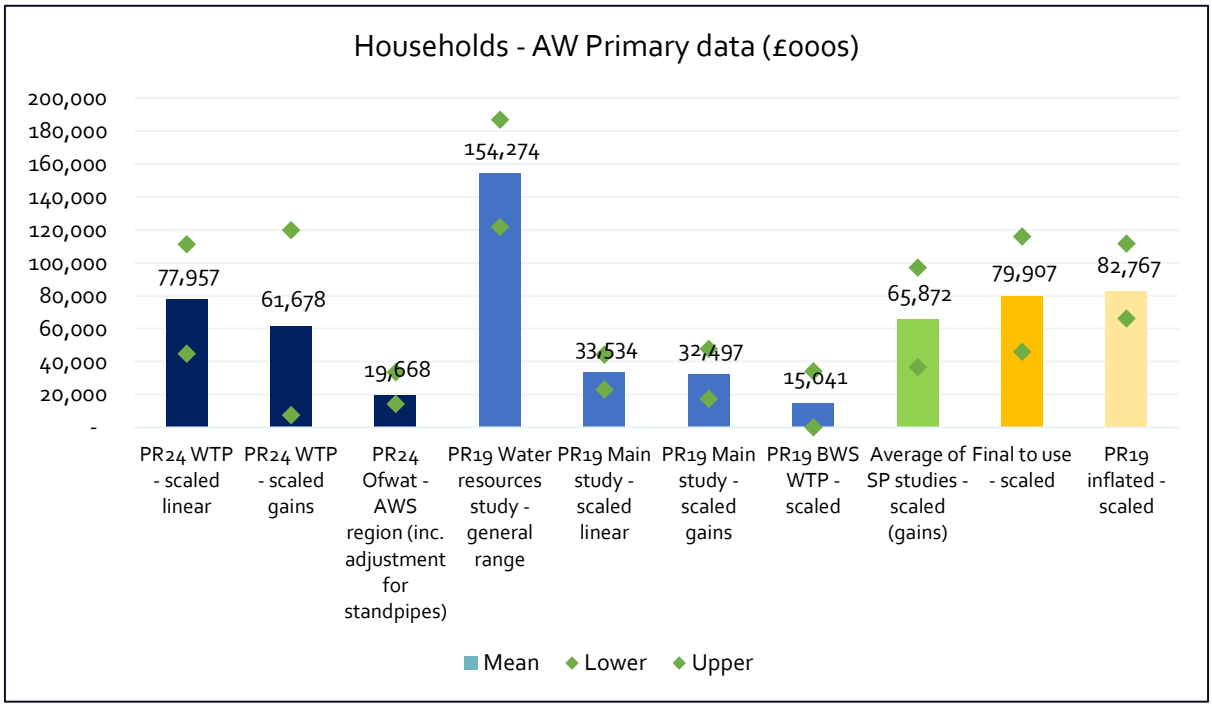

Figure 6-2: Household primary data – Severe water restrictions, £ per expected day of restriction

Both the scaled central value and range are based on the average of PR24 scaled gains, PR19 Water resources study as a dedicated source and the average of PR19 main gains value and the PR19 BWS value. The PR24 and PR19 scaled gains values are used in preference to the linear values as these are more conservative and the studies indicate that there are slightly lower preferences for improvements than avoiding a deterioration.

The PR24 value is between the ranges observed at PR19. In the assessment the findings from the PR19 main and BWS studies are grouped together as they provide lower values and including these separately may place undue weight on these PR19 studies.

There are no PR14 values to compare to.

[18] The PR24 and PR19 stated preference studies (water resources and main WTP) estimated a value for rota cuts. The PR19 water resources study provided a relative customer preference weight for standpipes compared to rota cuts. This has been used to produce a standpipe value. The rota cuts values are lower than the standpipe value. Evidence from the PR19 focus groups conducted as part of the research suggest that customers anticipate stockpiling water during the rota cut. This has reduced their perceived impact of a rota cut. The values are combined for a severe restriction to allow comparison to the macro-economic assessment value and the Water UK resilience study values that do not differentiate between rota cuts and standpipes.

For households, the recommended value is larger than the Ofwat and CCWater PR24 collaborative research value, which is aligned with the lower end of the SP values observed at PR19. This complies with theoretical expectations as the Ofwat and CCWater PR24 collaborative research values does not include altruism.

Table 6-3: Scaled household values severe water restrictions, £ per expected day of restriction/property affected

Lower	Central	Upper
21.02	36.61	53.08

Non-households

The primary data for AWS non-household customers is shown in Figure 6-3. The recommended range is shown both in the graph below and in Table 6-4.

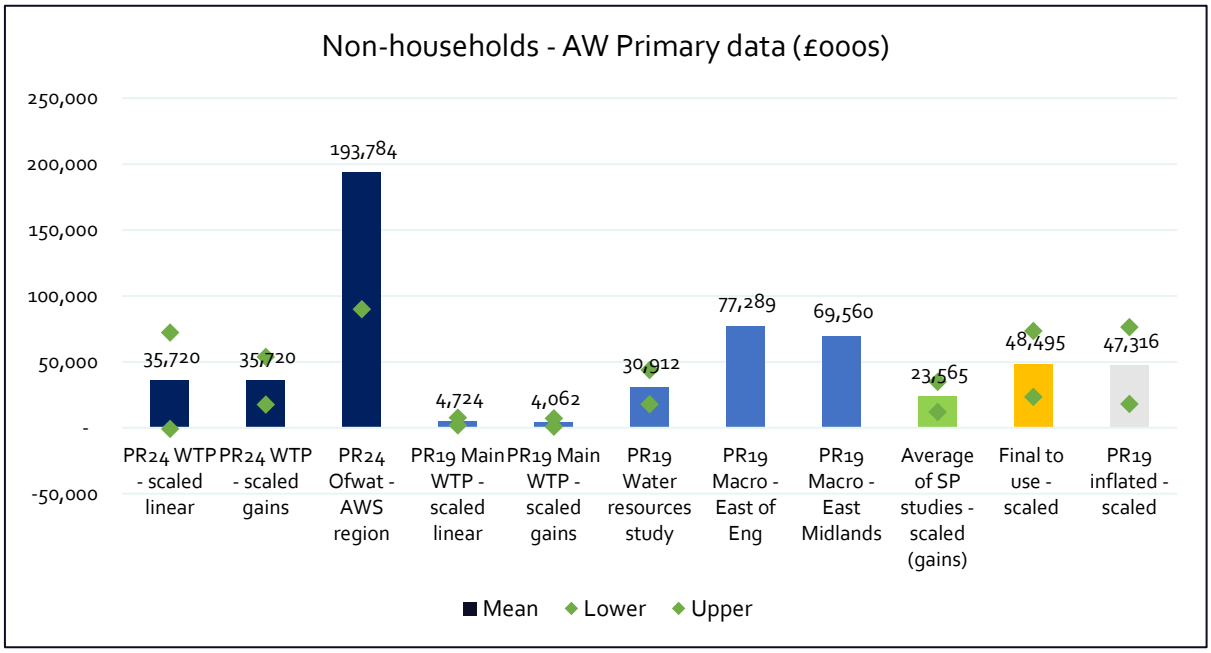

Figure 6-3: Non-household primary data – Severe water restrictions, £ per expected day of restriction

The central value is based on the average of the stated preference studies and the macroeconomic studies. The upper range is based on the macroeconomic study and the lower range is based upon the average of just the stated preference studies.

It is worth noting that the PR19 Water Resource study values and PR24 values are similar and are higher than the PR19 main study values.

The values produced for the East of England and East Midlands areas are from the Macro-economic study. The final to use values are averaged for presentation here.

The macro-economic study values are higher than the AWS stated preference scaled values although they are lower than the unscaled value range. Possible reasons for the lower stated preference values include:

- Customers do not have experience of severed restrictions, so it is difficult for them to value, and they may therefore underestimate the impact in the stated preference studies.

- It is possible that the stated preference study underestimates the value (possibly due to the small level of risk involved causing customers to place less weight on these impacts during the study analysis).
- The macro-economic study may be over estimating the impact on businesses and the extent to which expenditure would be delayed or transferred to other regions. The study has looked to address this through interviews with businesses to understand their potential response to a restriction. To calibrate this further would require extending this and/or experience of an actual water restriction.

The Ofwat and CCWater PR24 collaborative research non-household values are significantly larger than the other sources.

Table 6-4: Scaled non-household values Severe water restrictions, £ per expected day of restriction/property affected

Lower	Central	Upper
10.80	22.22	33.64

Combined (households and non-households)

The primary data for AWS combined customers is shown in Figure 6-4. The recommended range is shown both in the graph below and in Table 6-5.

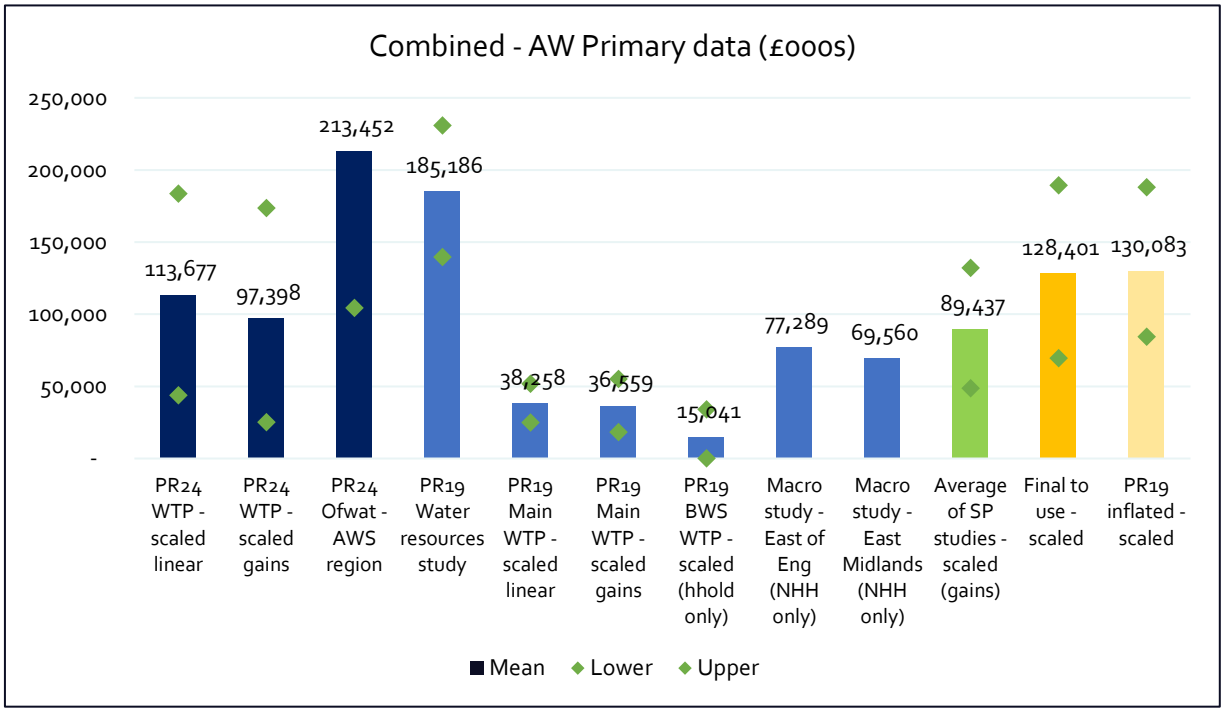

Figure 6-4: Combined primary data – Severe water restrictions, £ per expected day of restriction

The central value and range are an aggregation of the household and non-household values described above. The central and upper values for PR24 are close to those used at PR19, but the lower range is below the PR19 lower value.

Overall, the recommended range is lower than the Ofwat and CCWater PR24 collaborative research values for the Anglian water region, which is being driven by the non-household value. The combined

Ofwat and CCWater PR24 collaborative research value is similar to the value observed in the PR19 Water Resources study.

Table 6-5: Scaled combined values Severe water restrictions, £ per expected day of restriction/property affected

Lower	Central	Upper
31.82	58.83	86.72

Step 3b: Triangulating against other sources (secondary data)

Figure 6-5 to Figure 6-7 show how the ranges compare to the secondary data sources available.

The sources for the values included are:

- Accent WTP comparison study from 2018
- Household value range from a Resilience Study by Water UK, which is a meta study that collated PR14 information from water companies that are not in the public domain.
- Ofwat and CCWater PR24 collaborative research values for England and Wales.

In all cases the recommended AWS values align with the upper end of the studies from PR19. The PR19 values are thought to be scaled values with the exception of South Staffs Water.

The AWS value transfer study value is derived from the values collated in the 2018 Accent study and uses regression analysis combined with characteristics of the companies to create a value transfer function. The approach to the regression analysis draws upon the Defra guidance on benefit transfer[19]. Prior to interrogating the data potential explanatory factors were identified based on both economic theory and a previous meta-analysis of stated preference data completed by UKWIR in 2010[20].

Full details are included in Appendix 3. The severe restriction model uses total connected properties and service level (chance of a rota cut).

The household values are lower than the Water UK resilience study range. The Water UK resilience study presents an expected WTP per household range for severe water restrictions. It is expected that this is a mix of scaled and unscaled values. This suggests that company household values have decreased between PR14 and PR19.

The Ofwat and CCWater PR24 collaborative research range for England and Wales is aligned but slightly lower than the recommended range for the combined findings. This complies with theoretical expectations as the Ofwat and CCWater PR24 collaborative research values does not include altruism.

The collaborative research values are lower than the recommended range for households and higher for non-households.

[19] eftec (2009) Valuing Environmental Impacts: Practical Guidelines for the use of value transfer in policy and project appraisal. Report submitted to Defra.

[20] UKWIR (2010) Review of Cost-benefit analysis and benefit valuation (RG07). Milestone D (Quantitative Analysis Working paper. Authors Carlo Fezzi, Ken Willis, Allan Provins, Chelsea Thomson (Cascade, eftec and ICS Consulting)

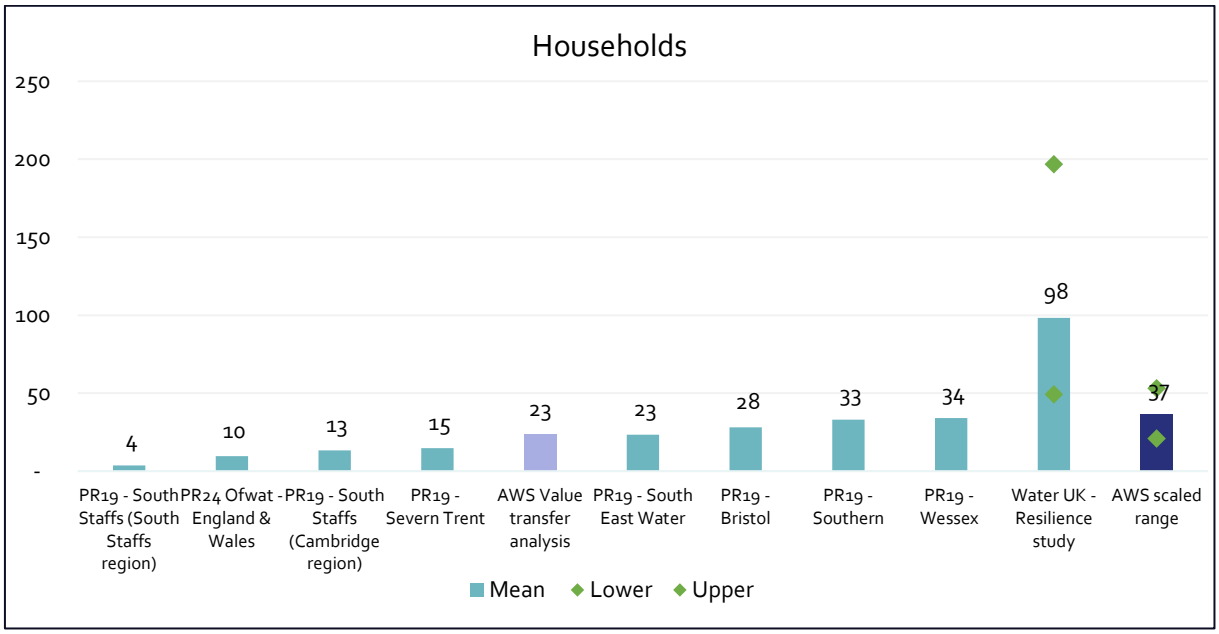

Figure 6-5: Comparing to household secondary data – severe water restrictions expected day of restriction/property affected

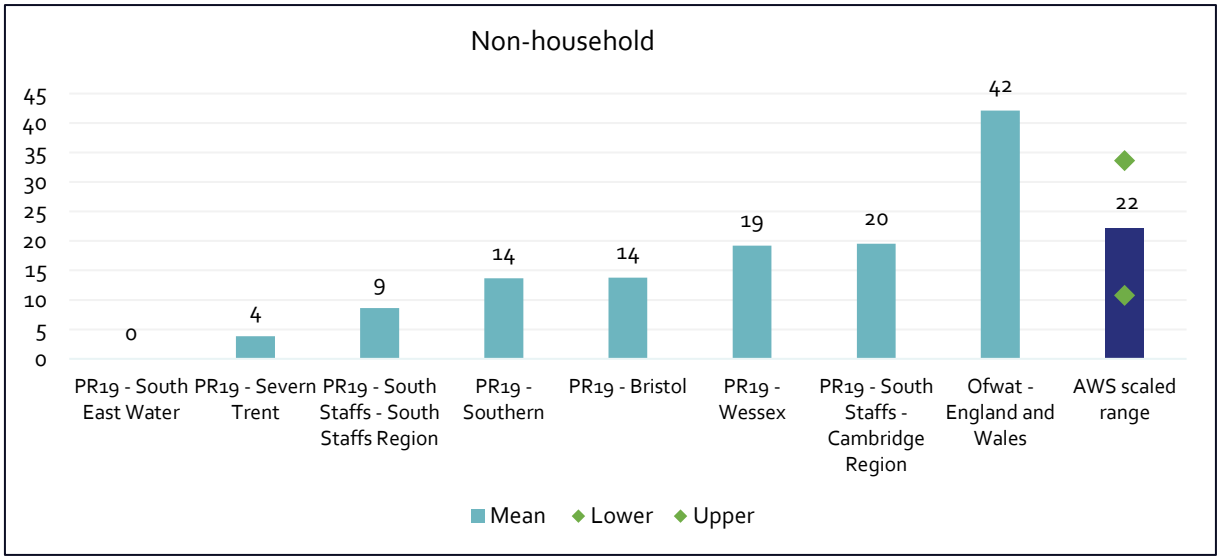

Figure 6-6: Comparing to non-household secondary data – severe water restrictions expected day of restriction/property affected

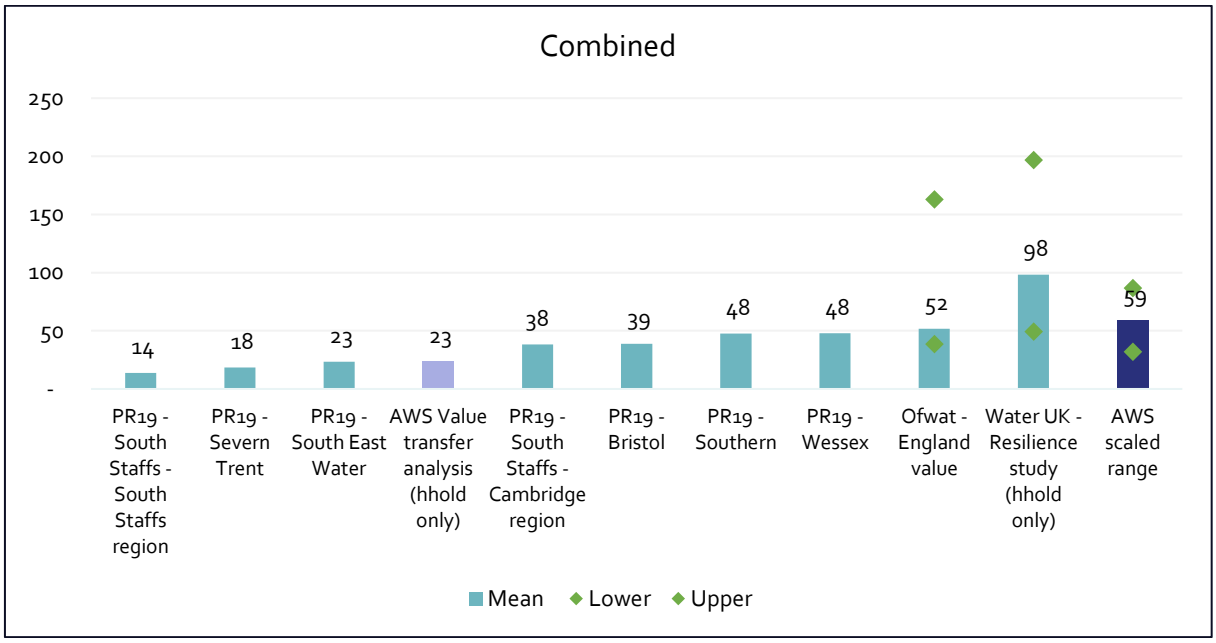

Figure 6-7: Comparing to combined secondary data – severe water restrictions expected day of restriction/property affected

Step 3c: Applying the values to the wider service measure framework and triangulating against other data (primary and secondary)

The scaled values for severe water restrictions have been mapped to the wider service measures for the other water use restrictions as well as supply deficit and aquifer protection. The results are presented in the table below.

The household value for a hosepipe ban has been linked to the severe water restrictions value using the Anglian Water PR24 weights. For non-households a weight relative to severe restrictions has been calculated using the triangulated values from PR19 adjusted for customer numbers and inflation. This approach has been applied as it utilises both the customers weights from the PR19 Water Resources study and the findings from the macroeconomic study.

The resulting values for a hosepipe ban have been compared to two other primary value sources. The first has been calculated by applying the PR24 household weight for a hosepipe ban relative to a supply interruption for households. The values are aligned. The second is the triangulated value for a hosepipe ban from PR19 adjusted for inflation and customer numbers. The PR24 value is higher but overlapping at the lower end of the range.

For a non-essential use ban the PR19 weights relative to a hosepipe ban have been used for households. The approach for non-households is the same as for hosepipe bans reflecting that the findings of the macroeconomic study. Similar to the findings for a hosepipe ban the resulting value is higher than the adjusted PR19 value but aligns with the lower to central values of the range. This reflects the change in value for a hosepipe ban.

The supply demand deficit value is derived from the values for water restrictions using data on the draft WRMP24 deficit and reduction in chance of severe restriction. The values are between the value for a reduction in demand and leakage (see water resource options section).

The aquifer protection value is the supply deficit value plus the value for aquifer storage and reuse from section 7.2. This reflects the avoidance of losing aquifers as a water source plus the additional value customers place on storing water underground[21].

[21] Note the approach to deriving these values removes potential double count.

The values for developer request for services are the macro-economic impact of severe restrictions in the AWS region for 1 year duration. This reflects a value of the impacts of not being able to supply houses in the region. The value presented is the macro-economic study value for 1 day per property multiplied by 365 days. 50% of value is allocated to water and 50% to sewerage to reflect that properties will be connected for a dual service.

Table 6-6: Scaled – water restrictions, supply deficit and aquifer protection, £

SMF duration	Unit	Lower	Central	Upper	Notes on values
Severe restrictions	£/expected day of restriction/ property	31.82	58.83	86.72	Anchor
Hosepipe ban	£/expected day of restriction/ property	0.45	0.72	0.99	The household value is aligned with the value derived from the interruption value with the PR24 weight applied (0.33 to 1.13 which compares to 0.29 to 0.74). The adjusted PR19 triangulated value (0.52 to 0.76) aligns with the lower to central part of the range. Consistent with the Water UK resilience study range of 0.31 to 3.07.
Non-essential use ban	£/expected day of restriction/ property	0.95	2.06	3.20	The value is higher than the adjusted PR19 triangulated value but overlaps at the lower end of the range (0.76 to 2.14).
Supply deficit	£/MLD	93,283	172,480	254,258	Comparable to reducing demand value (£76k to £187k) and leakage value (£116k to £284k).
Aquifer protection	£/MLD	198,736	355,772	510,026	Set equal to supply deficit value plus ASR option value (see next section).
Developer request for water services	£/property	4,995	6,243	7,492	Based on the macro-economic impact of level 4 restrictions in the AWS region for 1 year duration. 50% of value allocated to water and 50% to sewerage.
Developer request for water recycling	£/property	4,995	6,243	7,492	As above.

STEP 4.0 – ASSESS AND TEST VALUATIONS

The wider customer evidence from both PR19 and PR24 for water restrictions found customers to be particularly concerned about severe water restrictions and the effect this could have on their quality of life. PR19 research also found that customer understanding of severe water restrictions, such as standpipes, is not well known amongst customers and is a restriction that many customers believe should never be used. PR24 research shows the priority of drought resilience varies in the different insight but generally appears in the top third

In PR19 it was found that customers felt hosepipe and nonessential use bans not to be overly detrimental. In general, it was found that both household and non-household customers support maintenance of current service levels for hosepipe and nonessential use bans. More recent research for PR24 shows that over a quarter of customers to not believe that the public should have to face these restrictions during a drought.

The values are consistent with the key messages from the wider customer evidence.

7 Leakage

This section covers leakage and other water efficiency measures, water sources and smart meters. The results presented below are based on the most up-to-date triangulation of values. It should be noted that the values that underpin the development of the draft WRMP and demand management strategy are based on an earlier triangulation of the valuation evidence.

STEP 1.0 – SPECIFY AND UNDERTAKE RESEARCH

The evidence base for water resource options is given below. The anchor measure is leakage in Ml/d (highlighted in blue). The wider framework also covers the remaining water efficiency (demand) options and water sources (supply options) as well as Smart metering.

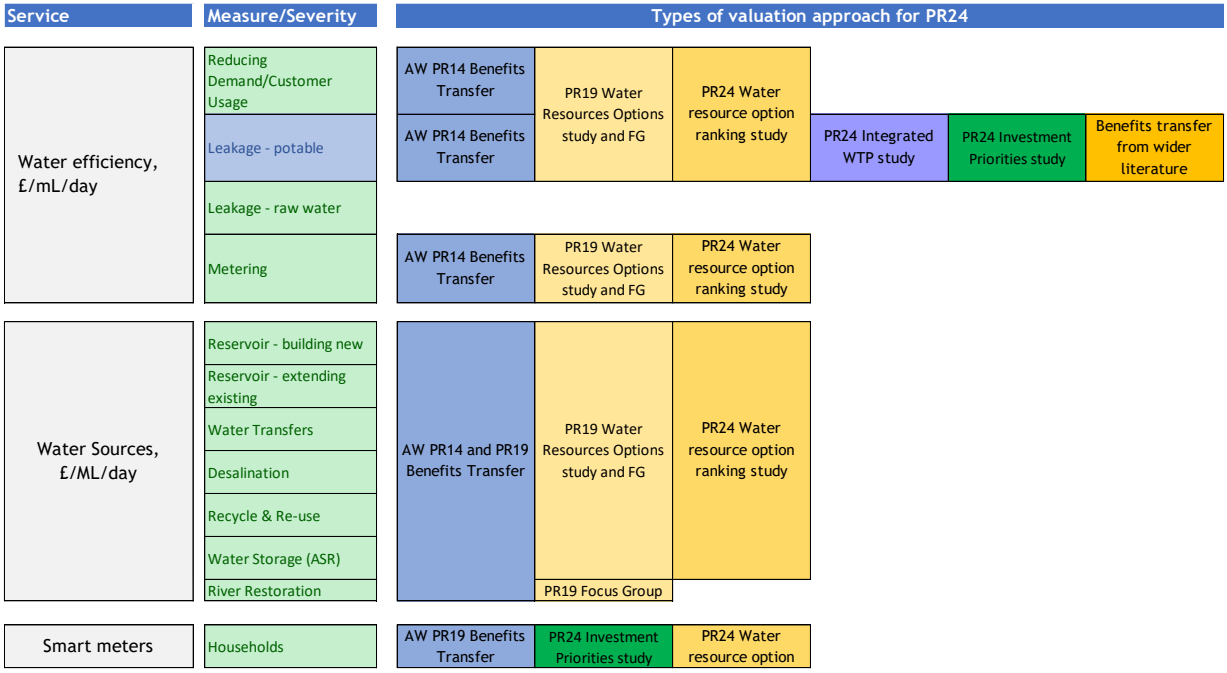

Figure 7-1: Leakage and water resource SMF and valuation evidence

STEP 2.0 SYNTHESIS OF RESEARCH

Table 7-1 presents a summary of the primary data. The studies listed in the table are stated preference studies. The valuation data from these studies covers the leakage measures. The triangulated 2nd stage PR19 WR study and PR24 rankings also provides additional customer preference weights that show how customers view the relative value of the different water resource option types.

Table 7-1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR24 integrated WTP study	Stated preference – valuation	Leakage	Household Non-household	H Good sample size DCE & DCCV methodology	H Definition relevant, new study
PR24 Water Resource option ranking	Preference shares for options	Preference weights for 12 options.	Household Non-household	M Good sample size, BWS approach Designed for wider strategic planning	H Definition relevant, new study
PR24 Investment priorities study (wave 3)	Stated preference - contingent valuation for package of service improvement; Acceptability of bill impact of individual elements	Leakage Smart meters	Household	M/H Good sample. Value range constrained to costs shown. Designed for wider strategic planning	H Definition relevant, new study
PR19 2nd stage Water resource survey	Stated Preference valuation	Leakage	Household Non-household	H Good sample size, CV methodology	M/H Definition relevant, PR19 study
PR19 2nd stage Water resource survey - options	Stated Preference customer preference weights and focus groups	Weights for all options except River restoration, canal transfer & network management, qualitative focus group for all other options.	Household Non-household	H Good sample size, DCE/pairwise comparison methodology	H Definition relevant, PR19 study

PR19 main stage study	Stated preference valuation	Leakage	Household	H Large sample DCE & DCCV methodology	M/H Definition relevant, PR19 study
PR19 Best-worst scaling	Stated preference valuation	Leakage	Household	H Good sample size, BWS methodology	M/H Definition relevant, PR19 study
PR19 2nd stage Water resource survey	Stated Preference valuation	Leakage	Household Non-household	H Good sample size, CV methodology	M/H Definition relevant, PR19 study

Table 7-2 presents a compilation of the secondary data that has been utilised in the triangulation. These 'other studies' are used as sense checks on the core valuation evidence provided by the primary data.

In addition to other company SP values, two further values are identified:

- ONS 2020 Natural Capital Accounts resource rent value which is referenced in the Defra ENCA. This is the value of raw water abstraction for public water supply based on data from 2013 to 2017. This approach is under review and has been given a medium robustness score.
- Average incremental social cost from Water Resource Management Plans referenced in the HMT Greenbook. This value is also referenced in the Defra ENCA. The value includes the cost of addressing water resource deficit as well as the social impact. It is also a general value that covers all water resource interventions. As this value is not based on customer demand, we have allocated a low to medium the robustness score.

Table 7-2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
HMT Greenbook (2021) – from Water company WRMPs	Total incremental cost including social cost	Leakage	Combined	L/M Opportunity cost opposed to demand based value	M From PR14 WRMPs, average for England and Wales
ONS Natural Capital Accounts (2020) **Referenced in Defra ENCA**	Resource rent	Leakage	Combined	M Developing approach - under review by ONS	M/H Recent data, for abstraction, national value.
Accent WTP comparison study (2018)	Stated Preference valuation	Leakage for 7 companies	Household Non-household	M/H Mixed surveys, limited published information for majority of studies	M PR19 studies, definitions clearly set out, other regions.
Accent WTP comparison study (2018) **- AWS benefit transfer value**	Stated Preference valuation	Leakage	Household	M Based on additional calculations	M/H Uses a benefit transfer function so more relevant to AWS region than individual data points
Accent joint study **(2013) – WASC average**	Stated Preference valuation	Leakage	Household Non-household	L/M Back calculated from public domain data assuming average WASC properties	L/M PR14 study

7.1 Leakage

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

Step 3a: Primary data & initial recommended range

This section presents the primary data for households, non-household and the combined customer base.

Households

The primary data for AWS household customers is shown in Figure 7-2. The recommended range is shown both in the graph below and in Table 7-3.

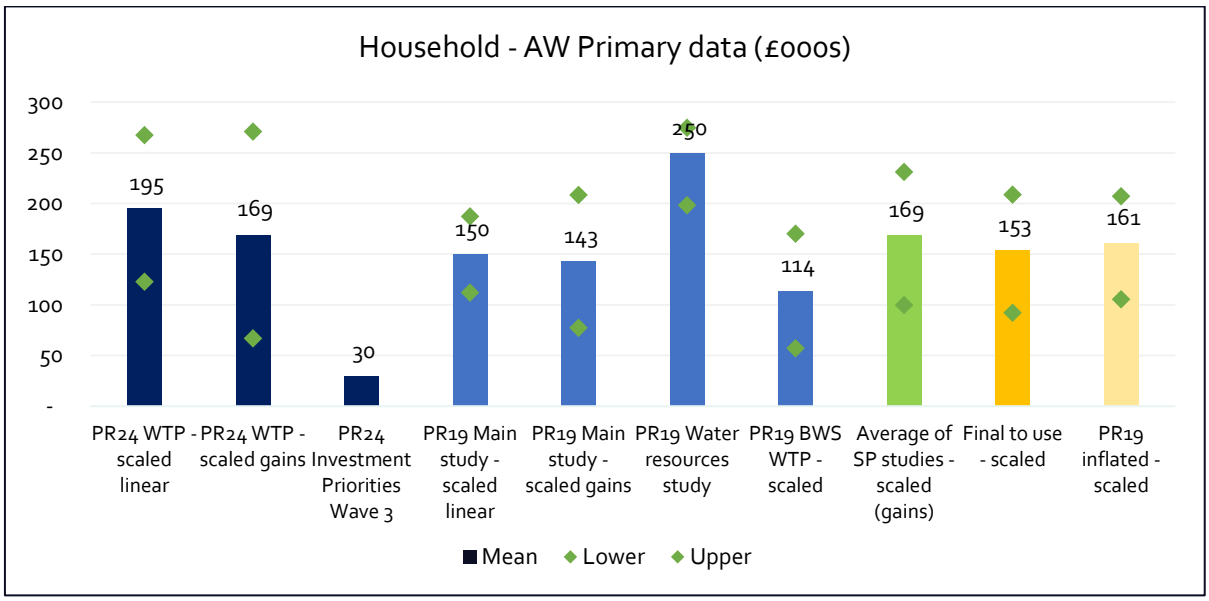

Figure 7-2: Household primary data – leakage £ per MLD (£000s)

Both the scaled central value and range are based on the long run average of the PR24 scaled gains value, PR24 Investment Priorities Wave 3 value, PR19 scaled gains value, the PR19 BWS and PR19 water resource study general values. The PR24 and PR19 scaled gains values are used in preference to the linear values as these are more conservative and the studies indicate that there are lower preferences for improvements than avoiding a deterioration. The PR24 Investment Priorities Wave 3 value is included with a 50% weighting within the average to reflect the values are constrained by the cost presented in the survey and that it is an outlier.

The PR24 value is between the ranges observed at PR19. There are no PR14 values to compare to.

Table 7-3: Scaled values - Scaled household values - leakage £ per MLD (£000s)

Lower	Central	Upper
92	153	209

Following the PR19 CEF feedback we have not applied an uplift to the leakage value to adjust for non-linear improvement values. This decision reflects that this adjustment made at PR19 was based on one study and that AWS have made some changes to the service levels. The service ranges covered PR19 studies remain relevant for the range of service being considered for PR24.

Non-households

The primary data for AWS non-household customers is shown in Figure 7-3. The recommended range is shown both in the graph below and in Table 7-4.

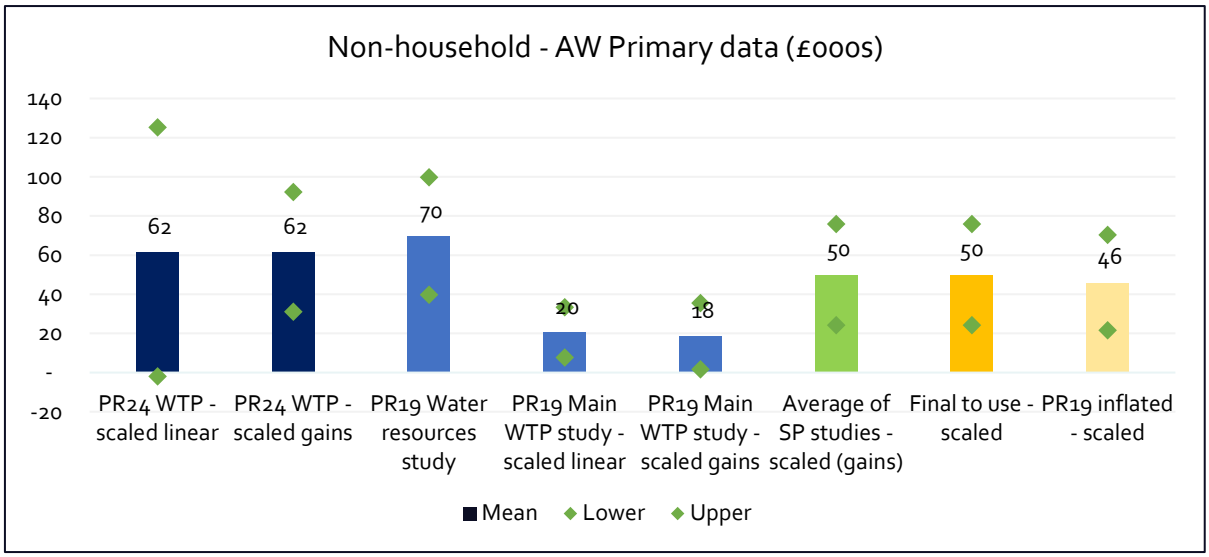

Figure 7-3: Non-household primary data – leakage £ per MLD (£000s)

Similar to the household approach, both the scaled central value and range are based on the long run average of the PR24 scaled gains value, PR19 scaled gains value and the PR19 water resource study general value. Both the PR19 and PR24 scaled gains values are used within the long run average as these values are more conservative than the scaled linear estimates. The PR24 scaled gains value also has a narrower uncertainty range around it.

Table 7-4: Scaled values - Scaled non-household values - leakage £ per MLD (£000s)

Lower	Central	Upper
24	50	76

Combined (households and non-households)

The primary data for AWS combined customers is shown in Figure 7.4. The recommended range is shown both in the graph below and in Table 7-5.

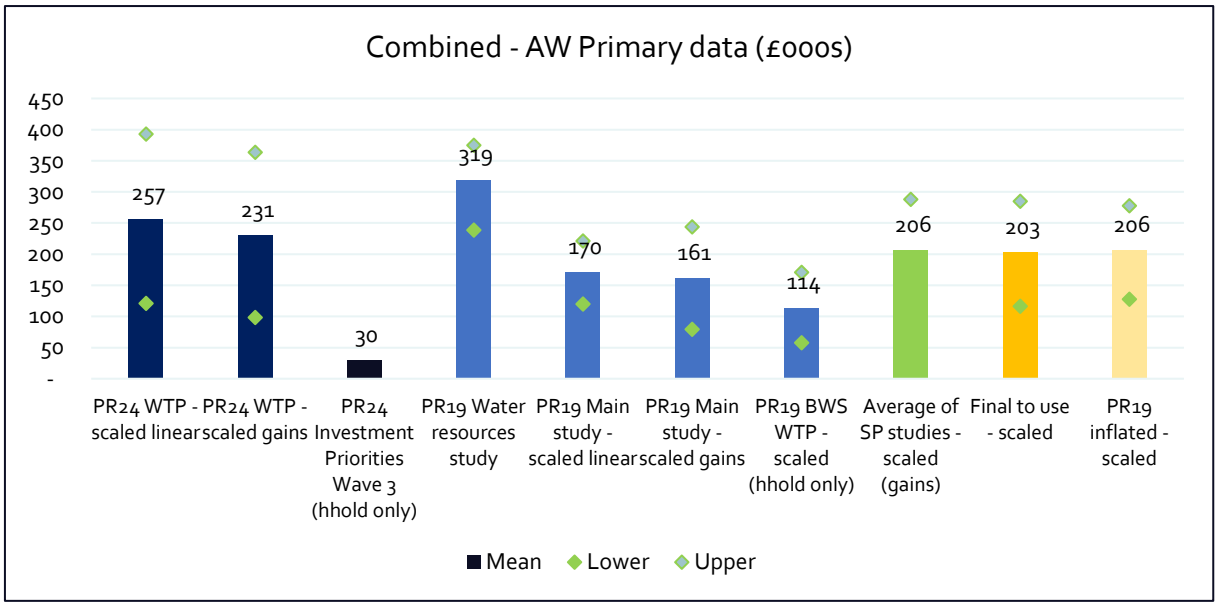

Figure 7-4: Combined primary data - leakage £ per MLD (£ooos)

The values presented are the household range plus non-household range. There are no PR14 values to compare to. The values are similar to the PR19 range. The recommended value also aligns with the supply deficit value (see Section 6 on water restrictions) which is calculated using the values for water restrictions, data on the draft WRMP24 deficit and reduction in chance of severe restriction.

Table 7-5: Initial recommended range – combined, £ per MLD (£ooos) (average for all improvements)

Lower	Central	Upper
116	203	285

Step 3b: Triangulating against other sources (secondary data)

Figure 7-5 to Figure 7-7 show how the ranges compare to the secondary data sources available. The sources for the values included are:

- Accent WTP comparison study from 2018
- Defra ENCA value for resource rent (combined graph only)
- The HMT Greenbook value for incremental costs taken from PR14 Water Resource Management Plans (combined graph only)

The findings are that recommended values are aligned with the studies. The preferred scaled values sit within the lower end of the range for household and non-household values from PR19. The combined graph shows that the AWS recommended value is aligned with the Defra ENCA resource rent value. It is considerably lower than the HMT Greenbook value which reflects the cost of a range of water resource interventions. This source is an opportunity costs value (not demand based) and therefore is not justification to amend the value.

Looking at the PR19 other company values, the South Staffs Water, South West Water and Thames Water values are unscaled. All other values are thought to be scaled.

It is not clear from the information available whether other companies have designed studies to produce a leakage value that is either: a) additional to the impacts of water restrictions due to drought or b) includes both the value for leakage and water restrictions. Given this, as the Anglian Water primary values are in addition to the impacts of water restrictions, it is probably appropriate that the triangulated value is towards the lower end of the secondary range.

The AWS value transfer study value is derived from the values collated in the 2018 Accent study and uses regression analysis combined with characteristics of the companies to create a value transfer function. The approach to the regression analysis draws upon the Defra guidance on benefit transfer[22]. Prior to interrogating the data potential explanatory factors were identified based on both economic theory and a previous meta-analysis of stated preference data completed by UKWIR in 2010[23].

Full details are included in Appendix 3. The leakage model uses service level (Percentage chance of a hosepipe ban) and an explanatory variable for whether the study was scaled. The resulting value is higher than the recommended value probably reflecting the discussion above on the scope of the other company PR19 values.

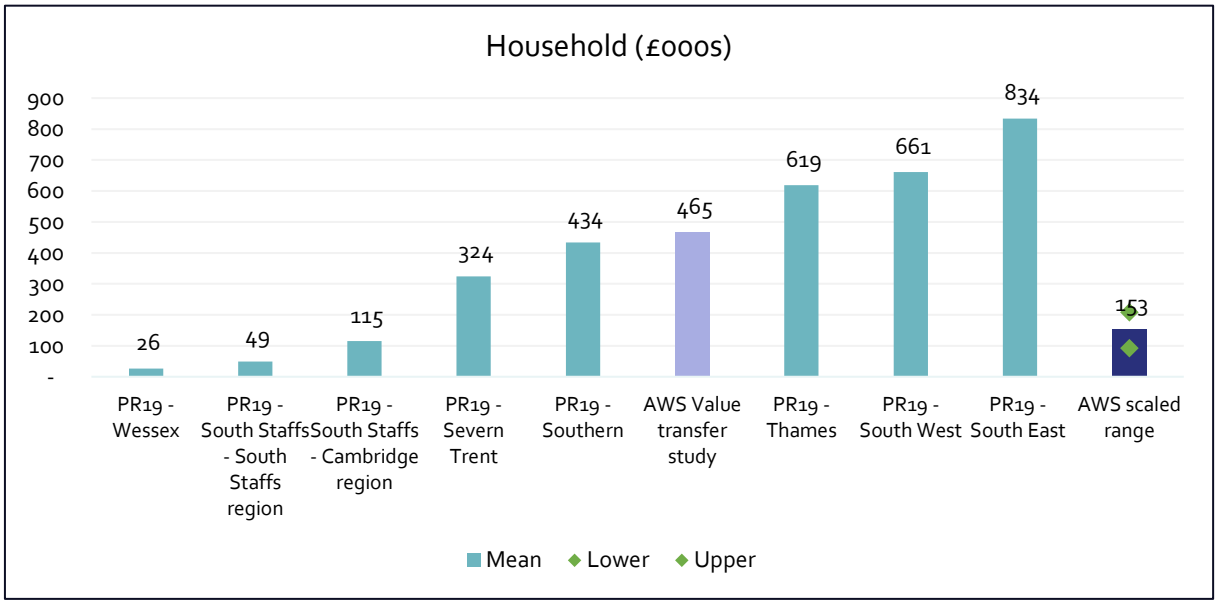

Figure 7-5: Comparing to household secondary data - leakage £ per MLD (£000s)

[22] eftec (2009) Valuing Environmental Impacts: Practical Guidelines for the use of value transfer in policy and project appraisal. Report submitted to Defra.

[23] UKWIR (2010) Review of Cost-benefit analysis and benefit valuation (RG07). Milestone D (Quantitative Analysis Working paper. Authors Carlo Fezzi, Ken Willis, Allan Provins, Chelsea Thomson (Cascade, eftec and ICS Consulting)

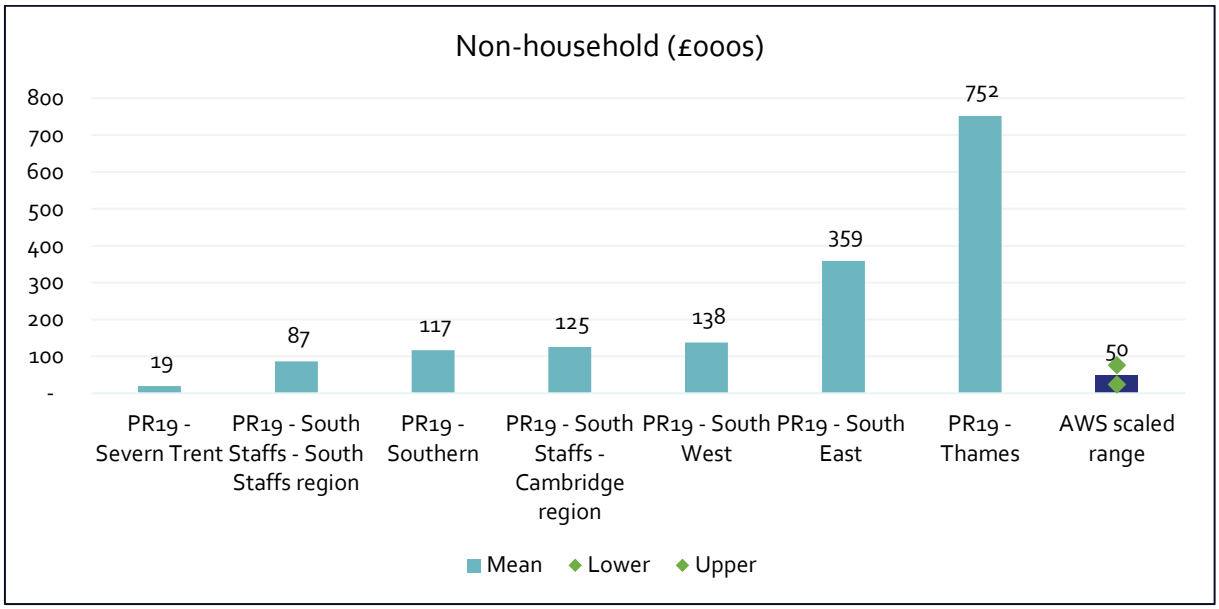

Figure 7-6: Comparing to non-household secondary data - leakage £ per MLD (£000s)

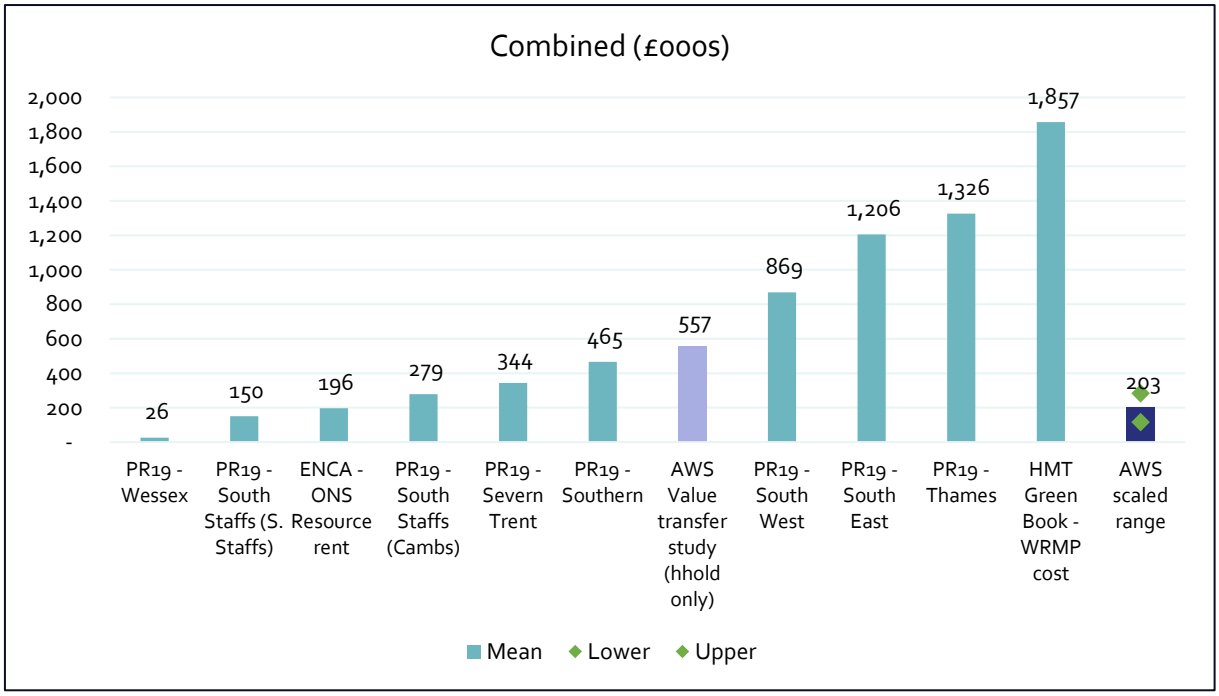

Figure 7-7: Comparing to combined secondary data - leakage £ per MLD (£000s)

Step 3c: Applying the values to the wider service measure framework and triangulating against other data (primary and secondary)

Not applicable for this measure.

STEP 4.0 – ASSESS AND TEST VALUATIONS

The wider customer evidence for leakage continues to show that leakage is a high customer priority with support to reduce leakage. This evidence aligns with the recommendations presented in this report.

7.2 Water resource options

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

As outlined in Step 1, the values for below are linked to the anchor value for leakage.

- Water efficiency
- Water sources
- Smart meters

This is applied in Step 3c below prior to comparing the results to the available primary and secondary data.

Step 3c: Applying the values to the wider service measure framework and triangulating against other data (primary and secondary)

The scaled values for leakage have been mapped to the wider service measures for water resource options and the results are presented in the table below.

The leakage value is mapped to other options using weights from the PR19 water resources stated preference study triangulated with ranking preferences from the PR24 water resource option study.

To triangulate the weights the ranking order of the options has been compared where the same options have been included in both studies. The findings show:

- There is a stronger preference for reducing demand for both household and non household customers in the PR24 study. The weight of this option has been increased from PR19 to reflect this.
- There is a lower preference for aquifer storage and recovery for household customers. The weight of this option has been reduced from PR19.
- There is a slightly higher preference for desalination for household customers. The weight of this option has been increased slightly from PR19.
- There is a higher preference for water transfer and re-use for non-household customers. The weights of these options have been increased from PR19.
- There is a higher preference for reservoirs for non-household customers and the weights have been increased from PR19. For household customers, the PR19 study shows that preference for reservoirs differs depending on whether the reservoir option refers to a new reservoir or extending an existing one. The PR24 household preferences are between the two options and the PR19 weights have been retained to reflect this distinction.

River restoration was not included in the PR19 survey. The option was instead assessed in a post survey focus group undertaken as part of the PR19 Water Resource study. Based on the findings, an average of the extend reservoir and ASR options has been used to value this option.

The PR19 Water Resource study also provided weightings for the values depending on reliability. This enables the values to be adjusted to reflect options with low, medium and high reliability. The results shown relate to the general range of service level improvements. No other primary value evidence is available to compare to.

The recommended central value for smart meters an average of the PR19 Water Resources study value, the value for metering (compulsory and voluntary) adjusted to be equivalent for a household's

water saving[24] and the Investment priorities study. The PR24 Investment Priorities Wave 3 value is included with a 50% weighting within the average to reflect the values are constrained by the cost presented in the survey and that it is an outlier.

The investment priorities study value is higher than the other sources. This source is used as the upper value. The lower value excludes this source and is an average of the other two sources.

Table 7-6: Scaled – Water resources options & smart metering, £ per MLD, medium reliability

SMF band	Unit	Lower	Central	Upper	Notes on values
Leakage - potable	£/MLD	116,334	203,310	284,538	Anchor value.
Reducing Demand / Customer Usage	£/MLD	75,622	133,024	186,820	
Leakage – raw water	£/MLD	116,334	203,310	284,538	Set equal to the potable leakage value
Metering	£/MLD	49,461	86,713	121,562	
Reservoir - building new	£/MLD	57,385	101,356	142,656	
Reservoir - extending existing	£/MLD	102,182	175,460	243,212	
Water Transfers	£/MLD	36,279	63,209	88,315	
Desalination	£/MLD	32,205	56,865	80,022	
Recycle & Re-use	£/MLD	74,185	129,792	181,754	
Water Storage (ASR)	£/MLD	105,453	183,293	255,768	
River Restoration	£/MLD	103,818	179,376	249,490	
Smart meters	£/property	3.38	9.52	27.34	Metering value range is from £1.85 to £4.53 per property, the PR19 survey value is £4.91 to £8.86.

STEP 4.0 ASSESS AND TEST VALUATIONS

The wider synthesis found that before any supply options can be considered customer have a strong view that Anglian Water should get their house in order first. For a significant majority of customers this means fixing leaks. The research consistently found that reducing customer consumption is a high priority but lower than leakage.

This is aligned with PR19 research that indicated that customers prefer options that are more reliable and options that avoid perceived waste and promote efficiency. The values are consistent with these key messages from the wider customer evidence.

[24] This assumes a 10% water saving based on 145 litres per capita and an average occupancy of 2.36 (Sources: Per capita Consumption from AWS; Occupancy based on the ONS 2022 Families and households publication).

8 Lead

STEP 1.0 – SPECIFY AND UNDERTAKE RESEARCH

The evidence base for lead in tap water is given below.

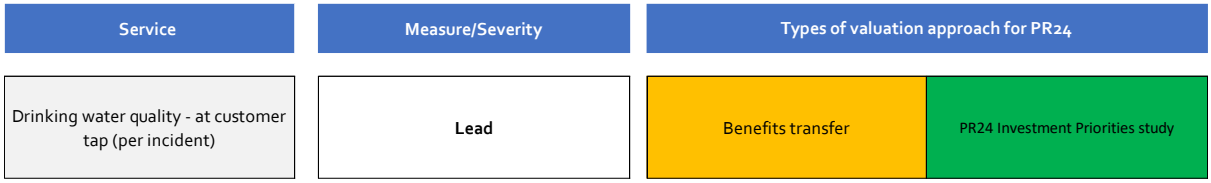

Figure 8-1: Lead evidence base

STEP 2.0 SYNTHESIS OF RESEARCH

The valuation is based on value transfer for lead standards. The sources are outlined in Table 8-1 below.

Table 8-1: Data sources for lead

Study	Valuation type	Measure covered	Data	Robustness	Relevance
AWS PR24 Investment priorities study (wave 3)	Stated preference - contingent valuation for package of service improvement; Acceptability of bill impact of individual elements.	Lead in drinking water	Household value	M/H Good sample. Value range constrained to costs shown. Designed for wider strategic planning	H Definition relevant, new study, regional value.
DWI (2021) Long-term Strategies to Reduce Lead Exposure from Drinking Water	Value transfer	Lead in drinking water.	Health consequences of lead in blood and associated household benefit values	H Detailed assessment	H Relationship relevant to existing service target, new study.
Study by Triantafyyllidou and Edwards (2012)	Value transfer	Lead in drinking water.	Link between lead in water levels and the level in blood.	H	H Relationship relevant to existing service target.
HSE health and safety values (2018)	Value transfer	Illness	General value	H Published values	H Relevant definition

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

The approach for valuing lead combines information on the effects of lead on the health of adults and children and with benefit values primarily drawn from the DWI (2021) Long-term Strategies to Reduce Lead Exposure from Drinking Water and supplemented by a health and safety value published by the HSE to produce a per property value for the removal of lead in drinking water.

Summary of approach

The DWI study outlines three main health impacts of lead exposure and the associated approach to measure the health end-points. These are set out in the table below:

Table 8-2: Health impacts of lead exposure and end-point measure

Health impact	Health end point measure
Impaired neurodevelopment	• Intelligence Quotient (IQ) at age 10
Impaired renal function	• Prevalence of Stage 3 or worse Chronic Kidney Disease (CKD) (defined as an eGFR < 60ml/min)
Cardiovascular dysfunction	• Prevalence of: a) hypertension (defined as measured by Systolic Blood Pressure (SBP) ≥ 140mmHg at rest) b) mortality due to Cardiovascular Diseases (CVD), defined in terms of lost life expectancy

The benefits of reducing lead exposure in tap water for each of the health end-points is characterised in terms of dose-response relationships between the health measures and Blood Lead Level (BLL).

These dose-response relationships are of varying complexity as described in DWI (2021) and is not possible to replicate the modelling undertaken by WRC.

Where possible we have extracted simplified dose-response relationships to allow the calculation of an overall benefit £ per property from reduced lead exposure in tap water. The key assumption made in these simplified relationships is that they represent the incremental impact on the end-point measure for a 1 mg/dL reduction in BLL.

Table 8-3 shows the estimated scale of health impacts from lead pipe removal at 1,000 properties.

Table 8-3: Reductions in health impacts for per 1000 properties

Impact	Lower bound (Number)	Upper bound (Number)
Adults that develop health effects		
Major Illness		
Renal: Male	-0.14	-0.56
Renal: Female	-0.23	-0.93
CVD: Male	-0.02	-0.06
CVD: Female	-0.01	-0.06
Hypertension: Male	-0.01	-0.05
Hypertension: Female	-0.01	-0.04
Minor illness	-58	-231
Children that develop health effects		
Reduction in Total IQ Impairment by Age 10	-92	-461

The benefit of these improved health outcomes are primarily estimated using values from the DWI (2021) covering the following

- Value of Avoided CKD
- Value of Avoided Hypertension Prevalence.
- Value of Avoided CVD Mortality
- Minor lost time accident - Ill health up to 6 days
- Lifetime Earnings Reduction from Total IQ Impairment by Age 10

The DWI (2021) benefit values are applied to the forecast number of health improvements before conversion to a per property value, shown in Table 8.4 as an annualised value[25]. **A full write up of the method is included in appendix 3 of this report.**

Table 8-4: Drinking water quality at customer tap; Lead, £

SMF band	Unit	Lower	Central	Upper
Drinking water quality - at customer tap (per incident); Lead	£/property	53	156	260

[25] The full discounted lifetime benefit values from the DWI study have been annualised (which accounts for discounting and time preference) to produce a benefit value for each year lead is removed. This makes the values consistent with the other values presented in the triangulation report.

The resulting value has been compared to the investment priorities study value. The results are presented below. The Investment priorities study value falls within the range from the analysis.

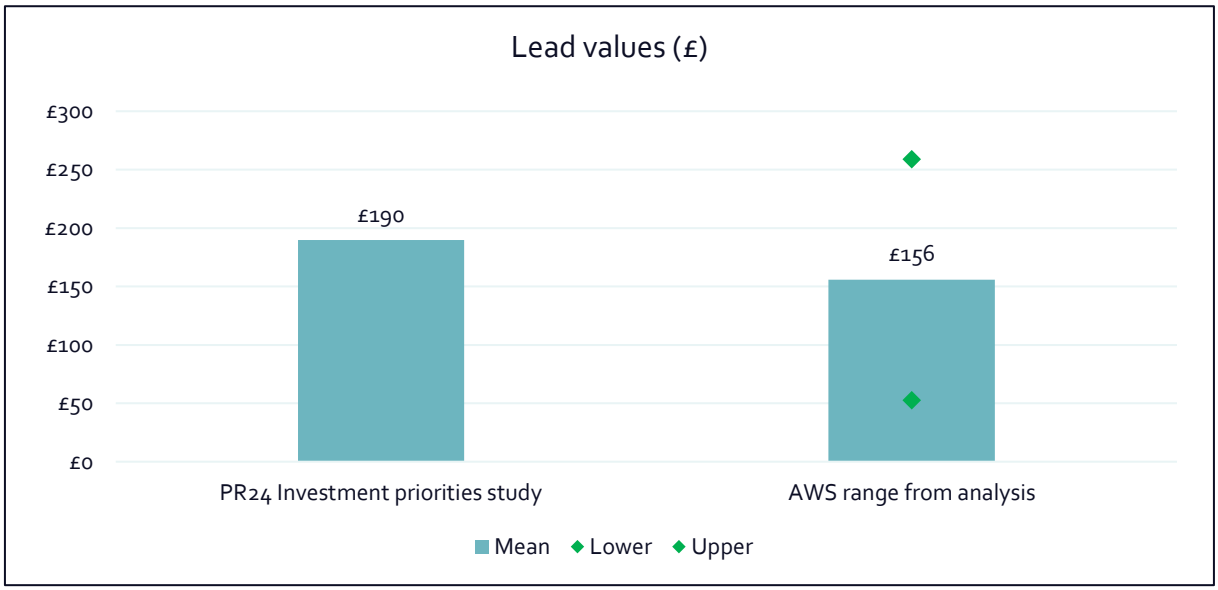

Figure 8-2: Values for lead – £ per property

STEP 4.0 ASSESS AND TEST VALUATIONS

Lead pipe replacement is viewed as a high priority for customers.

9 Flooding

This section covers internal flooding categories (including civic centre), loss of facilities, external flooding (including civic centre), odour, first time sewerage.

STEP 1.0 SPECIFY AND UNDERTAKE WORK

The evidence base for internal sewer flooding is given below. The anchor measure is internal flooding of a domestic property – living area (highlighted in blue). The wider framework also covers flooding of civic centres, non-domestic property, external flooding, loss of facilities, odour and first-time sewerage.

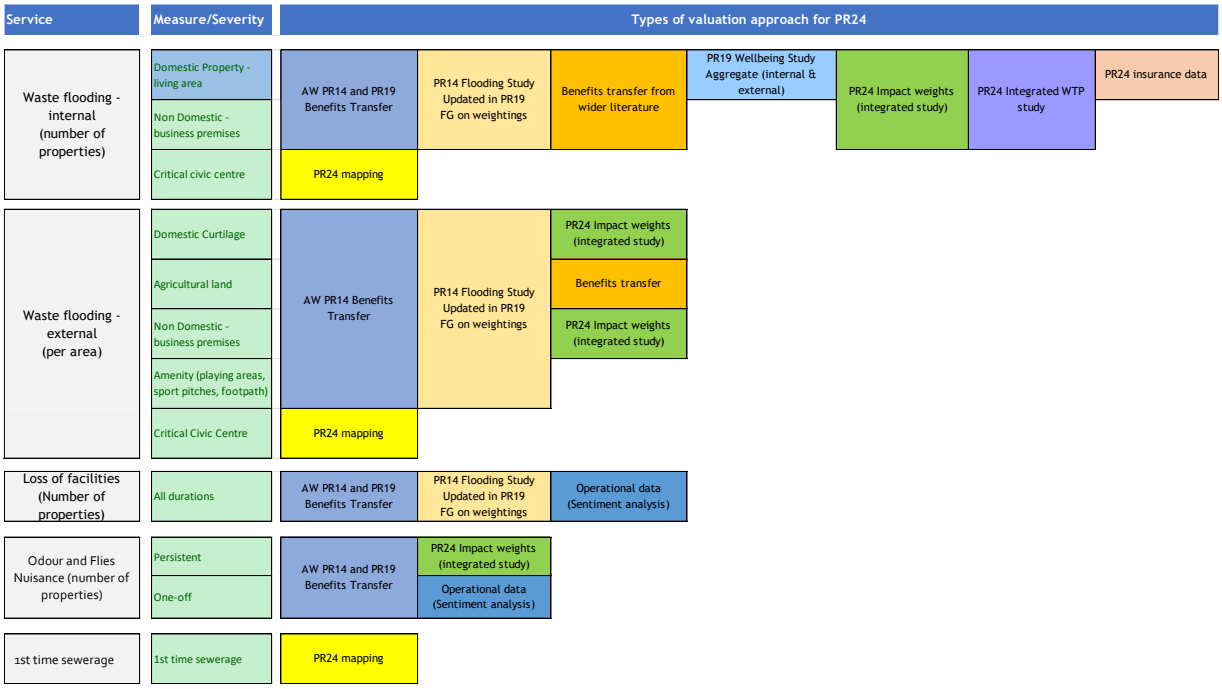

Figure 9-1 Flooding SMF and valuation evidence

STEP 2.0 SYNTHESIS OF RESEARCH

Table 9-1 presents a summary of primary data. The table includes a range of valuation types covering Stated Preference studies, subjective wellbeing expenditure, insurance data and qualitative focus group review of relative preferences. The subjective wellbeing values are different to the stated preference values:

- Stated preference values aim to capture the total economic value that includes a public good or altruism value that will not be fully captured by a subjective wellbeing value. On its own this would suggest that the stated preference values should be higher than the subjective wellbeing value.
- The subjective wellbeing analysis has included a constraint on income to reflect budget constraints. Both the unscaled and scaled values implicitly allow for an income constraint. However, the scaled value reflects 'package effects' that allow for the income and substitution effects associated with delivering large improvements to multiple service areas (see Part 1 of this report). This second point, on its own, suggests that the subjective wellbeing value should

be greater than the scaled stated preference value but lower than the unscaled stated preference value.

Conceptually it is not clear which of these effects will outweigh the other.

The insurance data is also a partial value that can be viewed as similar to a damage cost. The value does not include altruism and non-use value.

Table 9-1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR24 integrated WTP study	Stated preference – valuation	Internal sewer flooding	Household Non-household	H Good sample size DCE & DCCV methodology	H Definition relevant, new study
PR24 Ofwat centralised research – AWS region	Stated preference – (compensation)	Values and customer preference weights for internal and external flooding	Household Non-household	M/H Good sample size for AWS region, BWS and compensation methods, excludes altruism	H Definition relevant, new study.
PR24 insurance data	Damage cost	Internal water flooding	Household, Non-household	M Partial value	M For internal water flooding not wastewater
PR24 sentiment analysis	N/a Insight on relative severity	Odour Loss of facilities	Household	L Not valuation data	H Definition relevant, recent data from AWS customers
PR19 main stage study	Stated preference – valuation	Internal and external sewer flooding	Hhold, Non-hhold	H Large sample DCE & DCCV methodology	M/H Definition relevant, PR19 study
PR19 Best-worst scaling	Stated preference – valuation	Internal and external sewer flooding	Hhold	H Good sample size, BWS methodology	M/H Definition relevant, PR19 study

PR19 2nd stage water resources survey	Stated Preference – valuation	Internal sewer flooding	Hhold, Non-hhold	H Good sample size, CV methodology followed by allocation exercise	M/H Definition relevant, PR19 study
PR19 subjective wellbeing study	Subjective wellbeing	Internal and external sewer flooding, internal water flooding	Hhold	M/H Innovative method at time. Involved additional translations.	M/H Definition relevant, PR19 study.
PR19 relative preference focus group	Qualitative review of customer preference weights from PR09 water services 2nd stage study plus discussion	Majority of measures in the internal and external flooding SMF. Covers water and waste flooding.	Hhold	L/M Qualitative, Small sample size	H Definition relevant, PR19 research
PR14 main stage study	Stated preference – valuation	Internal and external sewer flooding	Hhold, Non-hhold	H Very large sample DCE & DCCV methodology	M/H Definition relevant, new study
PR14 2nd Stage flooding study	Stated Preference – customer preference weights	Weights for wider internal and external flooding SMF. Covers water & waste flooding.	Hhold	H DCE methodology, good sample size	H Definition relevant, PR14 study

Table 9-2 presents a compilation of the secondary data that has been utilised in the triangulation. These 'other studies' are used as sense checks on the core valuation evidence provided by the primary data. It covers other company stated preference surveys from PR14 and PR19, damage cost data and an assessment of the mental health impacts of flooding. The HMT Greenbook provides a standardised source or a damage cost estimate of flooding data. We have also included Environmental Agency data from the 2015 and 2016 winter floods.

The damage cost data alone will not capture the public good or altruism value, inconvenience or sentimental loss values that are captured in the stated preference values. The mental health study, which is reported in the Defra ENCA, captures the longer term impacts on health.

Table 9-2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR24 Ofwat centralised research – England and Wales	Stated Preference valuation – compensation	Values and customer preference weights for internal and external sewer flooding	Household Non-household	M/H Very large sample, BWS and compensation methods, excludes altruism	M/H Definition relevant, new study National values not AWS region
HMT Green Book (2021) – Damage costs	Damage costs	Internal water flooding	Household	M Produced by Government Partial value as does not include quality of life impact	M Recent data, General flooding not waste water flooding Value for UK.
Defra mental health costs (2020) – referenced in ENCA	Cost of treatment and economic losses	Internal water flooding	Household	M Partial value Government source	M General flooding not sewer flooding
Accent WTP comparison study (2018)	Stated Preference valuation	Internal wastewater flooding and external sewer flooding for 6 companies	Household Non-household	M/H Mixed surveys, limited published information for majority of studies	M PR19 studies, definitions clearly set out, other regions
Accent WTP comparison study (2018) – AWS benefit transfer value	Stated Preference valuation	Internal sewer flooding	Household Non-household	M Based on additional calculations	M/H Uses a benefit transfer function so more relevant to the AWS region than individual data points

Environment Agency 2015 and 2016 winter floods **Referenced in Defra ENCA**	Economic costs	Internal water flooding	Household Non-household	M Partial value	M Recent data, general flooding not waste water flooding
eftec (2016) Targeting investments to protect and improve natural capital in England	Market impact assessment (yield costs)	External water flooding	Non-household	H/M Yield value per hectare, partial value.	M/L New study, average yield value likely to be sensitive to agricultural use, requires conversion from hectares to average area size.
FHRC and Environment Agency (2013) - Flood and Coastal Erosion Risk Management - A Manual for Economic Appraisal	Damage costs	Internal water flooding	Household Non-household	M Partial value	M (household) Average cost over a range of depths, older study. L (non-hhold) Value not used as requires conversion from £/m2
Accent joint study – Unknown companies (2013)	Stated Preference valuation	Internal sewer flooding for six companies	Household Non-household	M Mixed surveys, limited published information	M/L Relevant definitions, PR14 study, unknown areas
Environment Agency (2010) The costs of the summer 2007 floods in England	Damage cost	Internal water flooding	Household Non-household	M Partial value	M (household) Average cost, depths not clear, older study.

9.1 Internal sewer flooding

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

Step 3a: Primary data & initial recommended range

This section presents the primary data for households, non-household and the combined customer base.

Households

The primary data for AWS household customers is shown in Figure 9-2. The recommended range is shown both in the graph below and in Table 9-3. The recommended central value is higher but aligned with the PR19 inflated value.

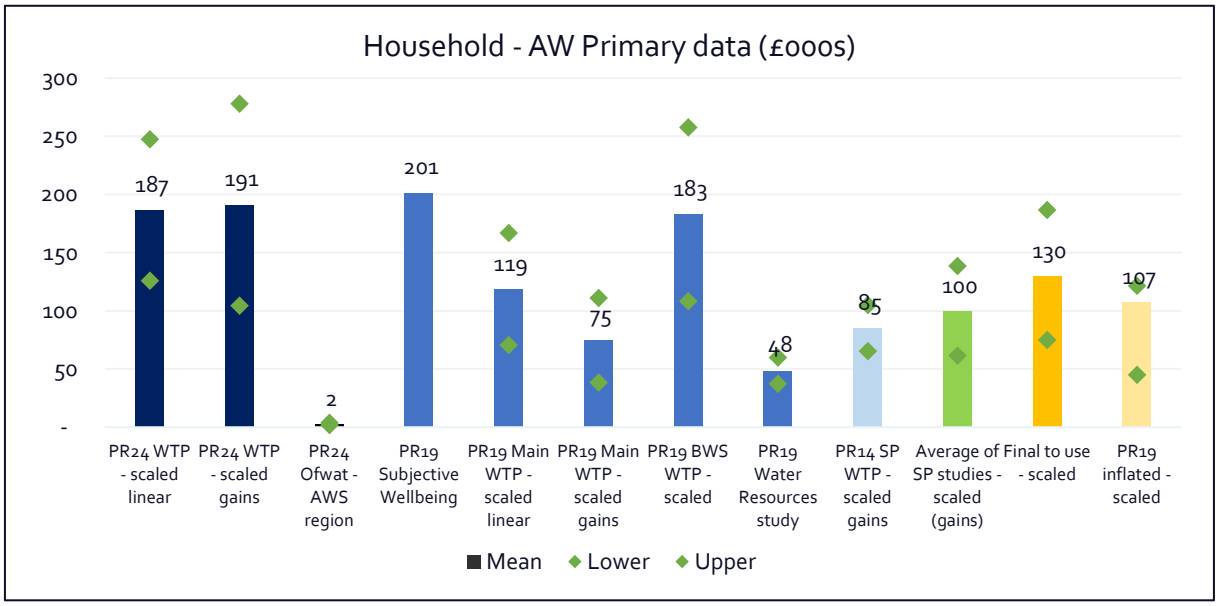

Figure 9-2: Household primary data - Internal Sewer Flooding: £ per property (£000s)

The scaled central value is based on a long-term average that includes the PR24, PR19 and PR14 AWS studies. This includes the PR19 subjective wellbeing value, which is closely aligned with the PR24 research and the RP19 Main, BWS and Water Resource study values. The long-term average is lower than the PR24 value. This reflects that whilst the PR24 level is observed at PR19 in one SP study (BWS) it is lower for two other studies (Water Resources and the PR19 main study). This indicates that the value could vary.

The PR24 scaled linear and PR19 scaled gains values are used as these are more conservative.

The lower range uses a similar approach based on the confidence intervals. It excludes the subjective wellbeing value as this has no confidence intervals and the range is lower than if the subjective wellbeing mean value is included. The upper range is set equal to the PR24 central value to reflect that this is higher than the central value.

The values from all sources are significantly higher than the Ofwat and CCWater PR24 collaborative research value. Whilst this complies with theoretical expectations due to the Ofwat and CCWater PR24 collaborative research values not including altruism. The wider evidence suggests the collaborative research values is disproportionately low and an outlier (see step 3b in this section).

Table 9-3: Scaled household values - Internal Sewer Flooding: £ per property (£000s)

Lower	Central	Upper
75	130	187

Non-households

The primary data for AWS non-household customers is shown in Figure 9-3. The recommended range is shown both in the graph below and in Table 9-4. The recommended central value is lower but aligned with the PR19 inflated value.

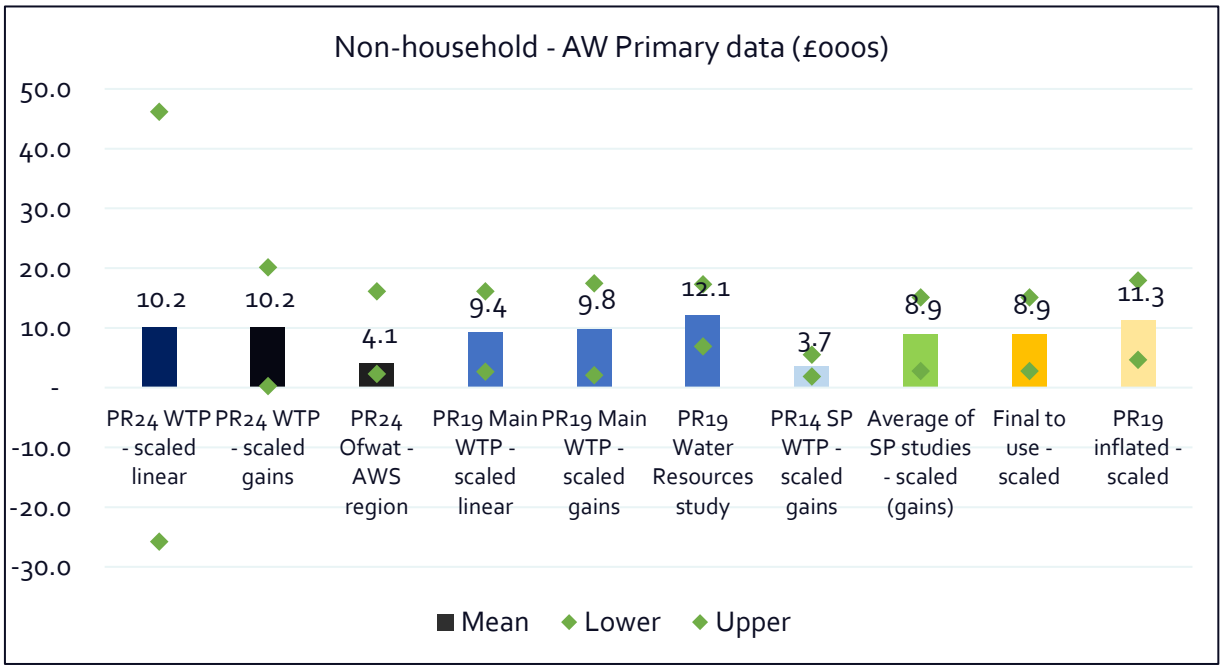

Figure 9-3: Non Household primary data - Internal Sewer Flooding: £ per property (£000s)

The non-household recommended values for the central value and the ranges are the long run average of the AWS commissioned primary research. The recommended value is lower than the PR19 value inflated. This reflects the lower value observed for PR14 relative to PR19 and PR24. The PR14 value has been included as the value is within the uncertainty bands observed for both PR19 and PR24.

The Ofwat and CCWater PR24 value aligns with the value observed at PR14 which is included in the analysis and is within the range recommended.

Table 9-4: Scaled non-household values - Internal Sewer Flooding: £ per property (£000s)

Lower	Central	Upper
2.8	8.9	15.1

Combined (households and non-households)

The primary data for AWS combined customers is shown in Figure 9-4. The recommended range is shown both in the graph below and in Table 9-5. The overall recommended central value is higher but aligned with the PR19 inflated value.

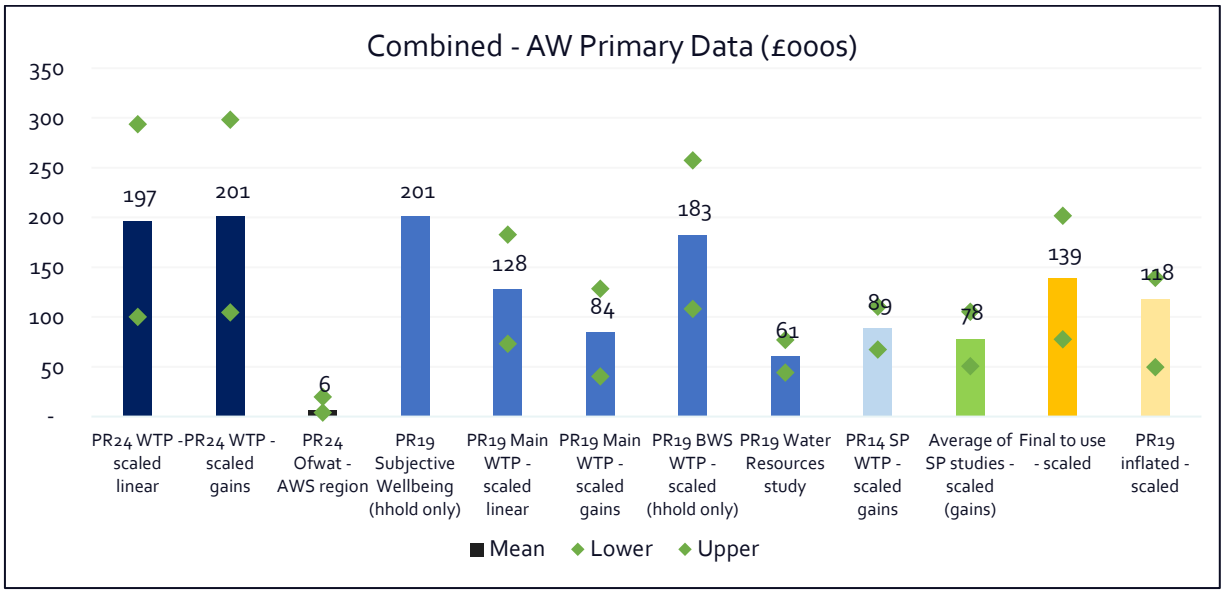

Figure 9-4: Combined primary data - Internal Sewer Flooding: £ per property (£000s)

The values presented are the household range plus non-household range. The Subjective Wellbeing study (SWB) is included here for completeness, however, this is a household only value. The same is true for the PR19 BWS value which is also household only. The recommended scaled values are higher than the PR19 inflated scaled values.

The differences to the Ofwat and CCWater PR24 collaborative research value are the same as for households. The wider evidence suggests the collaborative research values is disproportionately low and an outlier (see step 3b in this section).

Table 9-5: Initial recommended range – combined - Internal Sewer Flooding: £ per property (£000s)

Lower	Central	Upper
78	139	202

Step 3b: Triangulating against other sources (secondary data)

Figure 9-5 to Figure 9-7 show how the ranges compare to the secondary data sources available. For non-household comparisons, the recommended scaled value is towards the lower end but aligned with many of the other studies. The household and combined recommended ranges are towards the upper end of the range.

The sources for the values included are:

- Accent WTP comparison studies from 2018 and 2013
- An average WTP value from the PR14 equivalent Accent study
- Wider values from literature including damage costs from the Greenbook and EA studies and a study on the mental health impact of flooding from the Defra ENCA.
- Ofwat and CCWater PR24 collaborative research values for England and Wales.

For household the value is towards the upper end of the other company values. An interesting comparison is the HMT Greenbook values that have been combined with the Defra mental health impact value. A low and high value are included in the graph to show a range based on different

depths of flooding. These values are for general water flooding rather than sewer flooding and do not include public good/altruism value or sentimental loss values. They are also unlikely to capture the full value of inconvenience. The values relate to less than 0.1m flooding depth at the lower end and greater than 1.2m at the upper end. The sewer flooding depth will be between these values and towards the lower end.

The evidence suggests that the value for sewer flooding is higher than water flooding. A factor of three was found in the PR14 second stage SP flooding study and this is consistent with the findings of the PR19 subjective wellbeing study (a different approach). Adjusting for this factor based on damage costs of £25k gives a minimum value of £75k that if is consistent with the lower end of the recommended range. Multiplying the higher combined damage cost and mental health value by this factor gives a value that is consistent with the AWS upper range.

The AWS value transfer study value is derived from the values collated in the 2018 Accent study and uses regression analysis combined with characteristics of the companies to create a value transfer function. The approach to the regression analysis draws upon the Defra guidance on benefit transfer[26]. Prior to interrogating the data potential explanatory factors were identified based on both economic theory and a previous meta-analysis of stated preference data completed by UKWIR in 2010[27].

Full details are included in Appendix 3. The flooding model uses household income after housing costs and the sewerage bill as explanatory factors. The resulting value is lower than the central recommended value but within the confidence bands.

The Ofwat and CCWater PR24 collaborative research range for England and Wales is significantly lower than the recommended range and are the lowest values out of all the wider evidence for both the household and the combined findings. Whilst, the Ofwat and CCWater PR24 collaborative research values does not include altruism and can be expected to be lower than the AWS value the difference does not align with other sources, for example, the household value this is lower than the HMT Green Book value for general flooding. As discussed above this is a partial value and is expected to be much higher when adjusted for sewer flooding.

Note the studies have been adjusted for risk to allow for comparison to the AWS stated preference values.

[26] eftec (2009) Valuing Environmental Impacts: Practical Guidelines for the use of value transfer in policy and project appraisal. Report submitted to Defra.

[27] UKWIR (2010) Review of Cost-benefit analysis and benefit valuation (RG07). Milestone D (Quantitative Analysis Working paper. Authors Carlo Fezzi, Ken Willis, Allan Provins, Chelsea Thomson (Cascade, eftec and ICS Consulting)

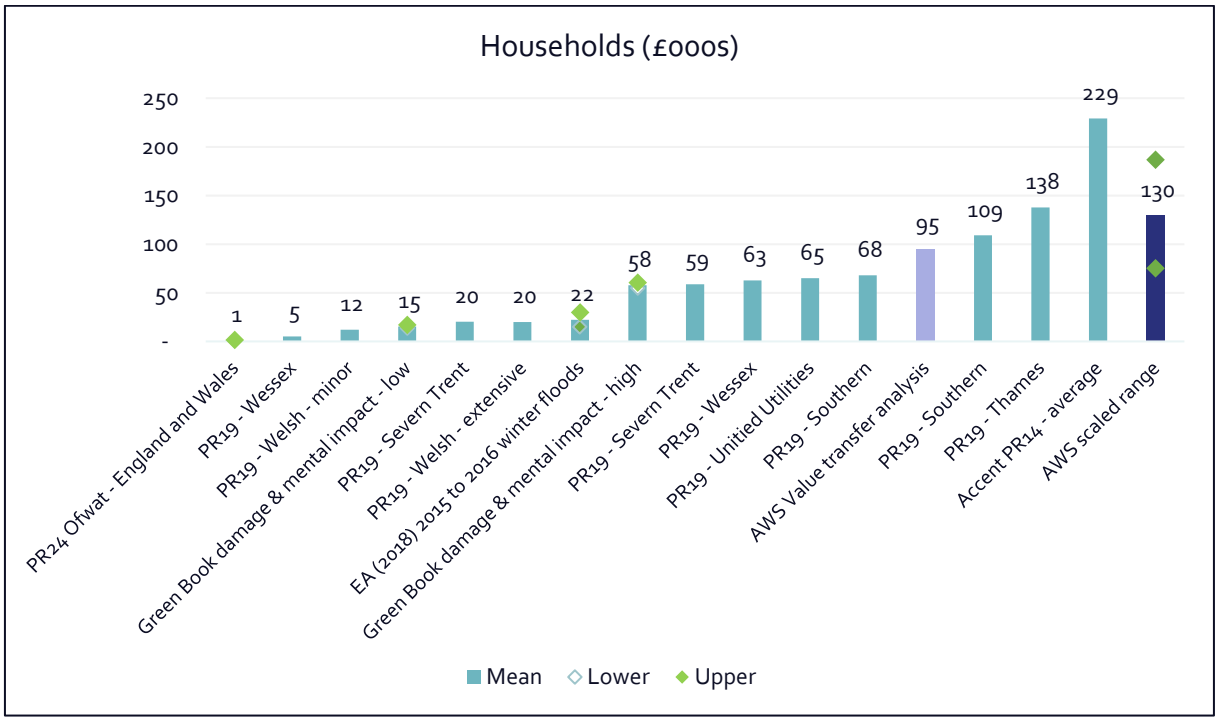

Figure 9-5: Comparing to household secondary data - Internal Sewer Flooding: £k per property

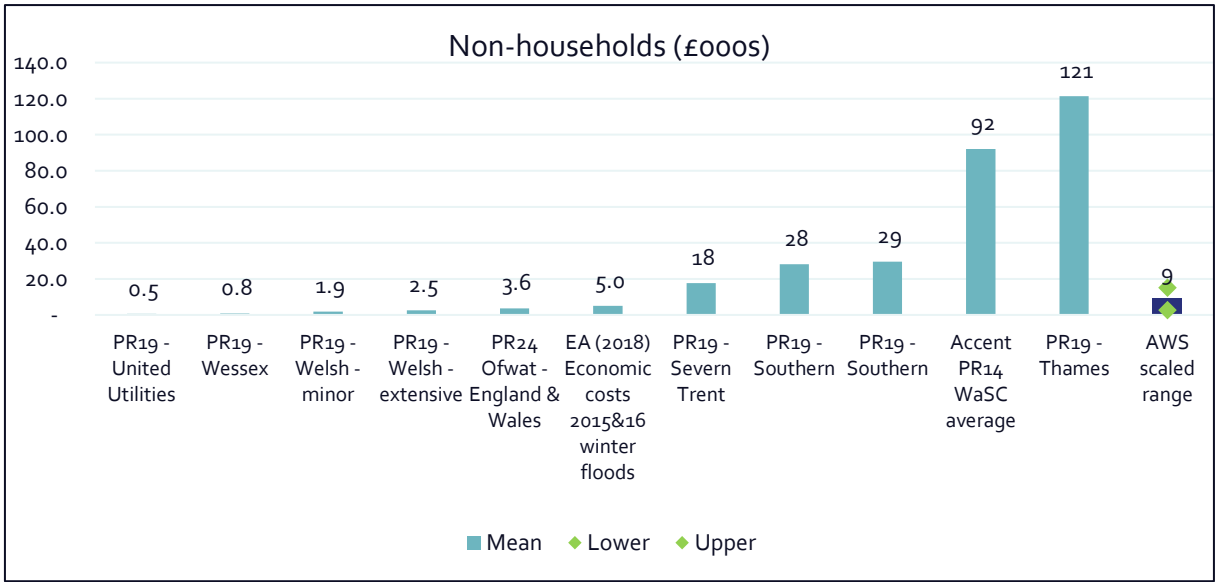

Figure 9-6: Comparing to non-household secondary data - Internal Sewer Flooding: £k per property

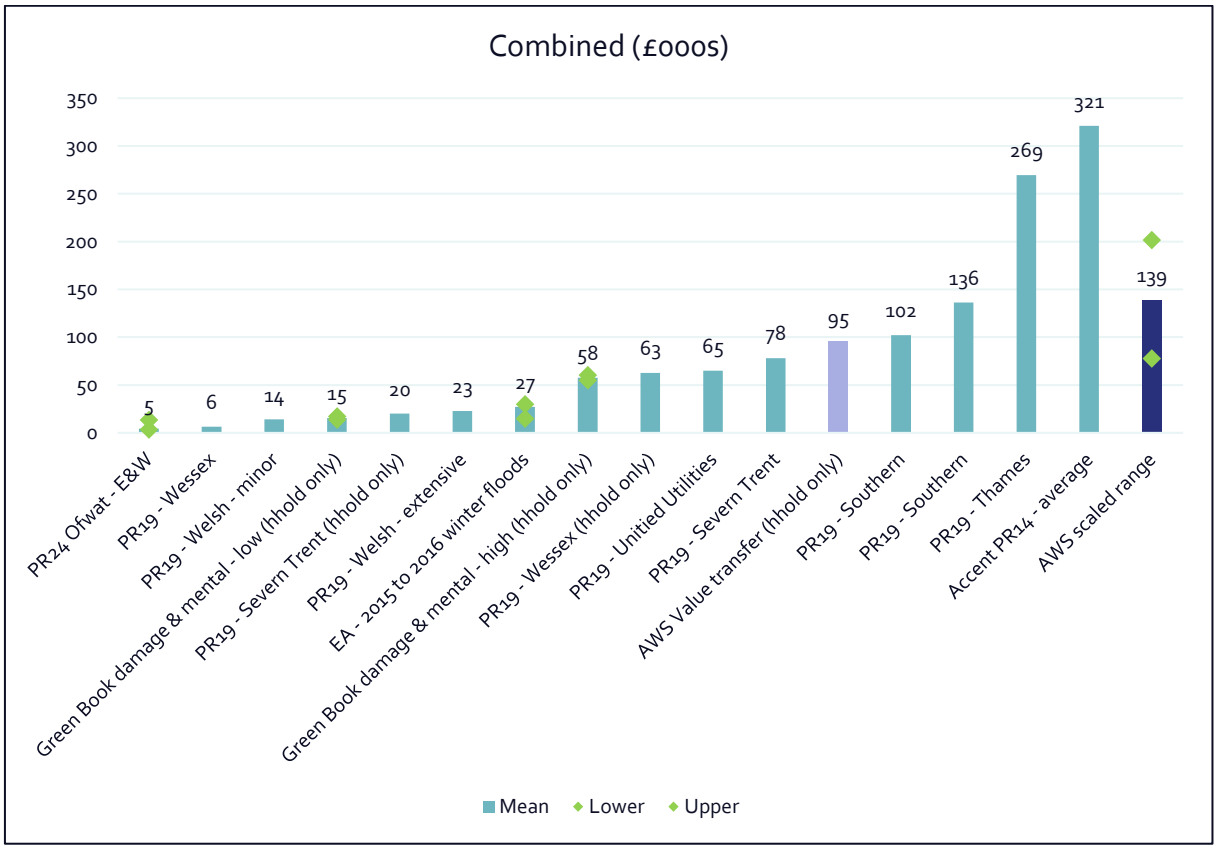

Figure 9-7: Comparing to combined secondary data - Internal Sewer Flooding: £k per property

Step 3c: Applying the values to the wider service measure framework and triangulating against other data (primary and secondary)

The scaled values for internal sewer flooding have been mapped to the wider service measures for wastewater internal flooding and the results are presented in Table 9-6 below. The internal domestic sewer flooding value is mapped to other measures using weights from the PR14 flooding stated preference study. The PR19 relative preference focus groups supported the weightings between categories.

The flooding of critical civic centres is based on the flooding domestic value with a weight applied for Civic Centres (schools, hospitals, prisons, and care homes). The weight is based on the average population weighted for frequency, time occupied and adjusted to be equivalent per property. This is a new measure which cannot be compared to PR19.

Loss of facilities is adjusted for a duration of 2 days to align with the AWS approach to applying the value.

Further primary evidence available to compare to the resulting values is limited for sewer flooding. AWS insurance data for flooding from water main bursts. This shows that values range between £0.3k to £129k, depending on the severity of the damage, with an average of £16.4 for domestic flooding. There is limited data for business premises, with a range of £14.7 to £144k. The secondary evidence of water flooding damage costs are consistent with these values.

The secondary sources indicate that the value from non-domestic properties is aligned with damage cost data for water flooding. Due to the difference observed for domestic customers this may indicate that the values may be low. However, the damage cost value is more likely to be representative for non-households as it is unlikely to include some of the wider values such as sentimental loss.

Table 9-6: Scaled – internal sewer flooding, £

SMF duration	Unit	Lower	Central	Upper	Notes on values
Domestic Property - living area	£/property	77,736	138,766	201,744	Anchor AWS insurance data for water flooding gives a range of £0.3k to 129k for damage costs. Secondary sources for internal water flooding provide a range between £13k and £39k for damage costs.
Critical civic centre	£/property	1,041,665	1,859,462	2,703,370	Calculated from the domestic value
Non-domestic property	£/property	31,843	58,097	85,128	AWS insurance data for water flooding gives a range of £14.7k to 144k for damage costs. The EA damage costs for 2015 to 2016 provide an average cost of £123k per business. This is for general flooding. Values from the 2007 floods are £53k (£23k to £86k).
Loss of facilities	£/property	1,071	1,916	2,788	Calculated from the domestic value – 2 days impact.

STEP 4.0 – ASSESS AND TEST VALUATIONS

The AWS PR24 synthesis report shows that internal flooding is consistently considered a very important service issue and priority. This is consistent with PR19 research findings.

There is discussion of how some of the AWS PR19 research found water flooding events have a higher per incident impact on customer wellbeing than sewer flooding, as these incidents tend to affect more people. The triangulated values in this report are per property and not per incident (which affects multiple properties) and are therefore consistent.

In the Ofwat and CCWater customer priorities research28 Internal and external flooding were ranked in the highest importance category, alongside supply interruptions and water quality.

The Ofwat and CCWater 2022 research on Customers Experiences of Sewer Flooding29 states:

[28] Ofwat & CCW Customer Preferences Research April 2022. Research by Yonder.
[29] Research is undertaken by Britain Thinks.

"The research found that any type of sewer flooding has a significant negative impact on customers regardless of severity. Even incidents that may seem 'low severity' can cause a lot of inconvenience and stress, while 'high severity' events can lead to significant emotional trauma."

9.2 External sewer flooding, odour and first time sewerage

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

As outlined in Step 1, the values for below are linked to the anchor value for internal sewer flooding.

- External sewer flooding
    - Domestic
    - Agricultural land
    - Non-domestic
    - Amenity areas
    - Critical civic centres
- Odour
- First time sewerage

This is applied in Step 3c below prior to comparing the results to the available primary and secondary data.

Step 3c: Applying the values to the wider service measure framework and triangulating against other data (primary and secondary)

The scaled values for domestic internal sewer flooding have been mapped to the wider service measures and the results are presented in Table 9-7 below. Evidence from other primary sources and notes on the calculations are shown in the final column.

The external sewer flooding value for flooding a domestic curtilage is linked to internal flooding anchor value using PR19 weights. This external sewer flooding value is then mapped to the other external flooding measures using weights from the PR14 flooding stated preference study. The PR19 relative preference focus groups support weightings between categories.

For external flooding (domestic curtilage) the AWS weight has been compared to the Ofwat and CCWater PR24 collaborative research weights relative to an internal sewer flooding incident. For households, the collaborative research weights produce lower but aligned values that overlap at the lower end of the AWS range. For non-households the collaborative research weights produce higher values. The upper end of the AWS range is similar to the lower end of the collaborative research range.

Secondary sources for external flooding of customers properties are available for six companies from PR19. The evidence is consistent with the recommended range proposed.

For flooding of agricultural land, two further secondary sources are available. The first is taken from a study by eftec on the natural capital value for flooding agricultural land (provided through the PR19 Environment Study). The study covers the impact of flooding on lost production. The value presented is an average of arable and pastoral land. The value is available in a £/hectare. This therefore relies on

an assumption on the average size of an area that the service measure intends to capture. The values in the table are based on 5% of the average size farm in the UK, which is 5.9 hectares.

The second study is analysis completed for the Environment Agency on the cost of the 2007 summer floods. It produces a similar £ per hectare which has been converted to an area using the same assumptions as above.

In both cases the values from these secondary sources are larger than the recommended range for scaled. However, as these sources rely on an assumption for the average size of agricultural land impacted or considered 'an area' we do not recommend amending the values. Further information is required on the average size of an area to improve the comparison.

The critical civic centre value applies the same approach as for internal flooding (e.g. a weight applied for the population of Civic Centres relative to a domestic property). See appendix 2 for details.

The odour value is the average of the PR19 triangulated value inflated and adjusted for customer numbers and the PR14 weight relative to internal sewer flooding. This has been included in preference to the PR24 weight. This is a more conservative approach than the PR24 weight which produced high values.

To produce a daily value for odour the persistent value is divided by 20 to reflect that persistent odour is both seasonal and intermittent. This produces a value per property for one day. We have compared this daily value to wider service measures where the unit is also per property. The value for odour (£401) is lower than loss of facilities for one day (£958) which is in turn lower than an interruption to the drinking water supply at a property for 12 to 24 hours duration (£1,270).

Further supporting evidence comes from sentiment analysis undertaken by Anglian Water on operational data from their call centre. This approach involves analysing customers calls for operational issues to identify positive and negative sentiment during the call. The findings show that sentiment is lower for odour relative to loss of facilities.

The first-time sewerage value is based on an assessment of first-time sewerage properties. The value is based on the likelihood of external flooding, loss of facilities and odour. Further details are provided in Appendix 2.

Table 9-7: Scaled – External sewer flooding, £

SMF duration	Unit	Lower	Central	Upper	Notes on values
Domestic Curtilage	£/property	5,517	9,872	14,365	Other company sources for PR19 range from £2.9k to 20.1k – median £7.7k.
Agricultural land	£/property	1,196	2,164	3,163	eftec natural capital study (£5.0k to £11.8k) based on an area of 5.9ha (5% of average farm), EA cost of summer floods between £6k to £13k based on an area of 5.9ha
Non Domestic - business premises	£/property	2,265	4,149	6,088	
Amenity (playing areas, sport pitches, footpath)	£/property	2,265	4,149	6,088	
Critical Civic Centre	£/property	73,923	132,282	192,488	Calculated from the domestic value
Odour and flies nuisance – persistent	£/property	3,384	8,017	12,718	Average of PR14 weights and PR19 inflated values.
Odour and flies nuisance – one-off	£/property	169	401	636	Based on 1/20th of the persistent value. Recognises that odour is seasonal and intermittent. Value lower than loss of facilities value for one day (£958).
First time sewerage	£/property	17,878	33,748	50,050	

STEP 4.0 ASSESS AND TEST VALUATIONS

The wide research and evidence findings for external flooding are similar to internal flooding.

Wider PR19 research also showed a mix of responses on whether internal or external flooding was more impactful – the synthesis report concludes that this may be due to the much lower frequency of internal flooding, therefore currently difficult to gauge the priority between the two.

10 Pollution incidents

This section covers pollution incident categories, combined sewer over (CSO) spill, over abstraction, Water Recycling Centre (WRC) quality and volumetric compliance.

STEP 1.0 – SPECIFY AND UNDERTAKE RESEARCH

The evidence base for pollution is given below. The anchor measure is a category 3 pollution incident (highlighted in blue). The wider framework covers combined sewer over (CSO) spill, over abstraction, WRC quality and volumetric compliance.

Service	Measure/Severity	Types of valuation approach for PR24		
Pollution (£ per incident)	Category 3	AW PR14 and PR19 Benefits Transfer	PR24 Integrated study Category 3	PR24 Impact weights (integrated study)
	Category 2			PR24 Impact weights (integrated study) Significant incident
	Category 1			
Combined Sewer Overflows (£ per spill)	Significant spill	PR24 Impact weights (integrated study)		
	Low significance spill - no visible impact or water quality impact	PR24 Investment priorities study		
Over Abstraction (£ per incident)	Daily licence breach Annual license breach	PR24 mapping		
WTW Discharge Compliance (£ per incident)	Discharge complaiance	PR24 mapping		
WRC Quality Compliance (£ per incident)	Measuring Point Failure Lab Sampling OSM Sample Fail Last Sample Failure Failing Works	PR24 mapping		
WRC volumetric compliance (£ per incident)	Dry weather flow Flow to full treatment Storm	PR24 mapping		

Figure 10-1 Pollution SMF and valuation evidence Up

STEP 2.0 SYNTHESIS OF RESEARCH

Table 10-1 presents a summary of primary data. The table includes a number of Stated Preference studies and qualitative focus group and online research on the relative preferences of customers.

At PR19 specific follow up research was completed on the PR19 studies to assess and check the relevance of the definition. For two studies the description for pollution was updated to refer to a category 2 incident.

Table 10-1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR24 integrated study	Stated preference – valuation	Value for pollution incident category 3	Household Non-household	H Good sample size DCE & DCCV methodology	H Definition relevant, new study
PR24 integrated study	Stated preference – customer preference weights	Weights for minor incident & significant incident	Household Non-household	H Good sample size BWS methodology	H Definition relevant, new study
PR24 investment priorities study (wave 3)	Stated preference – contingent valuation for package of service improvement; Acceptability of bill impact of individual elements	Storm overflows (number of spills per overflow), Additional to river quality	Household	M/H Good sample. Value range constrained to costs shown. Designed for wider strategic planning.	M/H Definition relevant, new study
PR24 Ofwat centralised research – AWS region	Stated preference – compensation	Pollution incidents minor and significant	Household Non-household	M/H Good sample size for AWS region, BWS and compensation methods, excludes altruism	H Definition relevant, new study
PR19 main stage study	Stated preference – valuation	Pollution incident – category 2	Household, Non-household	H Large sample DCE & DCCV methodology	M/H PR19 study, Definition relevant & tested with customers in March 18.

PR19 Best-worst scaling	Stated preference – valuation	Pollution incident – category 2	Household	H Good sample size, BWS methodology	M/H PR19 study, Definition relevant & tested with customers in March 18.
PR19 2nd stage water resources survey	Stated Preference – valuation	Pollution incident – category 3	Household, Non-household	H Good sample size, CV methodology followed by allocation exercise	M/H PR19 study, Definition relevant & tested with customers in March 18.
PR19 relative preference focus group	Qualitative review of customer weights from PR09 water services 2nd stage study plus discussion	Weights for all categories of pollution incident	Household	M/L Qualitative, Small sample size	H Definition relevant, PR19 research.
PR19 online community research – pollution exercise	Review of the PR19 pollution definition	PR19 definition	Household	H/M Reasonable sample size, Poll on the pollution category given the definition	H Relevant as testing the definition used in PR19 Stated preferences research, contemporary assessment on PR19 study definition interpretation.
PR14 main stage study	Stated preference – valuation	Pollution incident – category 3	Hhold, Non-hhold	H Very large sample, DCE & DCCV methodology	M/H Definition relevant, PR14 study
PR14 2nd Stage Environment study	Stated Preference – customer preference weights	Weights for all categories of pollution incident	Hhold	H DCE methodology, good sample size	H Definition relevant, PR14 study

Table 10-2 presents a compilation of the secondary data that has been utilised in the triangulation. These 'other studies' are used as sense checks on the core valuation evidence provided by the primary data. It covers a range of other company stated preference surveys from PR19 and PR14 average values covering multiple companies.

In addition to the sources listed below day-to-day operational data has been used to map the triangulated pollution value to the wider compliance service measures. This is not listed below as it does not provide a value or relative preference data.

Table 10-2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR24 Ofwat centralised research – England and Wales	Stated Preference weights	Minor pollution and significant pollution	Household Non-Household	M/H Very large sample, BWS method, excludes altruism	M/H Definition relevant, new study. National not regional.
Accent WTP comparison study (2018)	Stated Preference valuation	Pollution for 7 companies for minor pollution and 2 for significant pollution	Household Non-household	M/H Mixed surveys, limited published information for majority of studies	M PR19 studies, definitions clearly set out, other regions
Accent WTP comparison study (2018) – AWS benefit transfer value	Stated preference valuation	Category 3 pollution incident with variable for severity.	Household	M Based on additional calculations	M/H Uses a benefit transfer function so more relevant to the AWS region than individual data points.
Accent joint study – Unknown companies (2013)	Stated Preference valuation	Category 3 pollution incident for two companies, Category 2 pollution incidents for two companies and a category 1 pollution incident for one company	Household, Non-household	M Mixed surveys, limited published information	L/M Relevant definitions, PR14 study, unknown areas

10.1 Pollution incidents (Category 3)

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

Step 3a: Primary data & initial recommended range

This section presents the primary data for households, non-household and the combined customer base.

Households

The primary data for AWS household customers is shown in Figure 10-2. The recommended range is shown both in the graph below and in Table 10-3. The recommended central value is higher but aligned with the PR19 inflated value.

The PR19 main and BWS study values have been adjusted to a category 3 value using the PR14 environment study weight which were retested at PR19.

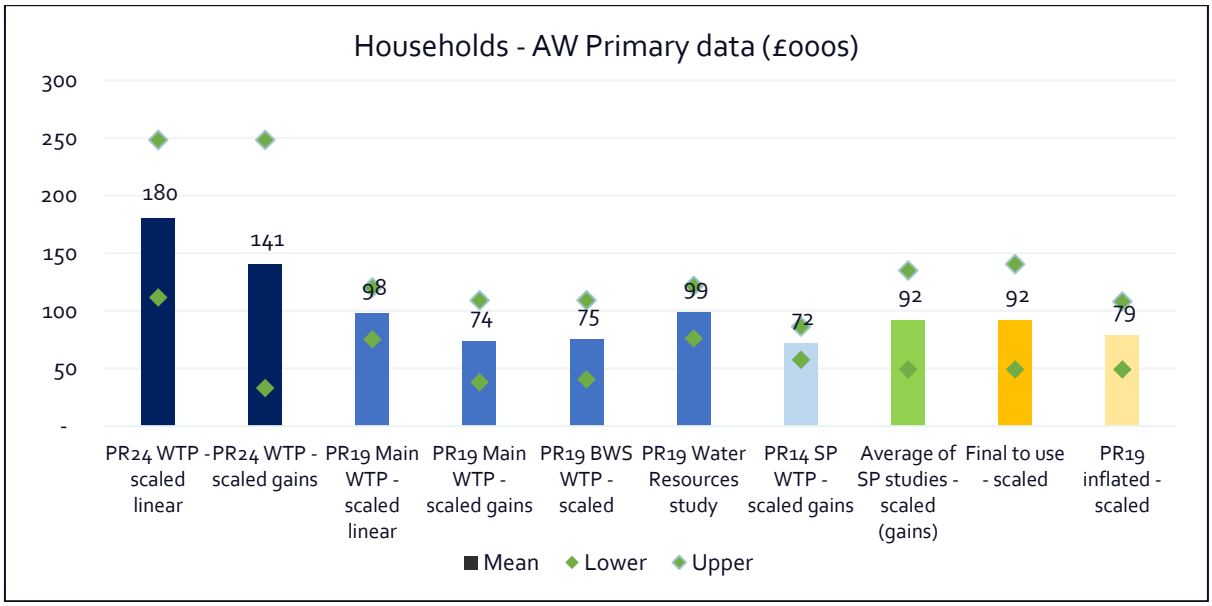

Figure 10-2: Household primary data – pollution incidents (Category 3), £ per incident

The central and lower values have been calculated based upon a long run average of the primary values (based on the PR24 gains, the PR19 main study gains, PR19 BWS, PR19 water resources study and the PR14 gains). The scaled gains values have been used within this average over the scaled linear value as they are more conservative, and they indicate that lower values exist for improvement compared to avoiding a deterioration to service.

The PR19 and PR14 values are aligned and show a similar range. The PR24 values are higher than those observed historically. This indicates that household customers have increased the value that they place on mitigating pollution. This may reflect the increased media attention. To reflect the higher values observed for PR24 the upper value of the recommended range is set at the PR24 gains value mean.

The recommended scaled values are largely aligned with the PR19 value range with the PR24 recommended range covering the PR19 range. The central and upper values are higher reflecting the increase in value for PR24. The lower value is similar to that used at PR19.

Table 10-3: Scaled household values - £ per category 3 incident (£000s)

Lower	Central	Upper
49	92	141

Non-households

The primary data for AWS non-household customers is shown in Figure 10-3. The recommended range is shown both in the graph below and in Table 10-4. The central value is similar to the inflated PR19 value.

Similar to the household values the PR19 main WTP values have been adjusted to reflect a category 3 incident.

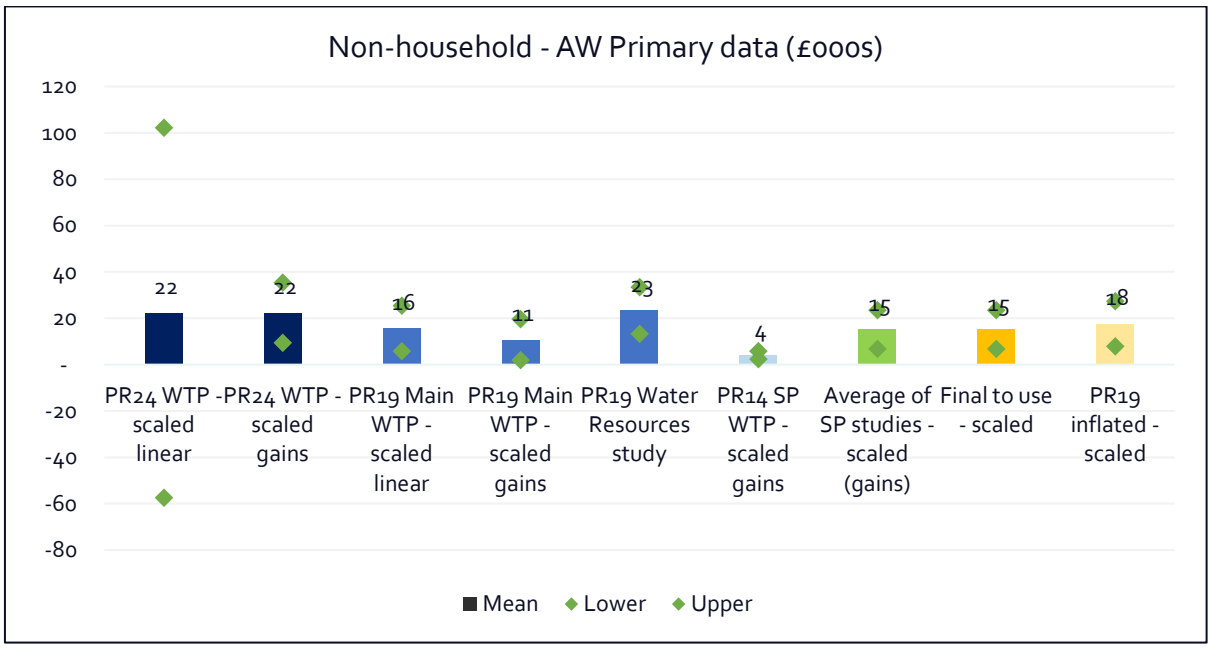

Figure 10-3: Non Household primary data - £ per category 3 incident (£000s)

The lower, central and upper values are based on a long run average of the respective PR24 scaled gains value, the PR19 scaled gains values, PR19 water resources study values and the PR14 SP WTP scaled gains values.

Table 10-4: Scaled household values - £ per category 3 incident (£000s)

Lower	Central	Upper
7	15	24

Combined (households and non-households)

The primary data for AWS combined customers is shown in Figure 10-4. The recommended range is shown both in the graph below and in Table 10-5.

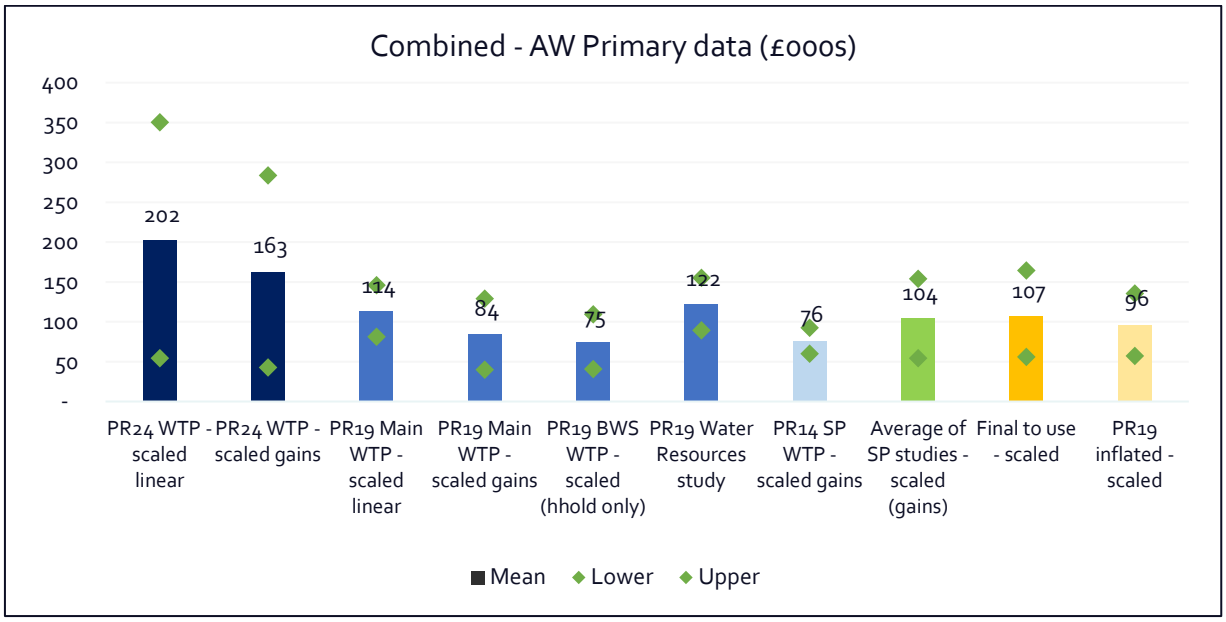

Figure 10-4: Combined primary data - £ per category 3 incident (£000s)

The values presented are the household range plus non-household range. The recommended values are a little higher than the PR19 values inflated. This change has been driven by an increased value amongst household customers.

Table 10-5: Scaled combined values - £ per category 3 incident (£000s)

Lower	Central	Upper
56	107	164

Step 3b: Triangulating against other sources (secondary data)

Figure 10-5 to Figure 10-7 show how the ranges compare to the secondary data sources available. The sources are the other company SP values. Both the AWS household and non-household values are aligned with the ranges.

The AWS value transfer study value is derived from the values collated in the 2018 Accent study and uses regression analysis combined with characteristics of the companies to create a value transfer function. The approach to the regression analysis draws upon the Defra guidance on benefit transfer[30]. Prior to interrogating the data potential explanatory factors were identified based on both economic theory and a previous meta-analysis of stated preference data completed by UKWIR in 2010[31].

Full details are included in Appendix 3. The pollution model uses the average sewerage bill and a variable to differentiate between minor and significant incidents as explanatory factors. The resulting value shown is for a minor incident and is slightly higher than the central recommended value but is within the confidence bands.

[30] eftec (2009) Valuing Environmental Impacts: Practical Guidelines for the use of value transfer in policy and project appraisal. Report submitted to Defra.

[31] UKWIR (2010) Review of Cost-benefit analysis and benefit valuation (RG07). Milestone D (Quantitative Analysis Working paper. Authors Carlo Fezzi, Ken Willis, Allan Provins, Chelsea Thomson (Cascade, eftec and ICS Consulting)

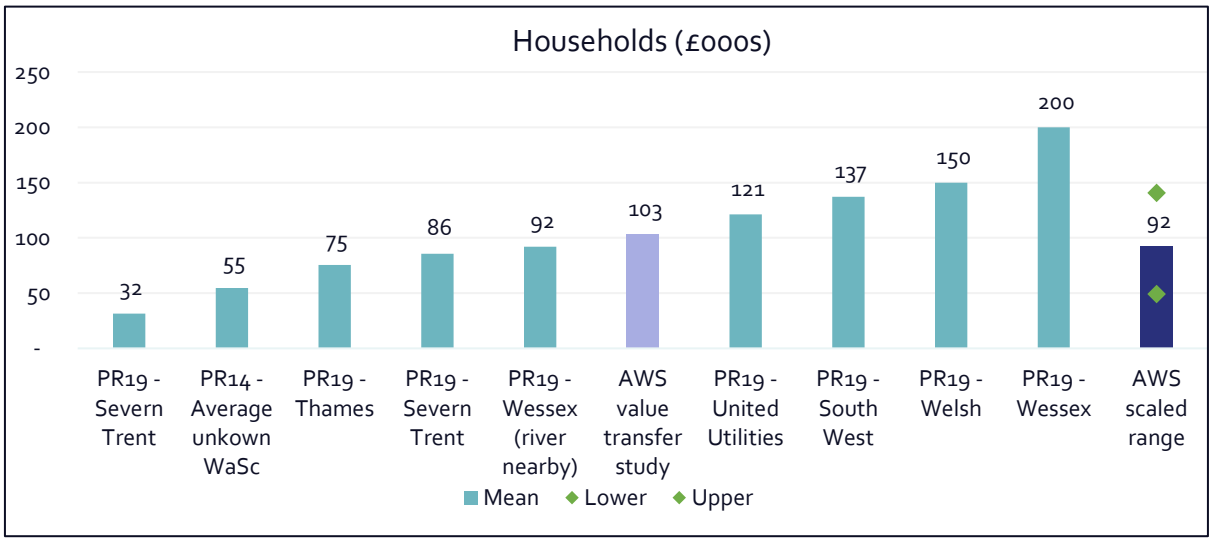

Figure 10-5: Comparing to household secondary data – £ per category 3 incident

Note: PR19 water company values are sourced from the Accent PR19 Comparative WTP study.

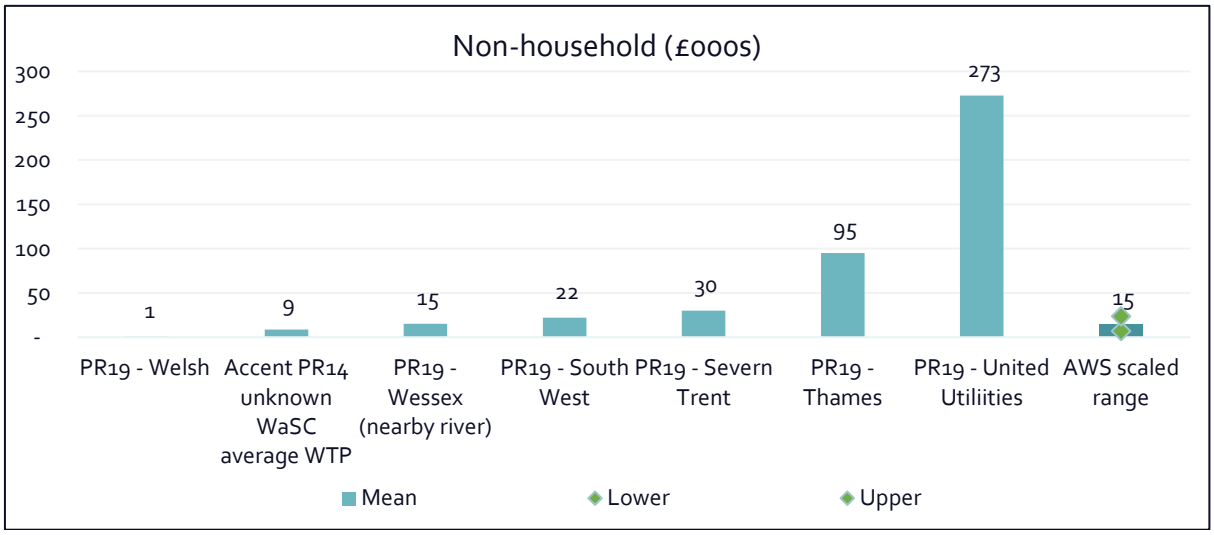

Figure 10-6: Comparing to non-household secondary data – £ per category 3 incident

Note: PR19 water company values are sourced from the Accent PR19 Comparative WTP study.

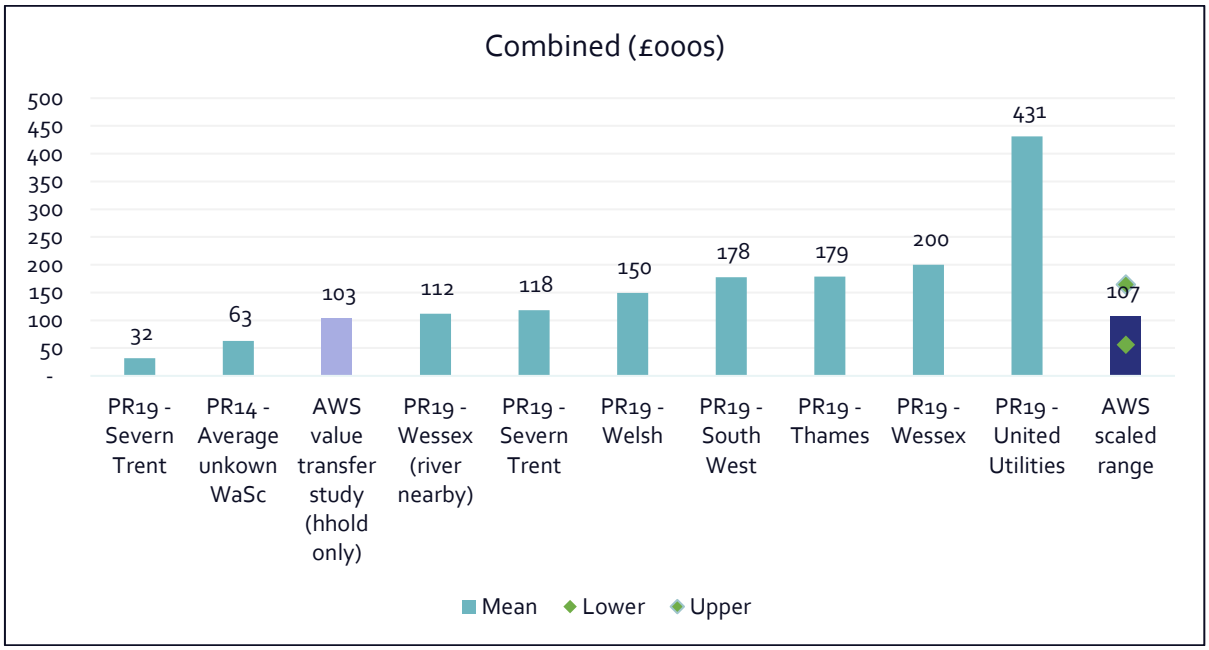

Figure 10-7: Comparing to combined secondary data – £ per category 3 incident

Step 3c: Applying the values to the wider service measure framework and triangulating against other data (primary and secondary)

The scaled values for a category 3 pollution incident have been mapped to the categories of pollution and combined sewer flooding and the results are presented in the table below.

The category 3 pollution incident values have been mapped to category 1 and 2 pollution incidents using weights from Anglian Water PR14 Environment Stated Preference Study. A category 4 incident is not valued as this is assumed to have no impact.

The PR14 weights were tested in the PR19 relative preference focus groups and found to be highly valid. They are also aligned with the weights for a minor/category 3 and significant incident (category 1 or 2 incident) from the PR24 study[32] and similar weights (pollution elsewhere) from the Ofwat and CCWater PR24 collaborative research project.

Weights are expected to be more consistent over time than values and the evidence for PR24 suggests that whilst the absolute value may have increased over time the relative difference between the incidents has remained consistent. The resulting pollution values are consistent with the limited secondary sources from other companies.

The value for a combined sewer overflow has been split into two categories for this 2nd iteration. The two values are:

- Significant spill - based on the AWS PR24 customer weight relative to a category 3. This value is aligned with the Flow To Full Treatment (FFT) persistent value (see section 0)
- Low significance - no visible or water quality impact – based on the Investment priorities study value for a change in the average spill at any storm overflow33. This value is in addition to impacts on river water quality due to this being included separately in the study.

[32] The significant pollution incident was included in the PR24 survey to provide a benchmark for customers when assessing other impacts, such as combined sewer overflows. The weight is used here as a sense check.
[33] The investment priorities study captures the value for a change in the average number of spills per storm overflow. This has been converted into a value per spill using Event Duration Monitoring 2021 Annual Return data.

The values for storm overflows have not been valued directly prior to PR24. Therefore, the customer evidence is based on PR24 values.

Table 10-6: Scaled – pollution incidents, £ per incident

SMF severity	Unit	Lower	Central	Upper	Notes on values
Category 4	£/incident	-	-	-	No value
Category 3	£/incident	55,818	107,173	164,232	Anchor value
Category 2	£/incident	104,768	201,159	308,254	PR24 weights for a significant incident (category 1 or 2) gives a value of £243k which is between the category 2 and1 values.
Category 1	£/incident	205,612	394,783	604,963	Two secondary sources for a significant incident range from £385k to £799k.
Combined sewer overflow spills; Significant spill	£/spill	51,546	99,605	152,735	Consistent with WRC values (see next section).
Combined sewer overflow spills; Low significance - no visible or water quality impact	£/spill	2,323	3,424	4,469	Low value based on the investment priority study value which is additional to river quality improvements.

STEP 4.0 ASSESS AND TEST VALUATIONS

The wider customer evidence for pollutions has been collated and reviewed by AWS as part of the research synthesis for PR24.

For PR24 customers rank pollution (alongside flooding) as the third highest priority for Anglian Water. The synthesis report concludes this is possibly linked to the value customers place on rivers as a place of relaxation and wellbeing and the increased awareness of this issue due to recent media coverage.

This is reflected in the higher value observed at PR24 for household customers relative to PR19.

10.2 WRC volumetric and quality compliance and over abstraction

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

As outlined in Step 1, the values for below are linked to the anchor value for pollution incidents.

- Water Treatment Works discharge compliance
- Water Recycling Centre (WRC) volumetric compliance
- WRC quality compliance
- Over abstraction

This is applied in Step 3c below prior to comparing the results to the available primary and secondary data.

Step 3c: Applying the values to the wider service measure framework and triangulating against other data (primary and secondary)

The pollution incident values for the different category incidents have been mapped to the remaining wider service measures and the results are presented in Table 5-7 below. Following discussion with AWS it was agreed that pollution incident categories are the best representation of the environmental impact of non-compliance incidents.

To map the values to the compliance service measures, we have analysed the AWS Pollution Data and the AWS Compliance Classification Scheme (CCS) data. The CCS data is submitted to the Environment Agency. For each service measure the proportion of failures mapping to each pollution category has been analysed. In the case of WRC quality compliance, the analysis has been completed for OSM fail/last sample fail and failing works and the results have been scaled to reflect the individual service measures. Full detail of the approach is included in Annex 2.

The WRC volumetric compliance storm value is set equivalent to the combined sewer overflow value derived through the customer weights. The value is considered consistent with the other WRC values as it is lower than the persistent failure to treat flow to full treatment and also the dry weather flow exceedance.

No value is allocated to the flow to full treatment one off breach as AWS use the pollution incident values to capture the social impact.

Table 10-7: WRC volumetric and quality compliance and over abstraction values scaled, £

SMF severity	Unit	Lower	Central	Upper
WTW discharge compliance	£/incident	38,637	74,184	113,679
WRC quality compliance: Measuring point failure	£/incident	2,840	5,453	8,357
WRC quality compliance: Lab sampling	£/incident	14,201	27,267	41,784
WRC quality compliance: OSM sample fail	£/incident	14,201	27,267	41,784
WRC quality compliance: Last sample failure	£/incident	28,403	54,534	83,567
WRC quality compliance: Failing works	£/incident	98,804	189,707	290,705
WRC volumetric compliance: Dry weather flow	£/incident	72,893	139,957	214,469
WRC volumetric compliance: Flow to full treatment – one off breach	£/incident	-	-	-
WRC volumetric compliance Flow to full treatment - persistent	£/incident	90,544	173,849	266,404
WRC volumetric compliance; Storm	£/incident	51,546	99,605	152,735
Over abstraction: Daily licence breach	£/incident	55,818	107,173	164,232
Over abstraction Annual licence breach	£/incident	55,818	107,173	164,232

STEP 4.0 ASSESS AND TEST VALUATIONS

Wider day to day operational data has been used to map the values in this section of the report.

11 River water quality

This section covers river quality and litter.

STEP 1.0 – SPECIFY AND UNDERTAKE RESEARCH

The evidence base for river water quality is given below. The anchor measure is river water quality from non-good status to good status in terms of £ per km improved to good status (highlighted blue). All other measures shown are linked to this.

Figure 11-1 River water quality SMF and valuation evidence

STEP 2.0 SYNTHESIS OF RESEARCH

Table 11-1 presents a summary of primary data. The table includes a number of stated preference studies and qualitative focus group research on the relative preferences of customers.

Table 11-1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR24 integrated study	Stated preference – valuation	River water quality improvement – km to good status	Household Non-household	H Good sample size DCE & DCCV methodology	H Definition relevant, new study
PR24 Investment priorities study (wave 3)	Stated preference – contingent valuation for package of service improvement; Acceptability of bill impact of individual elements	River water quality improvement – km to good status	Household	M/H Good sample. Value range constrained to costs shown. Designed for wider strategic planning	H Definition relevant, new study
PR19 main stage study	Stated preference – valuation	River water quality improvement, km to good status	Household, Non-household	H Large sample DCE & DCCV methodology	M/H Definition relevant, PR19 study
PR19 Best-worst scaling	Stated preference – valuation	River water quality improvement, km to good status	Household	H Good sample size, BWS methodology	M/H Definition relevant, PR19 study
PR14 main stage study	Stated preference – valuation	River water quality improvement, km to good status	Household, Non-household	H Very large sample DCE & DCCV methodology	M/H Definition relevant, PR14 study
PR14 2nd Stage Environment study	Stated Preference – customer preference weights	Weights for river water quality status & low flow.	Household, Non-household	H DCE methodology, good sample size	H Definition relevant, PR14 study

Table 11-2 presents a compilation of the secondary data that has been utilised in the triangulation. These 'other studies' are used as sense checks on the core valuation evidence provided by the primary data. It covers a range of other company stated preference surveys from PR19 and some PR14 average values covering multiple companies.

Table 11-2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
NWEBS (2012) **Referenced in Defra ENCA**	Stated Preference valuation	River water quality improvement, set of values km to good status from bad, poor, and moderate status	Household	H/M CV package methodology, good sample size. Sample size is low at a catchment level.	M/H – National study with values at catchment level. Applied values for AW catchments, Older study.
Accent WTP comparison study (2018)	Stated Preference valuation	River quality for 8 companies	Household Non-household	M/H Mixed surveys, limited published information for majority of studies	M/H PR19 studies, definitions clearly set out
Accent joint study – Unknown companies (2013)	Stated Preference valuation	River water quality improvement, km to good status	Household, Non-household	M Mixed surveys, limited published information	L/M Relevant definitions, PR14 study, unknown areas
UEA (2017)	Stated Preference valuation	River water quality, improvement to high ecological and recreational quality. General public value >8km distance	Household	M Small sample size	L/M New study in AW region, Value for high quality not good and for a specific 20km stretch of the River Yare.

11.1 River quality

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

Step 3a: Primary data & initial recommended range

This section presents the primary data for households, non-household and the combined customer base for improvements in river quality to good status as measured by the Water Framework Directive.

Households

The primary data for AWS household customers is shown in Figure 11-2. The recommended range is shown both in the graph below and in Table 11-3. The recommended central value is higher but aligned with the PR19 inflated value.

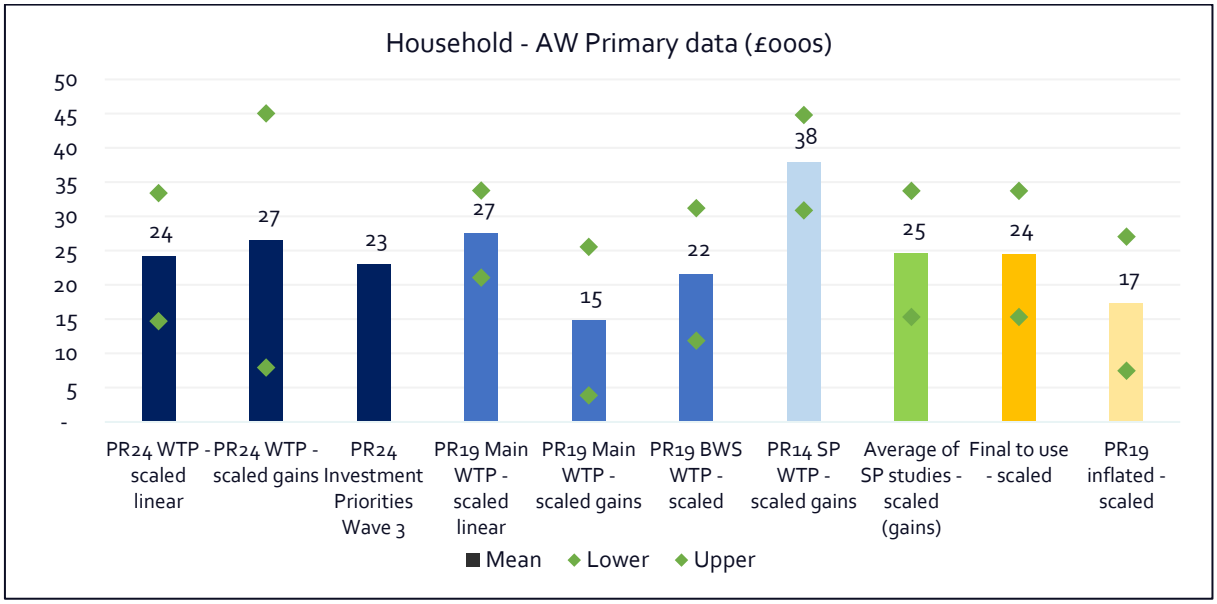

Figure 11-2: Household primary data - £ per km improved to good status (£000s)

Both the scaled central value and range are based on the long-term average. This is the average of the PR24 linear value, PR24 Investment Priorities Wave 3, PR19 main stage gains value, the PR19 BWS value and the PR14 WTP scaled gains value. The PR24 Investment Priorities Wave 3 value is included with a 50% weighting within the average to reflect the values are constrained by the cost presented in the survey.

The PR24 linear value is used in preference to the PR24 gains value as it lower and has a narrower confidence interval. The PR24 linear value is also in line with the PR19 BWS study value and the PR24 investment priorities study value.

Table 11-3: Scaled household values - £ per km improved to good status (£000s)

Lower	Central	Upper
15	24	34

Non-households

The primary data for AWS non-household customers is shown in Figure 11-3. The recommended range is shown both in the graph below and in Table 11-4. The central value has decreased relative to the inflated PR19 value reflecting the fall in value non-household customers place on this service failure for PR24.

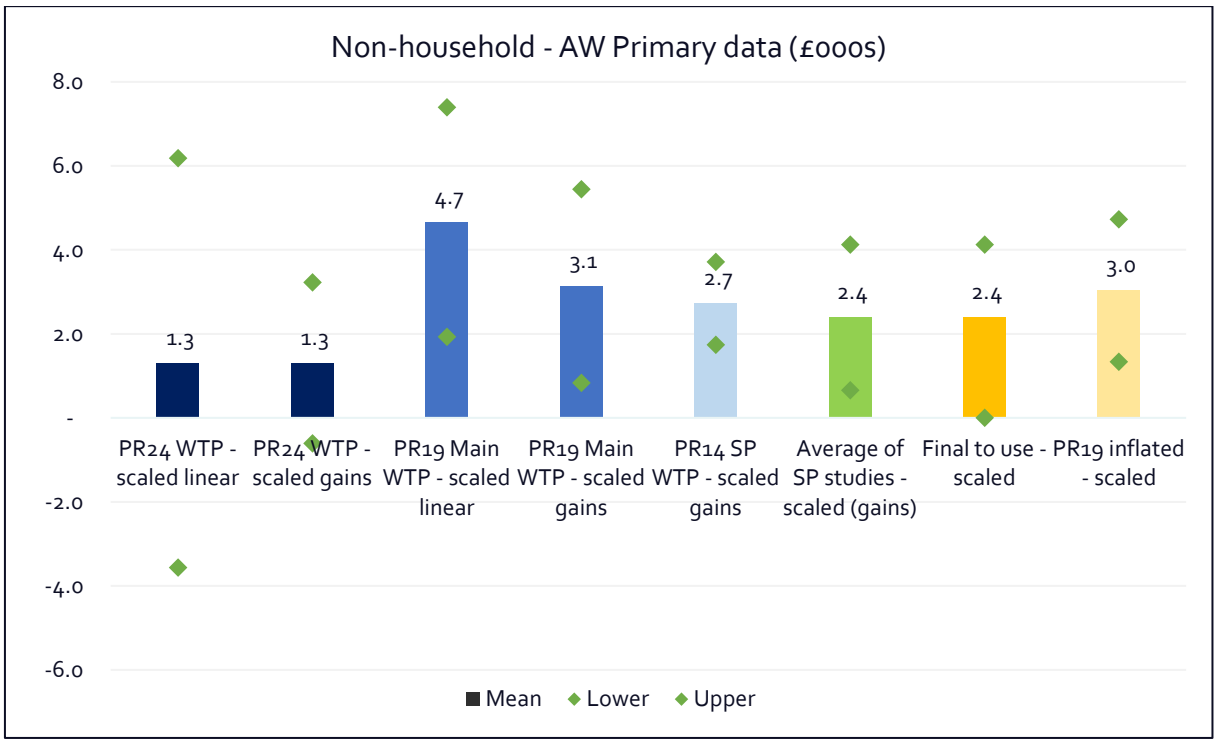

Figure 11-3: Non Household primary data - £ per km improved to good status (£000s)

The central and upper values are based on a long run average of the PR24 scaled gains value, PR19 main WTP scaled gains value and PR14 scaled gains value.

The lower range has been set to zero to reflect that the PR24 WTP scaled gains value was not statistically significant for non-household customers.

Table 11-4: Scaled non-household values - £ per km improved to good status (£000s)

Lower	Central	Upper
0.0	2.4	4.1

Combined (households and non-households)

The primary data for AWS combined customers is shown in Figure 11-4. The recommended range is shown both in the graph below and in Table 11-5.

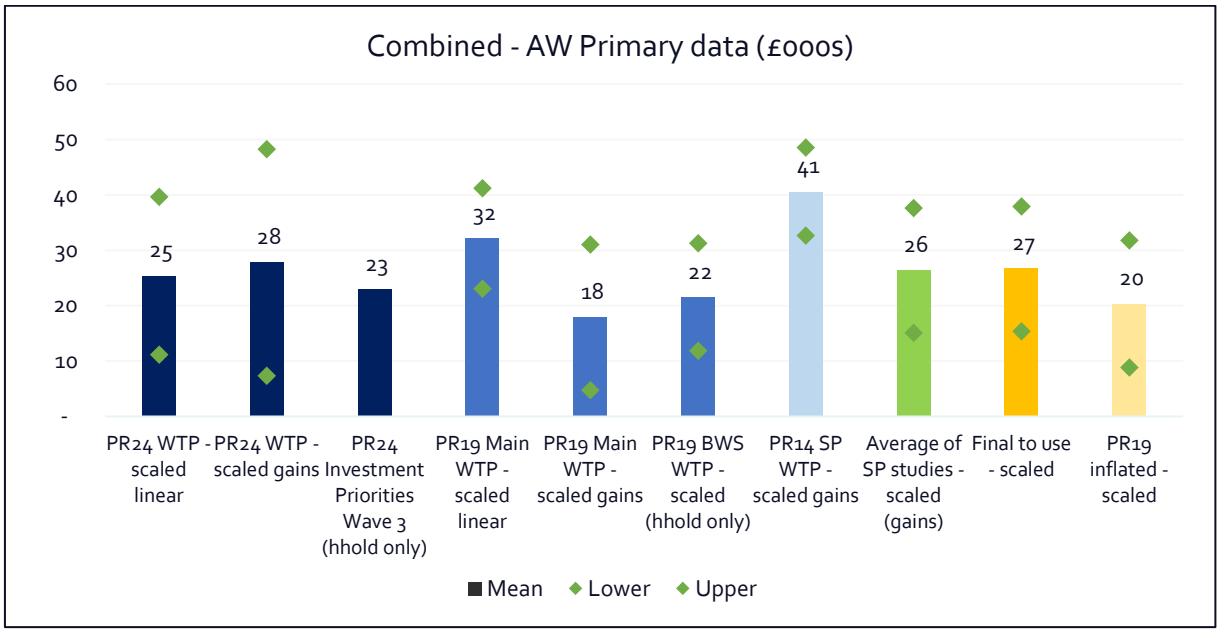

Figure 11-4: Combined primary data - £ per km improved to good status (£000s)

The values presented are the household range plus non-household range. The recommended values are slightly higher than the PR19 values.

Table 11-5: Initial recommended range – combined - £ per km improved to good status (£000s)

Lower	Central	Upper
15	27	38

Step 3b: Triangulating against other sources (secondary data)

Figure 11-5 to Figure 11-7 show how the ranges compare to the secondary data sources available. The sources for the values included are:

- Accent WTP comparison study from 2018
- The equivalent comparison study from PR14.
- The EA/Defra National Water Environment Benefit Survey (NWEBS) values from 2012 (household only). The NWEBS values shown are specific to catchments in the Anglian Water region.[34]

The AWS recommended range and the PR19 other company studies presented are for a move to 'Good' status. Both the household and non-household values are towards the lower end when compared to these studies. The Thames Water and South West Water values are unscaled values and the remainder are scaled values.

To compare to the NWEBS values, which show the values from a specific quality status to 'Good' status, the AWS values have been mapped to the WFD status categories using PR14 Environment Study customer preference weights (see Step 3c). The AWS recommended value for a change from bad to good status is aligned with the NWEBS value for the same change (also scaled gains values).

[34] Provided as part of the PR19 2nd stage environment study.

A further study was provided through the PR19 2nd stage Environment Study by UEA (2017)[35]. This study provided WTP values for a local river in the Anglian region. There are multiple values from this study. The lower value is a household / general public value living greater than 8km distance from the river for a change to high ecological and recreational quality (which is higher than good quality). This gives a large value of £5.5m per km; this value is not included in the household graph due to scale.

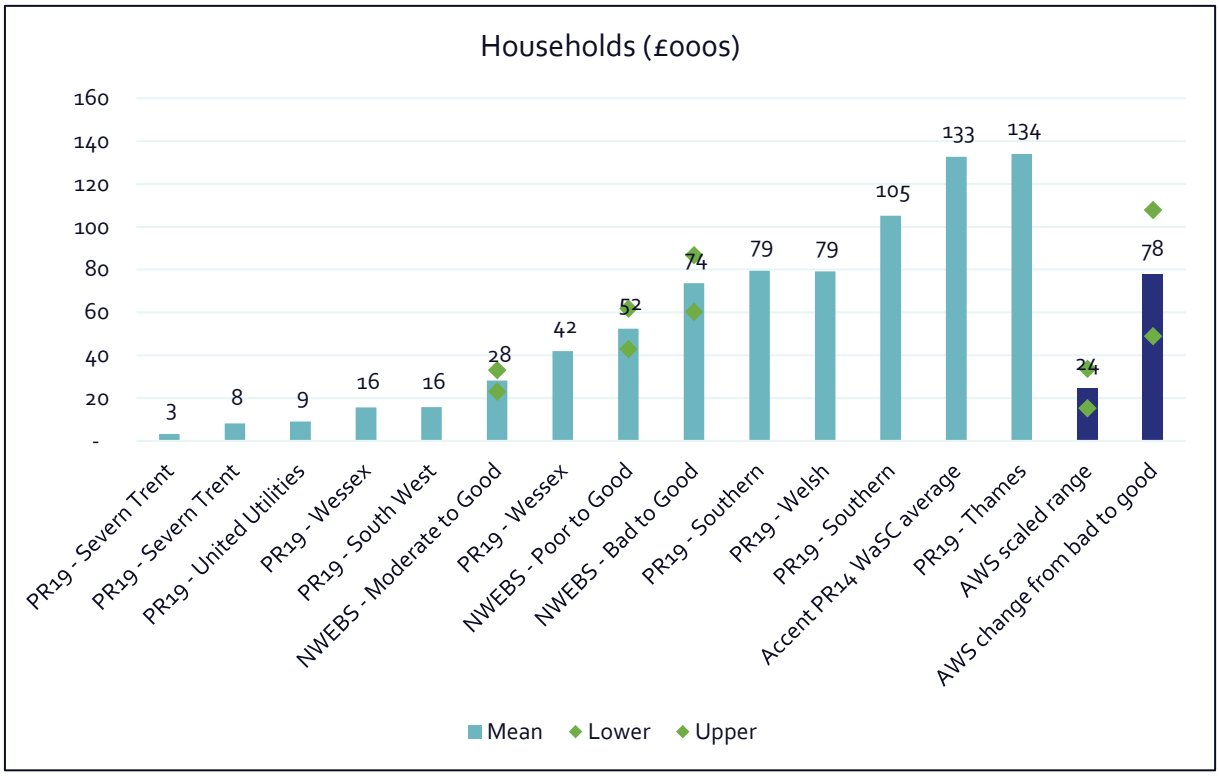

Figure 11-5: Comparing to household secondary data - £ per km (£000s)

Note: PR19 water company values are sourced from the Accent PR19 Comparative WTP study.

[35] UEA (2017) Combining Anglian Water's customers' subjective preferences with their willingness to pay for water quality improvements

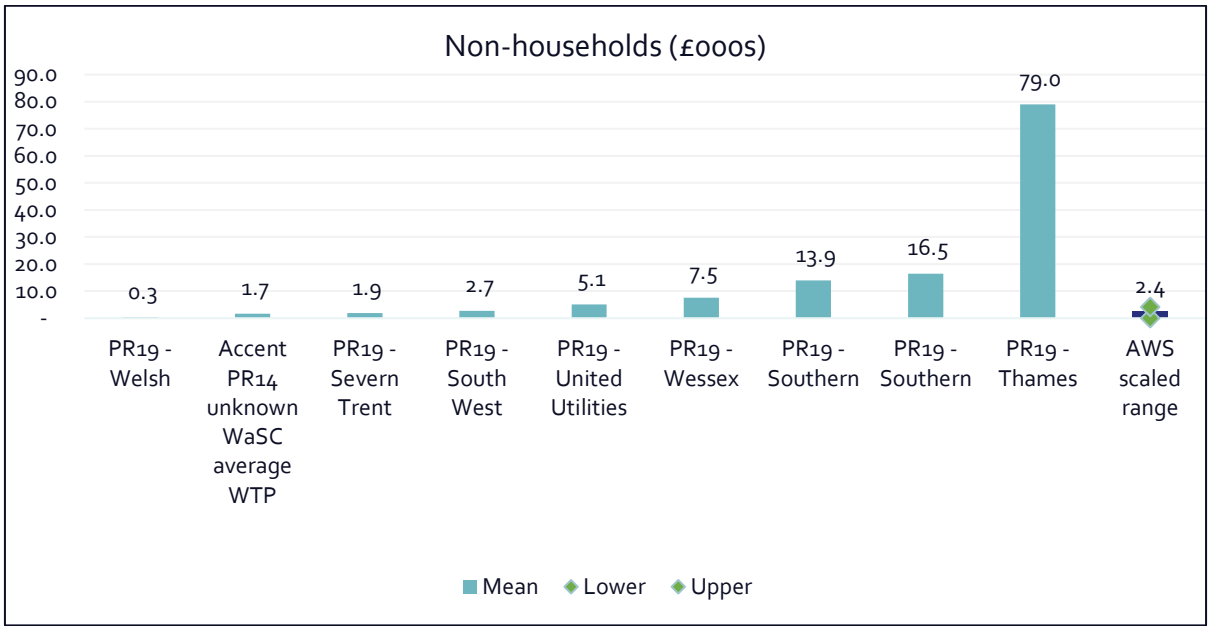

Figure 11-6: Comparing to non-household secondary data - £ per km (£ooos)

Note: PR19 water company values are sourced from the Accent PR19 Comparative WTP study.

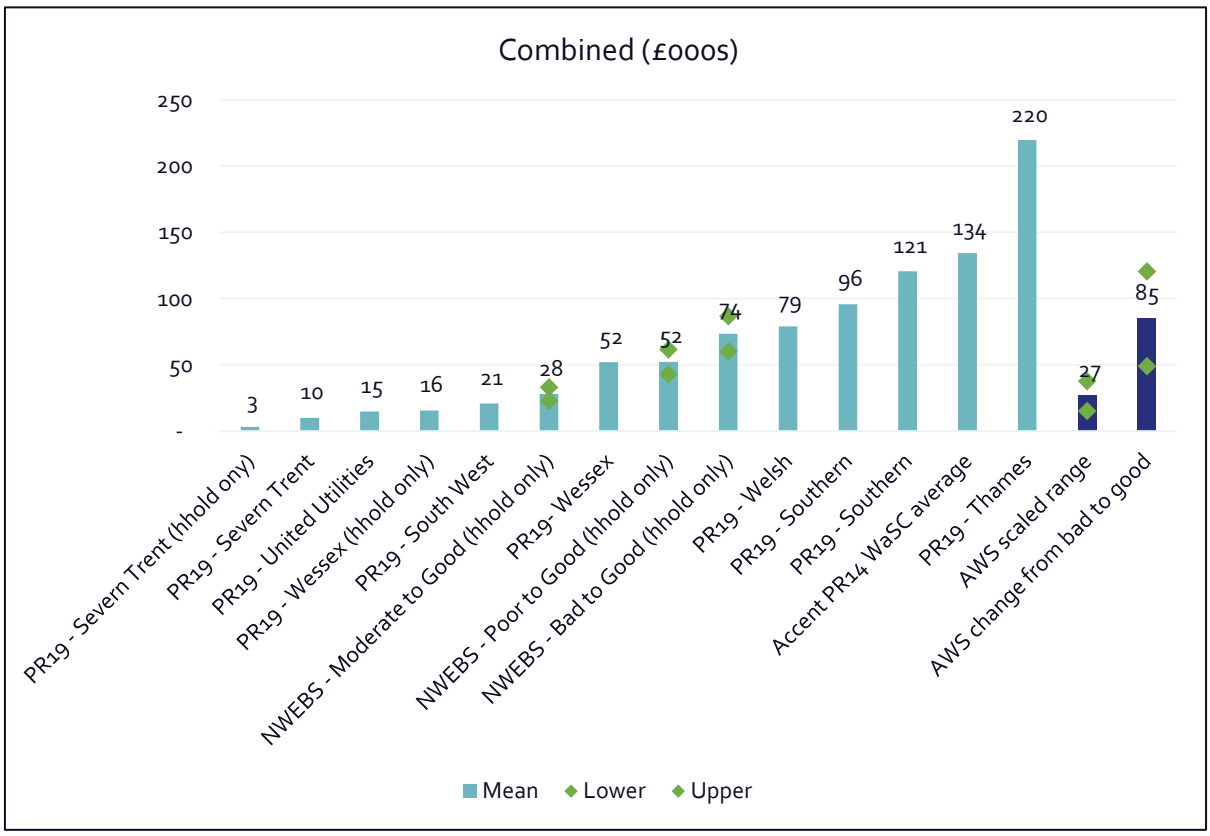

Figure 11-7: Comparing to combined secondary data - £ per km (£ooos)

Step 3c: Applying the values to the wider service measure framework and triangulating against other data (primary and secondary)

The scaled values for river water quality have been mapped to the wider service measures for river water quality and the results are presented in the table below.

The river water quality anchor value is a value for a non-good river changing to good status. The PR14 Environment Study provided a set of weights relative to this for the categories in the tables below.

The weights from the PR14 Second Stage Environment Study have been reapplied for PR24 to the recommended ranges. The PR14 Environment Study provided a weight for moving from low to moderate status. The low value was equivalent to either a bad or poor WFD status. For the PR19 SMF the value for a change from low to moderate has been split out into a value from bad to poor and from poor to moderate stats using the EA NWEBs study weights (provided as part of the PR19 2nd stage environment study).

The Total WFD values in the tables below represent the AW customer values that are equivalent to the NWEBS values. The overall scaled gains results can be compared to the NWEBs values for the Anglian catchments (which are also scaled gains values). This shows that the values are aligned with the NWEBs values. Analysis shows that the PR14 environment customer survey weights places slightly more weight on the move from moderate to good than the NWEBs values.

The litter values included in the SMF are the values for sewage related litter. An alternative value is available for general litter (Rivercare). Both of these values come from the PR14 Environment study which included litter as an additional category when surveying customers.

Table 11-6: River water quality: £ per km, by WFD quality category, scaled

SMF duration		Unit	Lower	Central	Upper
Average non-good to good	**Anchor**	**£/km**	15,354	26,775	37,898
Fish and other animals	Bad to Poor	£/km	6,012	10,492	14,853
	Poor to Moderate	£/km	6,895	12,033	17,035
	Moderate to Good	£/km	13,808	24,151	34,207
Plant life	Bad to Poor	£/km	3,497	6,082	8,603
	Poor to Moderate	£/km	4,011	6,975	9,866
	Moderate to Good	£/km	2,297	3,933	5,544
Water level and Flow	Bad to Poor	£/km	3,068	5,309	7,502
	Poor to Moderate	£/km	3,518	6,089	8,603
	Moderate to Good	£/km	5,910	10,227	14,452
Overall WFD	Bad to Poor	£/km	12,577	21,883	30,958
	Poor to Moderate	£/km	14,424	25,096	35,505
	Moderate to Good	£/km	22,014	38,311	54,203
Litter	N/a	£/km	14,493	25,490	36,147

The PR14 Environment Study raw econometric outputs are relative preference weights for how the categories shown in the tables relate to each other. At PR14 these weights were adjusted so they were expressed relative to an average assessment moving from non-good to good using the frequencies in each quality status category. This also allows the anchor value to be linked to the relative weights.

To update these relative weighting, we have analysed the WFD cycle 3 assessment data to produce a profile for the waterbody quality assessments in the AWS region. Full details are provided in the appendix 2.

The Ofwat and CCWater PR24 collaborative research study customer weights for low flow relative to overall river quality produce large values compared to those in the table above. This is due to the definitions being different. The PR24 collaborative weights for flow include impacts on wildlife and the wider environment that is not included in the AWS low water level and flow value.

We have applied the values in Table 11-6 above to produce a weighted value for a one-kilometre improvement and a deterioration in the AWS region. This assessment is based on the profile of the water bodies in the AWS region.

Table 11-7: River water quality: £ per km, capital framework metrics, scaled

SMF duration		Unit	Lower	Central	Upper
Average non-good to good	Anchor	£/km	15,354	26,775	37,898
Weighted river water quality metrics	Improvement	£/km	14,316	24,886	35,201
	Deterioration	£/km	12,867	22,393	31,683

STEP 4.0 ASSESS AND TEST VALUATIONS

The wider customer evidence for changes to river water quality has been collated and reviewed by AWS as part of the research synthesis for PR24.

PR19 research showed that being a recreational user of rivers has a positive impact on willingness to pay for improvements in recreational water quality. At PR24 improving river quality is ranked number four in Anglian Water consumers' priorities. This is above average although lower than other priorities.

12 Bathing water quality

This section covers bathing water quality – all categories.

STEP 1.0 – SPECIFY AND UNDERTAKE RESEARCH

The evidence base for bathing waters is given below. The anchor measure is a change to excellent status from good (highlighted in blue). The wider framework covers bathing water compliance, per site improvements in the classification of waters and deteriorations due to AWS assets.

Service	Measure/Severity	Types of valuation approach for PR24	
Bathing Water (Coastal Waters) anchor	Change to excellent status from good	AW PR14 and PR19 Benefits Transfer	PR24 Integrated WTP study
Bathing Water (Coastal Waters) - £ per site improvement in water quality status	Excellent	AW PR14 and PR19 Benefits Transfer	EA weights for changes in quality
	Good		
	Sufficient		
	Poor		
	Improvement in Beach Classification from Sufficient or Good		
	Improvement in Beach Classification from Closure or Poor		
Bathing Water (Coastal Water) - deterioration due to Anglian Water impact eg asset failure	Drop in Beach Classification to Good or Sufficient	AW PR14 and PR19 Benefits Transfer	EA weights for changes in quality
	Drop in Beach Classification to Poor		
	Drop in Beach Classification to Beach Closure		
Bathing water compliance	Sample failure (Bathing water)	PR24 mapping	

Figure 12-1 Bathing water SMF and valuation evidence base

STEP 2.0 SYNTHESIS OF RESEARCH

Table 12-1 presents a summary of primary data. The table includes a range of stated preference values from PR24 back to PR14.

Table 12-1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR24 integrated WTP study	Stated preference – valuation	Bathing water, site good to excellent status	Household, Non-household	H Good sample size DCE & DCCV methodology	H Definition different - converted from site movement to excellent status from average non-excellent status*, new study
PR19 main stage study	Stated preference – valuation	Bathing water, site good to excellent status	Household, Non-household	H Large sample DCE & DCCV methodology	M/H Definition different - converted from site movement to excellent status from average non-excellent status*, PR19 study
PR19 Best-worst scaling	Stated preference – valuation	Bathing water, site good to excellent status	Household,	H Good sample size, BWS methodology	M/H Definition different - converted from site movement to excellent status from average non-excellent status*, PR19 study
PR14 main stage study	Stated preference – valuation	Bathing water, site good to excellent status	Household, Non-household	H Very large sample DCE & DCCV methodology	M/H Definition different - converted from site movement to excellent status from good or sufficient status, PR14 study

** Most non-excellent sites are good*

Table 12-2 presents a compilation of the secondary data that has been utilised in the triangulation. These 'other studies' are used as sense checks on the core valuation evidence provided by the primary data. It covers a range of other company stated preference surveys from PR19 and PR14 average values covering multiple companies.

Table 12-2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR24 Ofwat centralised research – England and Wales	Stated Preference valuation and weights	Bathing water from good to excellent and from sufficient to either good to excellent	Household Non-household	M/H Very large sample size, BWS and compensation methods, excludes altruism	M/H Definition relevant, new study, National values not AWS region
Accent WTP comparison study (2018)	Stated Preference valuation	Bathing waters values for 4 companies from good to excellent or to excellent.	Household Non-household	M/H Mixed surveys, limited published information for majority of studies	M/H PR19 studies, definitions clearly set out
Accent joint study – Unknown companies (2013)	Stated Preference valuation	Bathing water good to excellent status	Household, Non-household	M Mixed surveys, limited published information	M/L Relevant definitions, PR14 study, unknown areas

12.1 Bathing water – good to excellent quality

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

Step 3a: Primary data & initial recommended range

This section presents the primary data for households, non-household and the combined customer base.

Households

The primary data for AWS household customers is shown in Figure 12-2. The recommended range is shown both in the graph below and in Table 12-3. The recommended central value is higher but aligned with the PR19 inflated value.

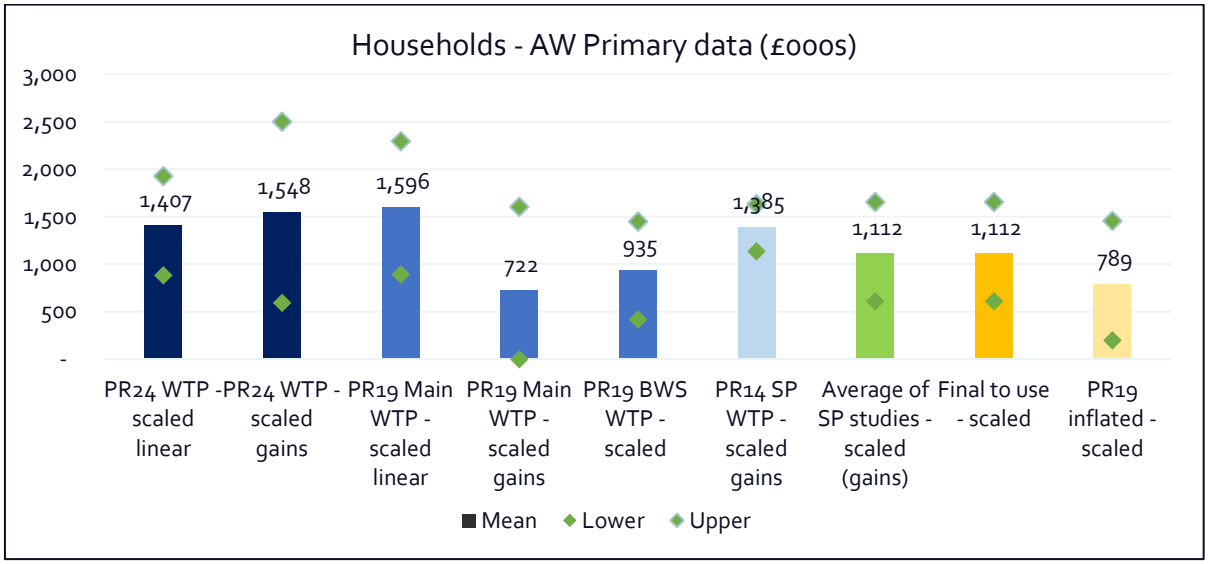

Figure 12-2: Household primary data - £ per site, good to excellent (£000s)

Both the scaled central value and range are based on the average of the PR24 linear value, PR19 main stage gains value, the PR19 BWS scaled value and the PR14 scaled gains value. The PR24 linear value is used in preference to the PR24 gains value as is more conservative than the gains value and has a narrower confidence interval. The PR24 linear value is also similar to the PR19 main study scaled linear value.

Table 12-3: Scaled household values - £ per site, good to excellent (£000s)

Lower	Central	Upper
610	1,112	1,655

Non-households

The primary data for AWS non-household customers is shown in Figure 12-3. The recommended range is shown both in the graph below and in Table 12-4. The central value is just above the inflated PR19 value.

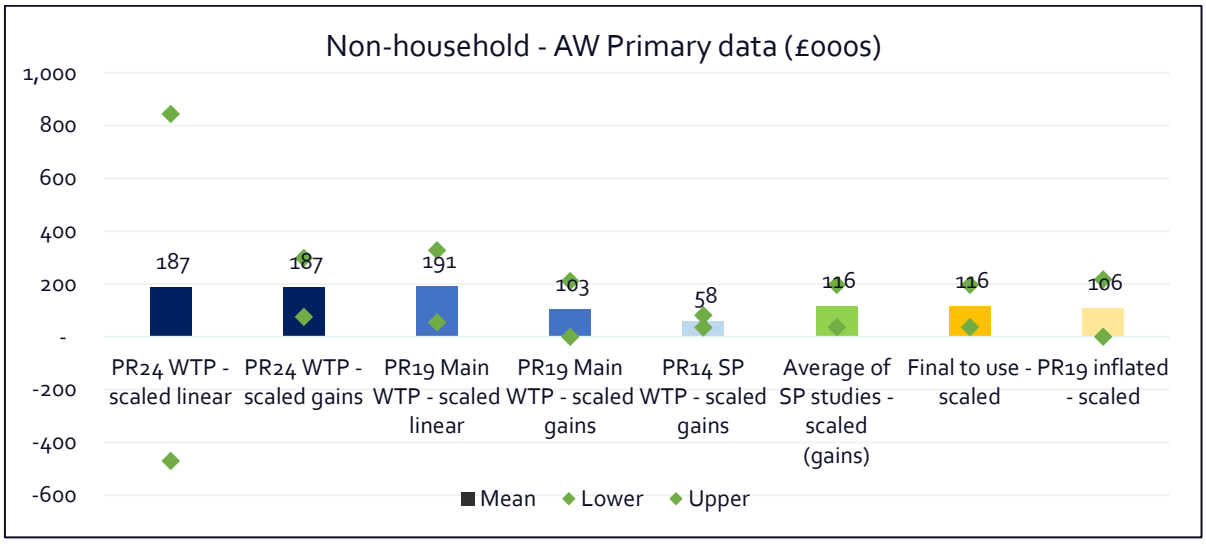

Figure 12-3: Non Household primary data - £ per site, good to excellent (£000s)

The central value and ranges are based on an average of the PR24 scaled gains value, the PR19 scaled gains value and the PR14 scaled gains value.

The final values are slightly higher than at PR19, however the range is narrower and the values sit within the PR19 range.

Table 12-4: Scaled non-household values - £ per site, good to excellent (£000s)

Lower	Central	Upper
37	116	197

Combined (households and non-households)

The primary data for AWS combined customers is shown in Figure 12-4. The recommended range is shown both in the graph below and in Table 12-5.

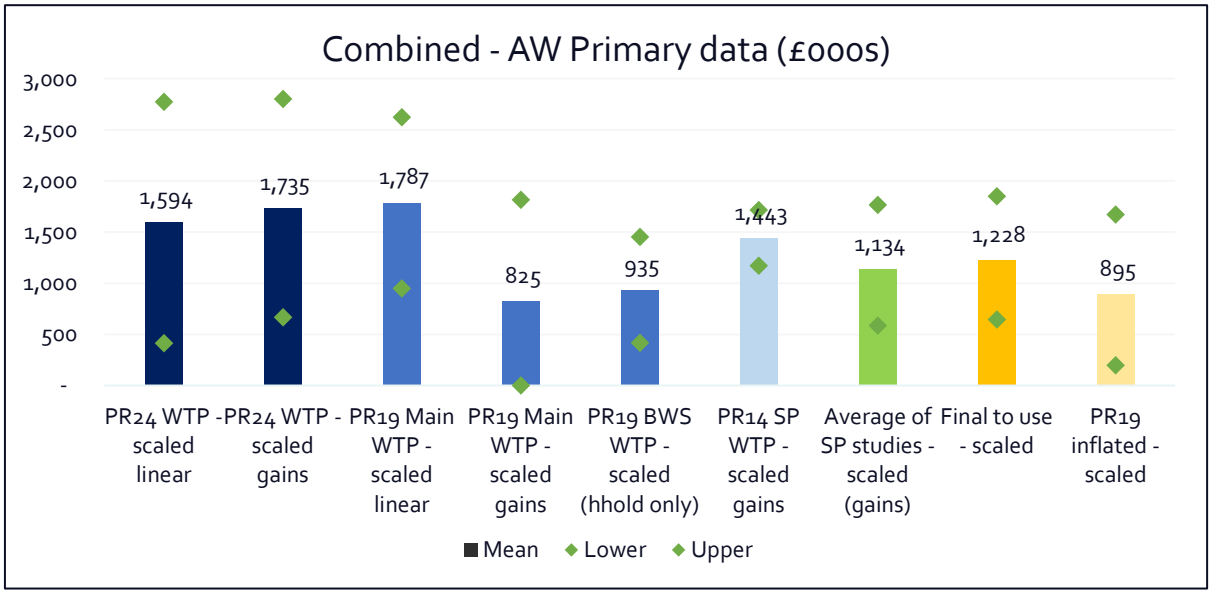

Figure 12-4: Combined primary data – £ per site, good to excellent (£000s)

The values presented are the household range plus non-household range. The recommended values are higher than the final PR19 values reflecting the change in the recommended value for household customers. The PR24 values are aligned closely with the PR19 Main WTP linear model.

Table 12-5: Initial recommended range – combined - £ per site, good to excellent (£000s)

Lower	Central	Upper
646	1,228	1,852

Step 3b: Triangulating against other sources (secondary data)

Figure 12-5 to Figure 12-7 show how the ranges compare to the secondary data sources available. The sources are the 2018 Accent comparison study and the equivalent study from PR14.

In all cases the recommended AWS values align with the lower values from other studies.

For comparison a majority of the values are thought to be scaled. The South West Water value is thought to be unscaled.

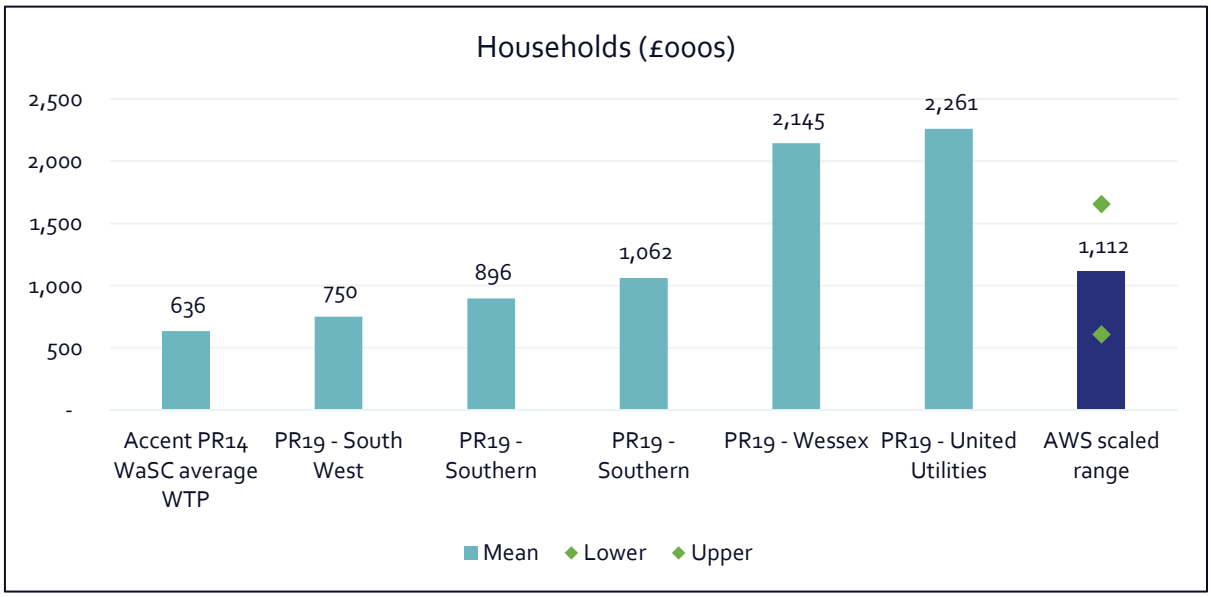

Figure 12-5: Comparing to household secondary data - £ per site, good to excellent (£000s)

Note: PR19 water company values are sourced from the Accent PR19 Comparative WTP study.

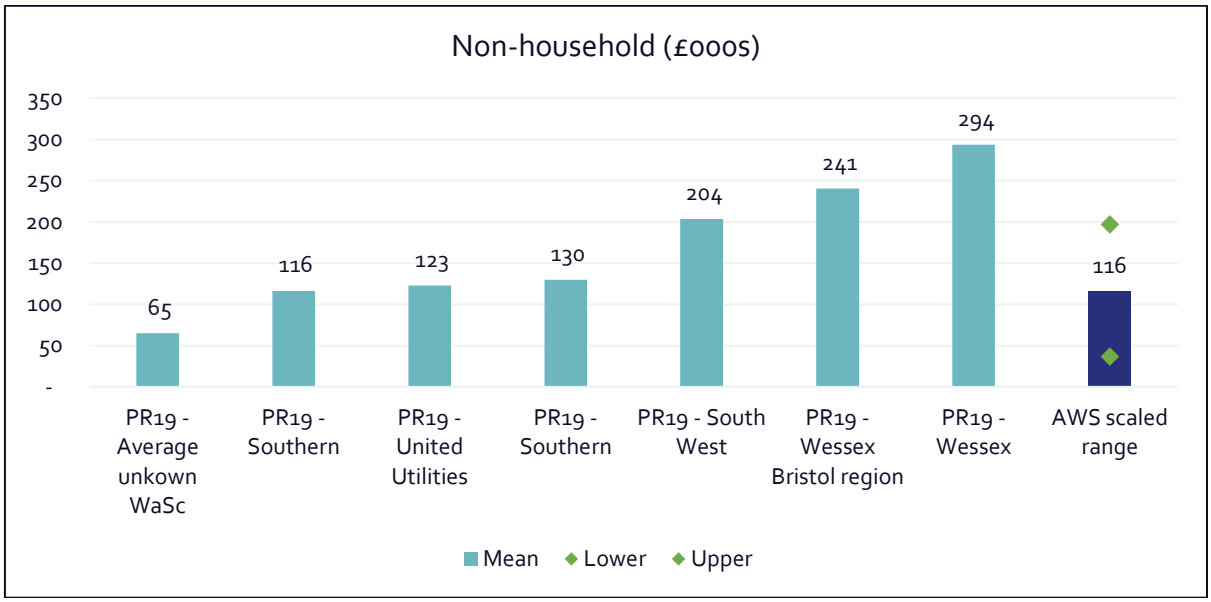

Figure 12-6: Comparing to non-household secondary data - £ per site, good to excellent (£000s)

Note: PR19 water company values are sourced from the Accent PR19 Comparative WTP study.

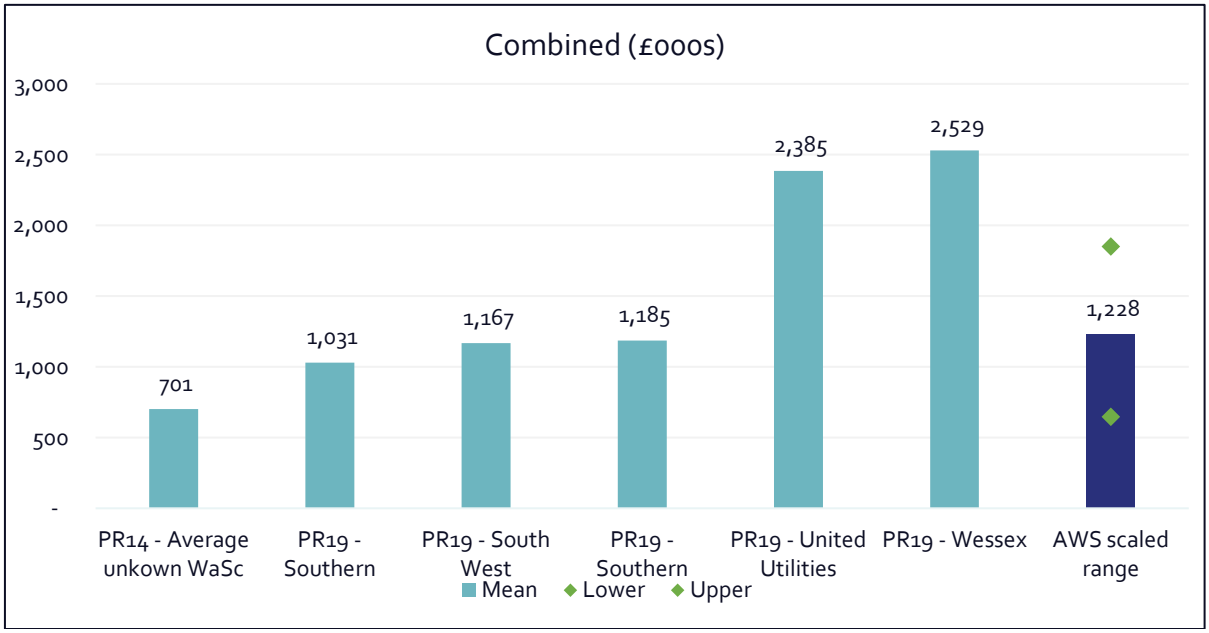

Figure 12-7: Comparing to combined secondary data - £ per site, good to excellent (£000s)

Note: PR19 water company values are sourced from the Accent PR19 Comparative WTP study.

12.2 Bathing water SMF categories

Step 3c: Applying the values to the wider service measure framework and triangulating against other data (primary and secondary)

The scaled values for bathing water quality have been mapped to the wider service measures for bathing waters and the results are presented in the tables below.

The links are based on the 2014 EA Bathing Water study and frequency of current beach status. Following the 1st iteration further investigation into the relative weights was undertaken and the weight for sufficient quality has been adjusted to take account of the Ofwat and CCW PR24 collaborative research weights which suggest a minor adjustment is appropriate. The amendment increases value between sufficient to good and decreases the value between poor to sufficient.

This adjustment was made using the joint household and non-household values. Following the completion of the second iteration dataset Ofwat and CCWater have updated the values to correct an error identified. Following a subsequent review, this suggests that the EA weights are more appropriate. The difference is, however, minor and captured within the uncertainty range.

The resulting values are then in turn used to calculate average weighted values for the improvement and deterioration metrics based on the current frequency of bathing waters in each quality category in the AWS region[36].

For the drop in classification to beach closure we have applied the value for a drop to poor quality plus a category one pollution incident. This reflects that the Environment Agency describe a beach closure as serious.

The compliance value is set relative to the value for a drop in classification from good or sufficient. A 10% weighting is used to reflect the proportional impact of a sample failure.

Table 12-6: Scaled – Improvement in Bathing Water, £

SMF band	Unit	Lower	Central	Upper	Notes on values
Excellent	£/bathing water	3,231,186	6,141,175	9,259,362	
Good	£/bathing water	2,584,949	4,912,940	7,407,490	
Sufficient	£/bathing water	2,197,206	4,175,999	6,296,366	
Poor	£/bathing water	-	-	-	
Improvement in Beach Classification from Sufficient or Good	£/bathing water	611,771	1,162,729	1,753,106	Weighted value for one step improvement
Improvement in Beach Classification from Closure or Poor	£/bathing water	2,197,206	4,175,999	6,296,366	Set equal to the value for poor to sufficient

NB: Values of improvements are total benefits compared to poor status unless otherwise stated. The difference between excellent and good values gives the value for moving from good to excellent status as shown in previous tables above.

[36] The current frequency of bathing waters in each category is 32 excellent, 13 good, 2 sufficient and 1 poor quality water

Table 12-7: Scaled – Deterioration in Bathing Water, £

SMF band	Unit	Lower	Central	Upper	Notes on values
Drop in Beach Classification to Good or Sufficient	£/bathing water	571,561	1,086,306	1,637,878	Weighted value for one step deterioration from either excellent or good.
Drop in Beach Classification to Poor	£/bathing water	3,008,440	5,717,825	8,621,057	Weighted value for deterioration to poor.
Drop in Beach Classification to Beach Closure	£/bathing water	3,214,052	6,112,609	9,226,021	Value for drop to poor plus a category 1 pollution incident value.

NB: Values of improvements are total benefits compared to poor status. The difference between excellent and good values gives the value for moving from good to excellent status as shown in previous tables above.

Table 12-8: Scaled – Compliance in Bathing Water, £

SMF band	Unit	Lower	Central	Upper	Notes on values
Bathing water (STW UV and CSO)	£/incident	57,156	108,631	163,788	10% of the value for a drop in classification to good or sufficient.

13 Shellfish

STEP 1.0 – SPECIFY AND UNDERTAKE RESEARCH

The evidence base for shellfish waters is given below.

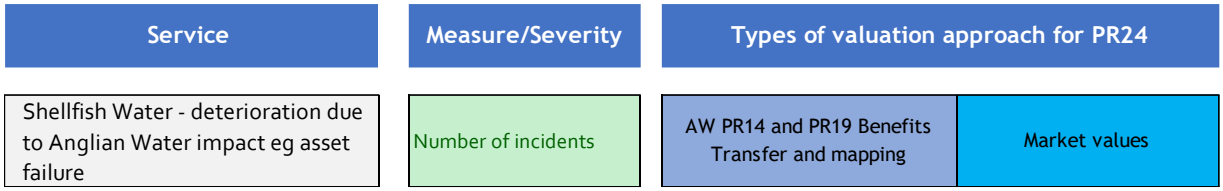

Figure 13-1: Shellfish SMF and valuation evidence base

STEP 2.0 - SYNTHESIS OF RESEARCH

The valuation is based on market data on shellfisheries.

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

The Shellfish values have been updated from PR19. The values are based on national average values from the Marine Management Organisation UK Sea Fishery Statistics 2020 report and the Centre for Environment Fisheries and Aquaculture Science (2012) report on aquaculture statistics for the UK. These reports provide information on the value and volumes of shellfish either landed in vessels or produced through aquaculture, respectively. These two sources have been combined as a majority of the shellfish produce harvested through aquaculture is grown in beds close to shore and is not harvested using sea vessels.

The deterioration value has been calculated as the average value of all shellfish from a designated shellfish water and is based on the following:

- the average value of shellfish per water in the Southern North Sea area (which covers the AWS region plus Kent) from the Sea Fishery Statistics report.
- PLUS the average value of clams, mussels and oysters for a shellfish water in England from the Aquaculture statistics.
- MINUS the average value of clams, mussels and oysters for a shellfish water in the Southern North Sea area (£1k) from the Sea Fisheries Statistics report to remove potential duplication between sources and avoid double counting.

The lower and upper values are set at +/- 20%.

These values are shown below.

Table 13-1: Shellfish waters, £ per shellfish water

SMF band	Unit	Lower	Central	Upper
Shellfish Water - deterioration due to Anglian Water	£/shellfish water	773,274	966,592	1,159,910

STEP 4.0 ASSESS AND TEST VALUATIONS

The wider customer evidence for environmental improvements has been collated and reviewed by AWS as part of their synthesis report. There is no specific information on shellfish water's in addition to the general customer support to protect and improve the environment.

The AWS engagement synthesis shows that customers consider environmental protection to be an important aspect of Anglian Water's work.

14 Dam failure

STEP 1.0 – SPECIFY AND UNDERTAKE RESEARCH

The evidence base for dam failure is given below.

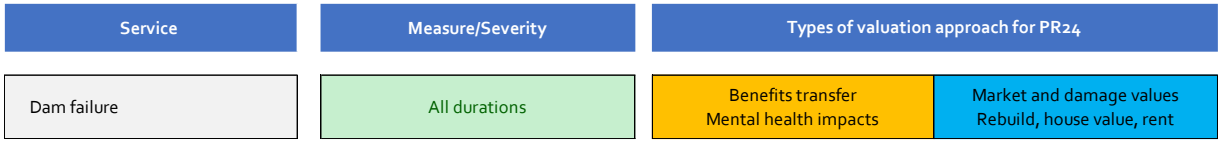

Figure 14-1: Dam failure SMF and valuation evidence base

STEP 2.0 - SYNTHESIS OF RESEARCH

The valuation is based on market data for housing and rebuild costs, supplemented by the costs of renting alternative accommodation and mental impacts on those affected.

Table 14-1: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
Nimble Fins Average Cost to Rebuild a House (2021)	Damage cost	Average rebuild costs	Household	H Source recommended by Confused.com as input for insurance quotes	H Relevant definitions; national average and regional (Peterborough)
Rightmove – house prices (2021)	Market value	Average house price for East of England	Household	H	H Relevant definition, value for East of England
ONS Private rental market summary statistics in England: Oct 2021 to Sept 2022 (2022)	Market value	Monthly rent statistics by region for East of England	Household	H Observed market data from ONS, median value	H Recent data for East of England
Defra mental health costs of flooding (2020) – referenced in ENCA	Value transfer - Cost of treatment and economic losses	Mental health costs of flooding per adult of >100cm	Household	M Produced by Government Partial value as does not include quality of life impact.	M Recent study. Impacts for general flooding in UK. Flooding impact less severe than dam failure.

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

The value set for dam failure is based on three types of impact:

- Property damage
- Alternative accommodation costs
- Mental health impacts

Our key assumption is that dam failure causes significant submersion and structural damage to properties affected and leads to the property owner having to leave the property for an extended period of time whilst the property is rebuilt.

The values for property damage are based on a mix of geographically specific rebuild and house value costs. The lower value is the estimated rebuild cost for typical home in the East of England. The rebuild costs are based on a home of 1,400 sq ft in 2021. This value has then been uplifted to 2022 prices[37].

The upper value is set at the average cost of home in East of England in 2021[38]. Again, this value has then been uplifted to 2022 prices. The central value is average of upper and lower values.

Further rental costs are included on the basis of alternative rental accommodation being required for a period of 36 months during the rebuild of the original property. This is based on the average rental cost in the East of England for the period 1st October 2021 to 30th September 2022. The rental costs are not varied for the lower and upper estimate.

The duration of the rental cost has been informed by the near dam failure incident at Whaley Bridge, where repair work on the dam is expected to take two years to complete upon commencement of the work (following project planning).

The mental health impacts associated with the flooding are included based upon the value assigned to a single individual experiencing flooding in excess of 100mm in their home estimated by Defra et al (2020). This value is also referenced in the flooding section of this report (section 9).

This mental health value is based upon the cost of treatment and prevalence of conditions such as anxiety, depression and post-traumatic stress disorder. This approach accounts for the likely impact of illnesses over the short term measured in days of work lost, covering impacts to the individual and society as a whole.

Mental health costs are converted from per person to per property on the basis of 2.41 people per property being the average occupancy for the region.

Incidents of dam failure are extremely rare, but it is likely the impacts of seeing your home destroyed along with many others in the surrounding area, and an extended period of displacement would have considerable mental impacts. To account for this the impact is extended to five years duration.

Mental health impacts are assumed constant across lower, central and upper estimates.

Table 14-2: Dam failure, £ per property

SMF band	Unit	Lower	Central	Upper
Dam failure	£/property	343,694	432,144	520,594

[37] https://www.nimblefins.co.uk/best-cheap-uk-home-insurance/average-cost-rebuild-house [Accessed 23/11/22]
[38] https://www.rightmove.co.uk/house-prices-in-East-of-England.html [Accessed 23/11/22]

STEP 4.0 ASSESS AND TEST VALUATIONS

The wider customer evidence for environmental improvements has been collated and reviewed by AWS as part of their synthesis report. There is no specific information on flooding due to dam failure.

15 Noise

The evidence base covers nuisance due to noise.

Service	Measure/Severity	Types of valuation approach for PR24	
Temporary non-Odour Nuisance (Noise) - collection and treatment (per day)	Excessive noise (eg Piledriver) - Urban residential	AW PR14 and PR19 Benefits Transfer and mapping	Benefits transfer
	Excessive noise (eg Piledriver) - Rural residential/ suburbs with little traffic		
	Excessive noise (eg Piledriver) - Rural; isolated residential		
	Loud noise (eg Bulldozer, excavators, crane) - Urban residential		
	Loud noise (eg Bulldozer, excavators, crane) - Rural residential/ suburbs with little traffic		
	Loud noise (eg Bulldozer, excavators, crane) - Rural; isolated residential		
	Moderate noise (eg Grinding, welding) - Urban residential		
	Moderate noise (eg Grinding, welding) - Rural residential/ suburbs with little traffic		
	Moderate noise (eg Grinding, welding) - Rural; isolated residential		
	Low noise (eg speaking voices) - Urban residential		
	Low noise (eg speaking voices) - Rural residential/ suburbs with little traffic		
	Low noise (eg speaking voices) - Rural; isolated residential		
Permanent non-Odour Nuisance (Noise) - collection and treatment (annual)	Loud noise (eg Generators) - Urban residential	AW PR14 and PR19 Benefits Transfer and mapping	Benefits transfer
	Loud noise (eg Generators) - Rural residential/ suburbs with little traffic		
	Loud noise (eg Generators) - Rural; isolated residential		
	Moderate noise (eg Vehicles and machines) - Urban residential		
	Moderate noise (eg Vehicles and machines) - Rural residential/ suburbs with little traffic		
	Moderate noise (eg Vehicles and machines) - Rural; isolated residential		
	Low noise (eg speaking voices) - Urban residential		
	Low noise (eg speaking voices) - Rural residential/ suburbs with little traffic		
	Low noise (eg speaking voices) - Rural; isolated residential		

Figure 15-1: Noise SMF and valuation evidence base

STEP 2.0 - SYNTHESIS OF RESEARCH

The values are based on the value transfer literature applied to Anglian Water. The sources are outlined in Table 15-1 below.

Table 15-1: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
AWS Social Capital (2020)	Value transfer	Noise for a range of locations	General value	H Partial value, uses Defra value plus analysis	H Relevant definition, new study
Defra (2014) Noise pollution economic analysis **Referenced in Defra ENCA**	Value transfer	Noise	General value	H Specific analysis combining most up to date information	H Detailed set of values for a range of noise levels (decibels), relevant to road disruption

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

The 2020 Social Capital Project analysis uses the latest noise values published by Defra. The analysis is based on the location and distance from source of noise and time of day. Values have been calculated for a wide range of noise nuisance that AWS may cause.

For each activity we calculated values for 8 hours duration either during the day or at night-time in three different locations (urban, rural residential/suburbs with light traffic and rural isolated).

The approach steps are:

1. Define the noise levels for each activity and how these change as distance from the source changes.
2. Determine the background noise for: a) different locations; and b) by time of day.
3. Calculate the marginal change in noise by distance.
4. Value the marginal change in noise per household affected using the values published by Defra. The night time value is based on the full Defra values whereas the day time value excludes the value for sleep disturbance.
5. Multiply the value for one household by the number of households affected dependent on the location.

Full details on the decibel levels and calculations assumed are included in the 2020 Social Capital report. The Defra values used in the analysis are a standardised source.

The values are shown below. The values are the average of the day and night time values and are based on an 8-hour duration per day. The temporary values are per day and the permanent values are per annum.

Table 15-2: Temporary noise nuisance, £ per property

SMF band	Unit	Lower	Central	Upper
Excessive noise (e.g. Piledriver) - Urban residential	£/day	22,803	30,523	39,099
Excessive noise (e.g. Piledriver) - Rural residential/ suburbs with little traffic	£/day	4,277	5,939	7,874
Excessive noise (e.g. Piledriver) - Rural; isolated residential	£/day	347	594	787
Loud noise (e.g. Bulldozer, excavators, crane) - Urban residential	£/day	2,951	6,650	13,412
Loud noise (e.g. Bulldozer, excavators, crane) - Rural residential/ suburbs with little traffic	£/day	535	1,114	2,474
Loud noise (e.g. Bulldozer, excavators, crane) - Rural; isolated residential	£/day	53	112	238
Moderate noise (e.g. Grinding, welding) - Urban residential	£/day	151	308	824
Moderate noise (e.g. Grinding, welding) - Rural residential/ suburbs with little traffic	£/day	1	89	193
Moderate noise (e.g. Grinding, welding) - Rural; isolated residential	£/day	-	9	19
Low noise (e.g. speaking voices) - Urban residential	£/day	-	2	6
Low noise (e.g. speaking voices) - Rural residential/ suburbs with little traffic	£/day	1	2	4
Low noise (e.g. speaking voices) - Rural; isolated residential	£/day	-	-	-

Table 15-3: Permanent noise nuisance, £ per annum

SMF band	Unit	Lower	Central	Upper
Loud noise (e.g. Generators) - Urban residential	£/annum	27,769	300,870	2,464,903
Loud noise (e.g. Generators) - Rural residential/ suburbs with little traffic	£/annum	10,495	70,407	411,291
Loud noise (e.g. Generators) - Rural; isolated residential	£/annum	875	7,216	41,107
Moderate noise (e.g. Vehicles and machines) - Urban residential	£/annum	15,306	51,821	167,162
Moderate noise (e.g. Vehicles and machines) - Rural residential/ suburbs with little traffic	£/annum	6,341	16,618	42,091
Moderate noise (e.g. Vehicles and machines) - Rural; isolated residential	£/annum	656	1,531	4,264
Low noise (e.g. speaking voices) - Urban residential	£/annum	-	656	2,187
Low noise (e.g. speaking voices) - Rural residential/ suburbs with little traffic	£/annum	219	656	1,531
Low noise (e.g. speaking voices) - Rural; isolated residential	£/annum	-	-	-

STEP 4.0 ASSESS AND TEST VALUATIONS

The wider customer evidence for noise disruption has been reviewed. The evidence is limited to concerns about noise during operational procedures such as using tankers to distribute water during an interruption to supply.

16 Amenity

This evidence base covers amenity access and visual impacts to amenity areas. Service changes valued are both permanent and temporary changes.

Service	Measure/Severity	Types of valuation approach for PR24	
Temporary amenity access - Aesthetic Green Space (SUD's, Street Greening)	Major adverse	Benefits transfer	PR19 2nd stage environment study
	Slight adverse		
	Slight benefit		
	Major benefit		
Temporary amenity access - Visited Green Space (eg park, beach)	Major adverse		
	Slight adverse		
	Slight benefit		
	Major benefit		
Temporary amenity access - Natural Tourist Hotspot	Major adverse	AW PR14 and PR19 Benefits Transfer and mapping	
	Slight adverse		
	Slight benefit		
	Major benefit		
Permanent amenity access - Aesthetic Green Space (SUD's, Street Greening)	Major adverse	Benefits transfer	PR19 2nd stage environment study
	Slight adverse		
	Slight benefit		
	Major benefit		
Permanent amenity access - Visited Green Space (eg park, beach)	Major adverse		
	Slight adverse		
	Slight benefit		
	Major benefit		
Permanent amenity access - Natural Tourist Hotspot	Major adverse	AW PR14 and PR19 Benefits Transfer and mapping	
	Slight adverse		
	Slight benefit		
	Major benefit		

Figure 16-1: Amenity SMF and valuation evidence base

Figure 16-2: Visual impact SMF and valuation evidence base

STEP 2.0 - SYNTHESIS OF RESEARCH

The values are based on the value transfer literature applied to Anglian Water. The sources are outlined in Table 16-1 below.

Table 16-1: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
AWS Social Capital (2020)	Synthesis of AWS visitor expenditure and benefit transfer	Amenity and visual impact for a range of environments	Visitor data, general values, hedonic pricing	H Uses actual visitor data with customers surveyed at the water parks	H Relevant definition as aligned with the PR24 SMF
AWS PR14 valuation completion	Visitor expenditure and Revealed preference – travel cost	Recreation – Water Parks	Visitor data	H Uses actual visitor data with customers surveyed at the water parks	M/H Relevant definition, same sites, PR14 study
PR19 2nd Stage Environment Study – ORVal analysis (University of Exeter 2016) **N.B. ORVal tool is referenced in Defra ENCA.**	Revealed preference Travel cost	Recreation – Water Parks, Grafham Water	General value	H Partial value but only compared to the relevant data from PR14	M/H Analysis of Grafham water, accounts for location and substitutes but not for unique characteristics.
Holzinger (2011) Study for The Wildlife Trusts	Value transfer –	Wetland creation; Woodland	Household	H Applied from on meta-analysis of 260 studies	M/H Some assumptions to transfer value.
Sen et al (2014/2010) – **Referenced in Defra ENCA**	Value transfer – recreational use value	Recreation – freshwater and flood plain, coastal, green belt and urban fringe, grassland; woodland	Household	H Meta study reviewing several hundred studies. Function from study used in the 2nd stage environment study to provide	M Relevant land uses, Does not account for site-specific variation in facilities

				values for the relevant sites by land use.	
Fields in Trust (2017)	Value transfer – Wellbeing value.	Wellbeing - parks and green space	Household	M Potential causal	M/H Relevant value, 2017 study
Dunse (2007)	Value transfer – Revealed preference (Hedonic)	Local park creation, open space creation	Household	M/H	M Relevant definition, Older study
Mourato et al (2010) **Referenced in Defra ENCA**	Value transfer – Quality Adjusted life years (QALY) Health utility index	Green space	Household	M Value described as tentative.	M Relevant definition, older study

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

The 2020 Social Capital Project analysis used the literature set out above to develop a set of values for visits to different landscape types and for each landscape type separate values for national/regional sites and local sites. The study also considered the allocation of the total value for a visit between visual and amenity values. The recommended allocation was 50:50 based on the findings of the Mourato et al 2010 study, which examined this relationship. The values presented are 50% of the total value.

The summary values are set out in Table 16-2. The values are expressed as £ per visitor and have been inflated to 2022 prices.

To differentiate between national/regional sites and local sites the study used visitor survey data for the AWS water parks. The AWS water parks are significant tourist and recreation sites that attract a large number of visitors. The travel cost data from the surveys allowed the relationship between distance travelled, volumes of visitors and expenditure to be examined.

The travel cost value for a water park value without on-site expenditure (£10.87) was compared to the value for visits from within a distance of 15km and no on-site expenditure (£7.50) to give a ratio of 1.45. The non-water park values are inflated by this factor prior to the on-site expenditure being added to produce values for national/regional important sites.

Table 16-2: Summary of the values from the 2020 Social Capital project, values inflated to 2022 prices

Landscape type/feature	Value £/person visit	Local importance £/person visit	Basis
AWS Water Park/Reservoir	17.25	9.00	Value is based on the PR14 (and updated in PR19) travel cost analysis of AWS Water Park visitors. Local value is the AWS Water Park value for visitors within 15km with on-site expenditure removed. It is intended to be a local value for a large body of water.
Freshwater & floodplain/Blue space/SuDs pond	6.10	1.30	Local value is average of two studies – Holzinger and Sen et al.
Park	10.20	4.15	Local value is weighted average of Sen et al, Dunse, Mourato et al and Fields in Trust studies. Mourato et al 2010 has been given a 50% weighting as this value is described as tentative by the study. The higher Fields in Trust value has been given a weighting of 50% as it is a subjective wellbeing value that is based on the correlation of wellbeing and park use. The value used as the central value in this report is the lower bound value from the study, which the study recommends as the main value due to upward bias. The approach assumes a causal relationship.
Open space / grassland	5.85	1.10	Local value is based on an average of Sen et al and Dunse.
Woodland	7.05	1.95	Local value is average of two studies – Holzinger and Sen et al.
Coastal	8.20	2.75	Local value is average of two studies – Sen et al and Dunse.

Note: Values rounded to nearest 5 pence

The values for amenity from above are used to produce two sets of values – national/regional importance and local. The values for the SMF assume a certain number of visitors per day which are shown in the top row of each table. The national/regional numbers for the Water Park value are influenced by the volume of visitors to the parks. The other national and regional important sites assume a lower value of 500 daily visitors. The local sites assume a value of 100 daily visitors.

The major impact category assumes that all of these visitors are prevented from accessing the site. The moderate value is assumed to be 50% of the major value and the slight value is assumed to be

10% of the major value. This approach can be used to capture impacts that lead to either a reduction in the number of visitors and/or the quality of the visit.

The values in the table below are £ per site per day. The benefit value is shown as the opposite of the adverse value with neutral impacts valued as zero.

Table 16-3: Output of the Social Capital project: Amenity or visual impact national/regional importance £/site per day, 2022 prices

	Reservoir	Fresh water & floodplain / blue space / SuDs pond	Park/ desirable space	Open green space	Street greening	Woodland	Coastal
Nr of daily visitors	1,000	500	500	500	500	500	500
Major adverse	-898	-132	-413	-114	-43	-198	-275
Moderate adverse	-449	-66	-207	-57	-22	99	-138
Slight adverse	-90	-13	-41	-11	-4	-20	-28
Neutral	0	0	0	0	0	0	0
Slight benefit	90	13	41	11	4	20	28
Moderate benefit	449	66	207	57	22	99	138
Major benefit	898	132	413	114	43	198	275

Table 16-4: Output of the Social Capital project: Amenity or visual impact local importance £/site per day, 2022 prices

	Reservoir	Fresh water & floodplain / blue space / SuDs pond	Park/ desirable space	Open green space	Street greening	Woodland	Coastal
Nr of daily visitors	100	100	100	100	100	100	100
Major adverse	-17,241	-3,053	-5,088	-2,903	-536	-3,532	-4,101
Moderate adverse	-8,621	-1,527	-2,544	-1,452	-268	-1,766	-2,050
Slight adverse	-1,724	-305	-509	-290	-54	-353	-410
Neutral	0	0	0	0	0	0	0
Slight benefit	1,724	305	509	290	54	353	410
Moderate benefit	8,621	1,527	2,544	1,452	268	1,766	2,050
Major benefit	17,241	3,053	5,088	2,903	536	3,532	4,101

Developing values for the Service Measure Framework

Some further adjustments were made prior to mapping values to the latest version of the SMF. Slight and moderate values were averaged to create the final slight values required due to the simplification of the framework.

The value set was then mapped to the locations required within the SMF as follows:

- Aesthetic Green Space (SUD's, Street Greening) is the average of the fresh water & floodplain / blue space / SuDs pond, open green space and street greening values.
- Visited Green Space (eg park, beach) is the average of the parks, woodland and coastal values.
- Natural Tourist Hotspot is the reservoir value.

The permanent service measures are valued using the regional/national values and the temporary service measures are valued using the local values. These assumptions will be reviewed for the 2nd iteration.

The lower and upper values are set at +/- 20%.

The SMF values are shown above in Table 16-5 through to Table 16-8.

Table 16-5: Temporary amenity access, £ per site

SMF band	Unit	Lower	Central	Upper
Temporary amenity access - Aesthetic Green Space (SUD's, Street Greening); Major adverse	£/site	-77	-96	-115
Temporary amenity access - Aesthetic Green Space (SUD's, Street Greening); Slight adverse	£/site	-23	-29	-35
Temporary amenity access - Aesthetic Green Space (SUD's, Street Greening); Slight benefit	£/site	23	29	35
Temporary amenity access - Aesthetic Green Space (SUD's, Street Greening); Major benefit	£/site	77	96	115
Temporary amenity access - Visited Green Space (eg park, beach); Major adverse	£/site	-236	-295	-354
Temporary amenity access - Visited Green Space (eg park, beach); Slight adverse	£/site	-71	-89	-107
Temporary amenity access - Visited Green Space (eg park, beach); Slight benefit	£/site	71	89	107
Temporary amenity access - Visited Green Space (eg park, beach); Major benefit	£/site	236	295	354
Temporary amenity access - Natural Tourist Hotspot; Major adverse	£/site	-718	-898	-1,078
Temporary amenity access - Natural Tourist Hotspot; Slight adverse	£/site	-216	-269	-323
Temporary amenity access - Natural Tourist Hotspot; Slight benefit	£/site	216	269	323
Temporary amenity access - Natural Tourist Hotspot; Major benefit	£/site	718	898	1,078

Table 16-6: Permanent amenity access, £ per site

SMF band	Unit	Lower	Central	Upper
Permanent amenity access - Aesthetic Green Space (SUD's, Street Greening); Major adverse	£/site	-2,383	-2,978	-3,574
Permanent amenity access - Aesthetic Green Space (SUD's, Street Greening); Slight adverse	£/site	-715	-894	-1,073
Permanent amenity access - Aesthetic Green Space (SUD's, Street Greening); Slight benefit	£/site	715	894	1,073
Permanent amenity access - Aesthetic Green Space (SUD's, Street Greening); Major benefit	£/site	2,383	2,978	3,574
Permanent amenity access - Visited Green Space (eg park, beach); Major adverse	£/site	-3,392	-4,240	-5,088
Permanent amenity access - Visited Green Space (eg park, beach); Slight adverse	£/site	-1,018	-1,272	-1,527
Permanent amenity access - Visited Green Space (eg park, beach); Slight benefit	£/site	1,018	1,272	1,527
Permanent amenity access - Visited Green Space (eg park, beach); Major benefit	£/site	3,392	4,240	5,088
Permanent amenity access - Natural Tourist Hotspot; Major adverse	£/site	-13,793	-17,241	-20,689
Permanent amenity access - Natural Tourist Hotspot; Slight adverse	£/site	-4,138	-5,172	-6,207
Permanent amenity access - Natural Tourist Hotspot; Slight benefit	£/site	4,138	5,172	6,207
Permanent amenity access - Natural Tourist Hotspot; Major benefit	£/site	13,793	17,241	20,689

Table 16-7: Temporary visual impact, £ per site

SMF band	Unit	Lower	Central	Upper
Temporary visual impact - Aesthetic Green Space (SUD's, Street Greening); Major adverse	£/site	-77	-96	-115
Temporary visual impact - Aesthetic Green Space (SUD's, Street Greening); Slight adverse	£/site	-23	-29	-35
Temporary visual impact - Aesthetic Green Space (SUD's, Street Greening); Slight benefit	£/site	23	29	35
Temporary visual impact - Aesthetic Green Space (SUD's, Street Greening); Major benefit	£/site	77	96	115
Temporary visual impact - Visited Green Space (eg park, beach); Major adverse	£/site	-236	-295	-354
Temporary visual impact - Visited Green Space (eg park, beach); Slight adverse	£/site	-71	-89	-107
Temporary visual impact - Visited Green Space (eg park, beach); Slight benefit	£/site	71	89	107
Temporary visual impact - Visited Green Space (eg park, beach); Major benefit	£/site	236	295	354
Temporary visual impact - Natural Tourist Hotspot; Major adverse	£/site	-718	-898	-1,078
Temporary visual impact - Natural Tourist Hotspot; Slight adverse	£/site	-216	-269	-323
Temporary visual impact - Natural Tourist Hotspot; Slight benefit	£/site	216	269	323
Temporary visual impact - Natural Tourist Hotspot; Major benefit	£/site	718	898	1,078

Table 16-8: Permanent visual impact, £ per site

SMF band	Unit	Lower	Central	Upper
Permanent visual impact - Aesthetic Green Space (SUD's, Street Greening); Major adverse	£/site	-2,383	-2,978	-3,574
Permanent visual impact - Aesthetic Green Space (SUD's, Street Greening); Slight adverse	£/site	-715	-894	-1,073
Permanent visual impact - Aesthetic Green Space (SUD's, Street Greening); Slight benefit	£/site	715	894	1,073
Permanent visual impact - Aesthetic Green Space (SUD's, Street Greening); Major benefit	£/site	2,383	2,978	3,574
Permanent visual impact - Visited Green Space (eg park, beach); Major adverse	£/site	-3,392	-4,240	-5,088
Permanent visual impact - Visited Green Space (eg park, beach); Slight adverse	£/site	-1,018	-1,272	-1,527
Permanent visual impact - Visited Green Space (eg park, beach); Slight benefit	£/site	1,018	1,272	1,527
Permanent visual impact - Visited Green Space (eg park, beach); Major benefit	£/site	3,392	4,240	5,088
Permanent visual impact - Natural Tourist Hotspot; Major adverse	£/site	-13,793	-17,241	-20,689
Permanent visual impact - Natural Tourist Hotspot; Slight adverse	£/site	-4,138	-5,172	-6,207
Permanent visual impact - Natural Tourist Hotspot; Slight benefit	£/site	4,138	5,172	6,207
Permanent visual impact - Natural Tourist Hotspot; Major benefit	£/site	13,793	17,241	20,689

STEP 4.0 ASSESS AND TEST VALUATIONS

The AWS synthesis report identifies that customers like the fact that Anglian Water offers recreational opportunities at water parks and nature reserves, whether they use them or not. It also suggests that the numbers of customer using these facilities on a frequent basis is relatively low with access being an influencing factor.

The evidence also shows that there is a wide desire for outdoor spaces and open areas to benefit physical and mental wellbeing. These additional benefits are not a higher property compared to the 'core' services.

17 Customer contacts

This section covers customer contacts. It is assumed that the values in this section are for contacts not covered by the other SMF values. For example, if a customer contacts AWS about a flooding incident, then the value of the contact in this instance should be considered part of the separate flooding values and the values here do not apply.

STEP 1.0 – SPECIFY AND UNDERTAKE RESEARCH

The evidence base for customer contacts is given below. The anchor measure is contact/ complaint.

Figure 17-1 Customer contacts SMF and valuation evidence

STEP 2.0 SYNTHESIS OF RESEARCH

Table 17-1 presents a summary of primary data. The table includes the PR19 Stated Preference study and an impact assessment that estimated the cost of a telephone call to contact AWS from PR14.

Table 17-1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR19 main stage study	Stated preference valuation	Repeat contacts	Household, Non-household	H Large sample DCE & DCCV methodology	M/H Definition relevant, PR19 study
PR19 Best-worst scaling	Stated preference – valuation	Repeat contacts	Household	H Good sample size, BWS methodology	M/H Definition relevant, PR19 study
PR14 impact study	Direct cost calculation	General contact	Does not distinguish between household or non-household	L/M Partial value, telephone call cost	L/M Definition is one contact

Table 17-2 presents a compilation of the secondary data that has been utilised in the triangulation. These 'other studies' are used as sense checks on the core valuation evidence provided by the primary data. It covers other company stated preference surveys from PR14.

Table 17-2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
Accent joint study – WaSC A (2013)	Stated Preference valuation	Unsatisfactory customer service, improvement to satisfactory, per customer	Hhold, Non-hhold	DCE methodology, good sample size	Different definition – converted to per customer from % but service description still not aligned, PR14 study

17.1 Customer contacts

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

Step 3a: Primary data & initial recommended range

This section presents the primary data for households, non-household and the combined customer base.

Households

The primary data for AWS household customers is shown in Figure 17-2. The recommended range is shown both in the graph below and in Table 17-3. The recommended central value is slightly higher but aligned with the PR19 inflated value. This reflects a change in customer numbers between PR24 and PR19.

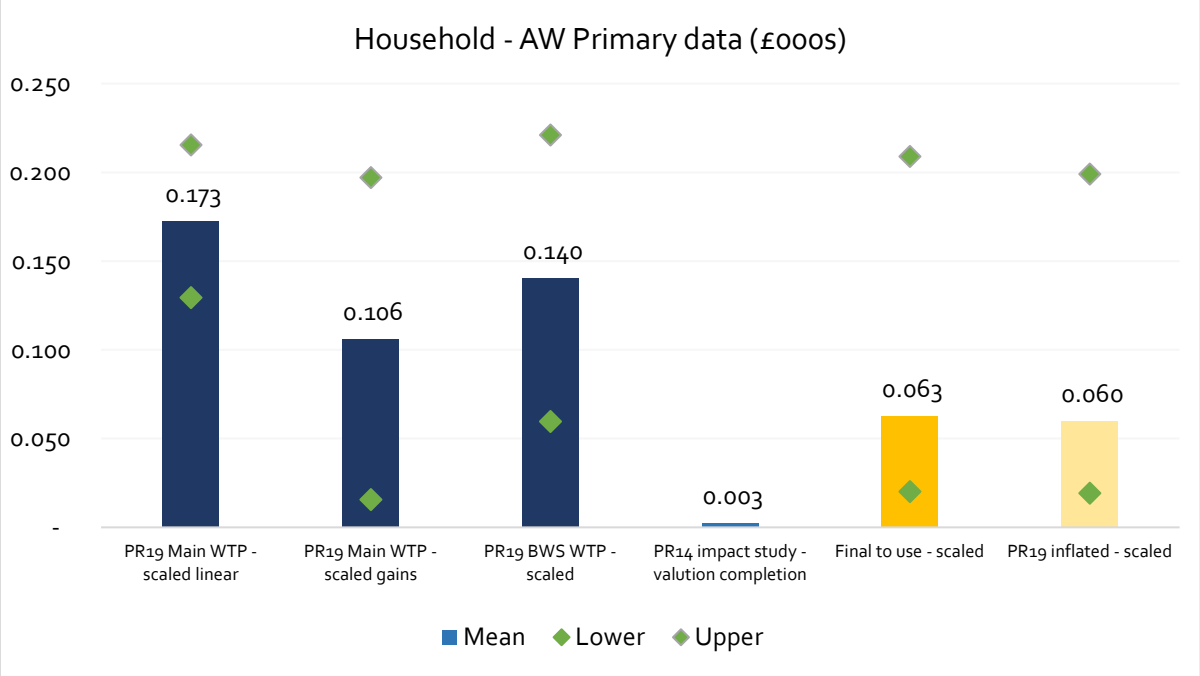

Figure 17-2: Household primary data - £ per contact, repeat contact (£ooos)

The central value is based on the average of the PR19 main stage scaled gains values, PR19 BWS values and the PR14 impact study. The impact study is the value of a phone call. This is a conservative assumption and is likely to underestimate the value.

The lower value is based on the average of the PR19 main stage scaled gains lower values, the PR19 BWS lower value and the PR14 impact study (mean value as there are no confidence intervals estimated). The upper value has been set at the average of the PR19 unscaled gains upper value and the PR19 BWS upper value. The impact study has been excluded as this is lower than the recommended mean. There are no PR14 WTP values to compare.

Overall, the gains value has been used in preference to the linear value as this is more conservative. The mean gains value is also below the confidence range of the linear value.

Table 17-3: Scaled household values £ per contact, repeat contact (£000s)

Lower	Central	Upper
0.020	0.063	0.209

Non-households

The primary data for AWS non-household customers is shown in Figure 17-3. The recommended range is shown both in the graph below and in Table 17-4. The values are aligned with the inflated value from PR19[39].

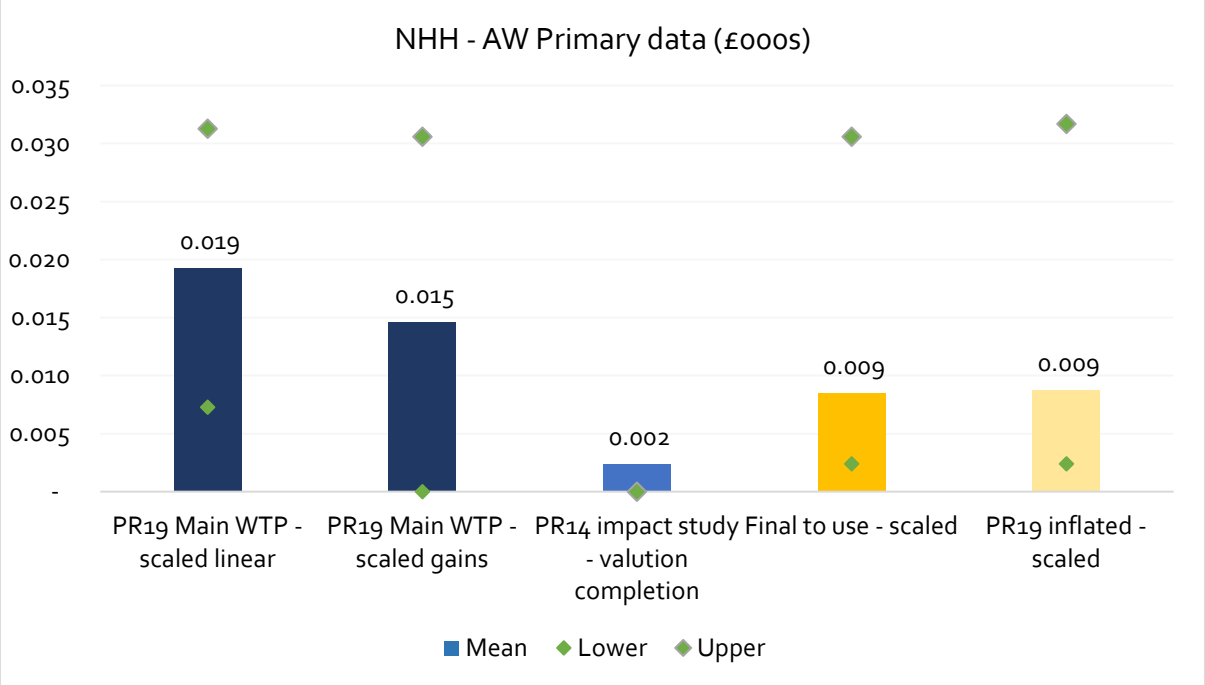

Figure 17-3: Non Household primary data – £ per contact, repeat contact (£000s)

[39] Note the number of non-household customers is lower for PR24. This change has not affected the overall value at 3 decimal places.

The central and range values are based on the same approach as households (excluding the PR19 BWS value as one does not exist for non-households). Similar to the household approach the PR19 main stage scaled gains value has been used in preference to the linear value as this is more conservative.

Table 17-4: Scaled non-household values £ per contact, repeat contact (£ooos)

Lower	Central	Upper
0.002	0.009	0.031

Combined (households and non-households)

The primary data for AWS combined customers is shown in Figure 17-4. The recommended range is shown both in the graph below and in Table 17-5.

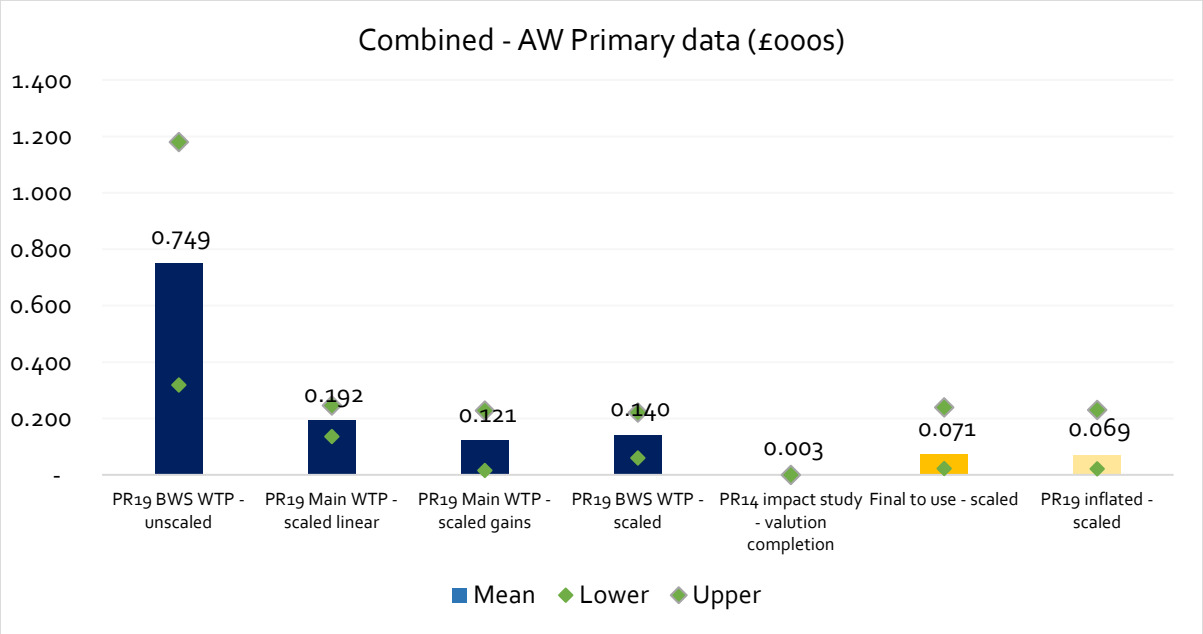

Figure 17-4: Combined primary data – £ per contact, repeat contact (£ooos)

The values presented are the household range plus non-household range. The impact study is not summed as this represents the cost of a phone call which is assumed to be the same for household and non-household customers.

Table 17-5: Initial recommended range – £ per contact, repeat contact (£ooos)

Lower	Central	Upper
0.023	0.071	0.240

Step 3b: Triangulating against other sources (secondary data)

Figure 17-5 shows how the ranges compare to the secondary data sources available. As there is limited data, we have shown the comparison for the overall value.

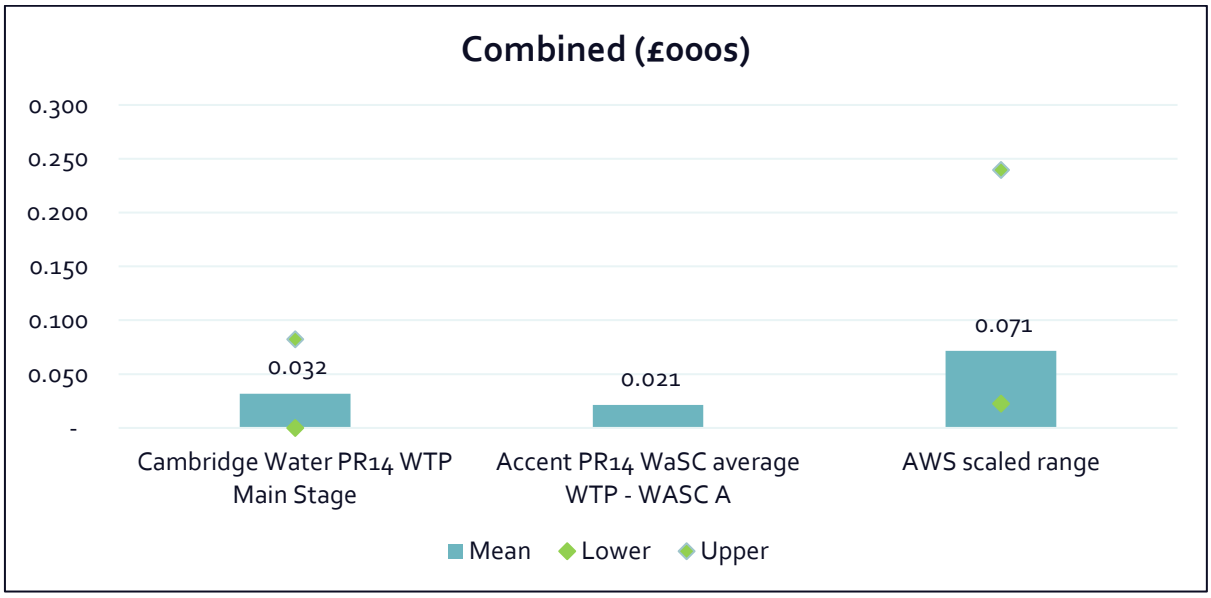

Figure 17-5: Comparing to combined secondary data – customer contacts, £k per property

Step 3c: Applying the values to the wider service measure framework and triangulating against other data (primary and secondary)

Not applicable for this measure.

STEP 4.0 ASSESS AND TEST VALUATIONS

The PR19 wider customer engagement evidence shows that customer service, particularly skilled staff who know how to respond to needs quickly, is important to customers. PR24 evidence shows that the online route for customer contacts is becoming increasingly important.

Whilst the PR14 cost of contact relates to telephone contacts the stated preference values are based on general contacts and therefore are likely to be representative of the preferred route of customers.

18 Health and Safety

STEP 1.0 – SPECIFY AND UNDERTAKE RESEARCH

The evidence base for health and safety is given below.

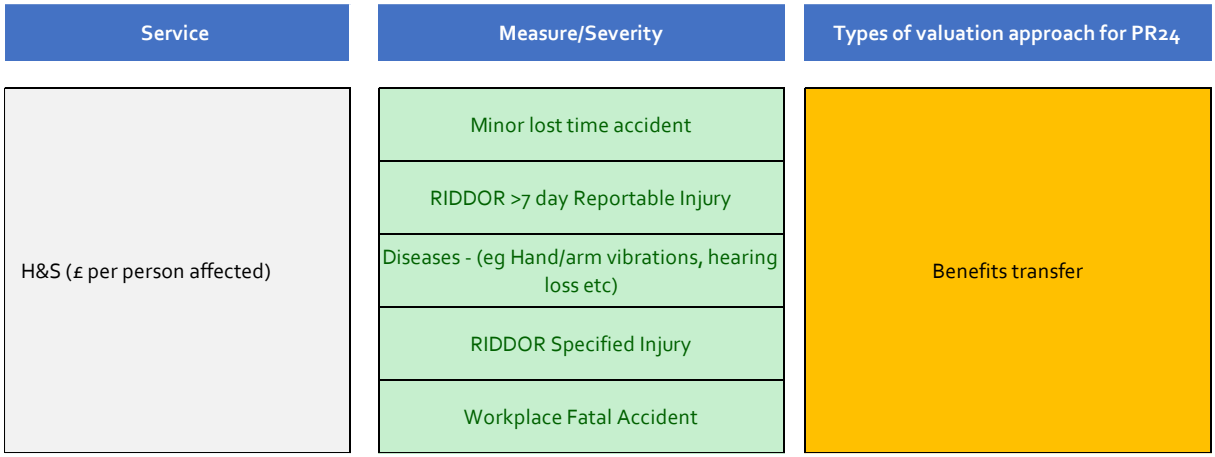

Figure 18-1: Health and Safety SMF and valuation evidence base

STEP 2.0 - SYNTHESIS OF RESEARCH

The values are sourced from the available value transfer literature. The values are based on latest published Health and Safety Executive recommended appraisal values.

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

The Health and Safety values are based on specified benefit transfer values from the Health and Safety Executive Costs to Britain of workplace fatalities and self-reported injuries and ill health, 2019/20. This report provides information on the impacts of workplace accidents so companies can evaluate investment decisions related to the wellbeing of their employees and the wider public.

Values entered into the Anglian Water Service Measure Framework are human costs to reflect the harm to individuals affected by incidents. Financial costs, such as productivity losses are accounted for elsewhere within private costs.

The value for disease is based on the 7 or more days absence due to ill health. Sentencing guidance suggests a RIDDOR notifiable injury is 10 x more serious than >7day injury, so that has been used as the scaling up factor for this severity.

The lower and upper values are set at +/- 20%.

These values are shown below.

Table 18-1: Scaled H&S, £

SMF band	Unit	Lower	Central	Upper
Minor lost time accident	£/person	337	421	506
RIDDOR >7 day Reportable Injury	£/person	27,516	34,395	41,274
Diseases - (e.g. Hand/arm vibrations, hearing loss etc)	£/person	18,587	23,234	27,881
RIDDOR Specified Injury	£/person	275,162	343,952	412,743
Workplace Fatal Accident	£/person	1,265,562	1,581,952	1,898,343

STEP 4.0 ASSESS AND TEST VALUATIONS

The recommended values are the values recommended by the Government. There is no further customer evidence on amenity impacts in the wider evidence review.

19 Congestion

STEP 1.0 – SPECIFY AND UNDERTAKE RESEARCH

The evidence base for congestion is given below.

Service	Measure/Severity	Types of valuation approach for PR24
Waste flooding - external (per area)	Dual Carriageway Roads	AW PR14 and PR19 Benefits Transfer
	Single Carriageway	
	Railway	
Traffic disruption - Motorway	Light traffic with narrowing	AW PR14 and PR19 Benefits Transfer
	Narrowing	
	Diversion	
Traffic disruption - Major 'A' Roads	Light traffic with narrowing	
	Narrowing	
	Diversion	
Traffic disruption - Minor roads	Light traffic with narrowing	
	Narrowing	
	Diversion	
Traffic disruption - Mixture of 'A' Roads and Minor Roads	Light traffic with narrowing	
	Narrowing	
	Diversion	

Figure 19-1: Congestion SMF and valuation evidence base

STEP 2.0 - SYNTHESIS OF RESEARCH

The values are sourced from the available value transfer literature with assumptions applied to correspond to Anglian Water.

Table 19-1 presents a summary of the data sources. The value is based on applying the Government value of time to road and speed data to estimate the impact of delays for a range of incident types.

Table 19-1: Data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
Value of time, Department of Transport, 2015	Value transfer	Congestion	Value of travel time.	H	H Definition relevant, latest available data.
2020 Social Capital project	Value transfer	Congestion at a range of locations	All vehicles Does not distinguish between hhold and non-hhold	H .	H Definition relevant, updated study.
The Environment Agency (2015)	Damage and compensation cost	Railway	General value	M Direct costs for 3 railway incidents, compensation costs not covered for all incidents, partial value.	M Incidents in other regions

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

The disbenefits of congestion are estimated using the Anglian Water traffic congestion model that was first developed for PR14.

The congestion calculator is based on a methodology published by NERA (1998)[40] for water companies analysing congestion when assessing the impact of leakage investments. The impact is calculated as the total delay for all motorists multiplied by the value of time. The analysis reflects the approach of the Department for Transport.

In 2020 this model was updated as part of the social capital project from the PR19 approach to include a more diverse range of road types and to integrate GIS analysis on the length of diversions in the AWS region. The full details of the approach are included in the 2020 Social Capital report.

Since 2020 the inputs have been further updated to include the latest regional road traffic statistics published by the Department of Transport. Where the latest traffic information available related to 2020, covering the early lockdown periods, the preceding year was used. This was to prevent underestimates of the number of road users being inconvenienced by AWS operations.

The value of travel time savings recommended by the Department of Transport[41], was applied to estimated delays for the different severities within the SMF within the congestion tool.

[40] NERA (1998) 'The Environmental and Social Value of Leakage Reduction'. A report for UKWIR.
[41] Arup, 2015. Report for Department for Transport. Provision of market research for value of travel time savings and reliability. Non-technical Summary Report.

All inputs to the traffic congestion tool were inflated to current prices.

The lower and upper values are set at +/- 20%. These values are shown below in Table 19.2.

Table 19-2: Congestion, £

SMF band	Unit	Lower	Central	Upper
Traffic disruption – Motorway; light traffic with narrowing	£/day	-	-	-
Traffic disruption – Motorway; Narrowing	£/day	465	581	697
Traffic disruption – Motorway; Diversion	£/day	99,328	124,160	148,992
Traffic disruption - Major 'A' Roads; light traffic with narrowing	£/day	1,448	1,810	2,171
Traffic disruption - Major 'A' Roads; Narrowing	£/day	915	1,143	1,372
Traffic disruption - Major 'A' Roads; Diversion	£/day	15,820	19,776	23,731
Traffic disruption - Minor roads; light traffic with narrowing	£/day	300	375	449
Traffic disruption - Minor roads; Narrowing	£/day	207	259	311
Traffic disruption - Minor roads; Diversion	£/day	1,311	1,639	1,966
Traffic disruption - Mixture of 'A' Roads and Minor Roads; light traffic with narrowing	£/day	759	949	1,138
Traffic disruption - Mixture of 'A' Roads and Minor Roads; Narrowing	£/day	490	613	736
Traffic disruption - Mixture of 'A' Roads and Minor Roads; Diversion	£/day	7,115	8,893	10,672

Step 3c: Applying the values to the wider service measure framework

The congestion values in Table 19-3 have been mapped to the wider framework values for flooding of roads. The values for flooding dual carriageways are the average of the motorway, rural dual carriageway major 'A' roads and urban 'A' roads values for diversions and narrowing. The values for flooding single carriageways are the average of the relevant single carriageway values (B roads, minor roads and single carriageway rural 'A' roads) for diversions and narrowing.

The railway value is set equal to the dual carriageway value.

The values assume that the disruption is one day duration in line with the application in the AWS SMF.

Table 19-3: Congestion due to external flooding, £

SMF band	Unit	Lower	Central	Upper
External flooding - Dual Carriageway Roads	£/road	22,784	28,480	34,176
External flooding - Single Carriageway	£/road	2,722	3,403	4,083
External flooding - Railway	£/incident	22,784	28,480	34,176

STEP 4.0 ASSESS AND TEST VALUATIONS

At PR19 AWS found that customers view traffic disruption and roadworks as one of the worse side-effects of Anglian Water work taking place and is a high topic of interest on social media channels. The flooding of roads is considered a lower impact compared to flooding of properties.

20 Carbon

STEP 1.0 – SPECIFY AND UNDERTAKE RESEARCH

The evidence base for carbon is given below.

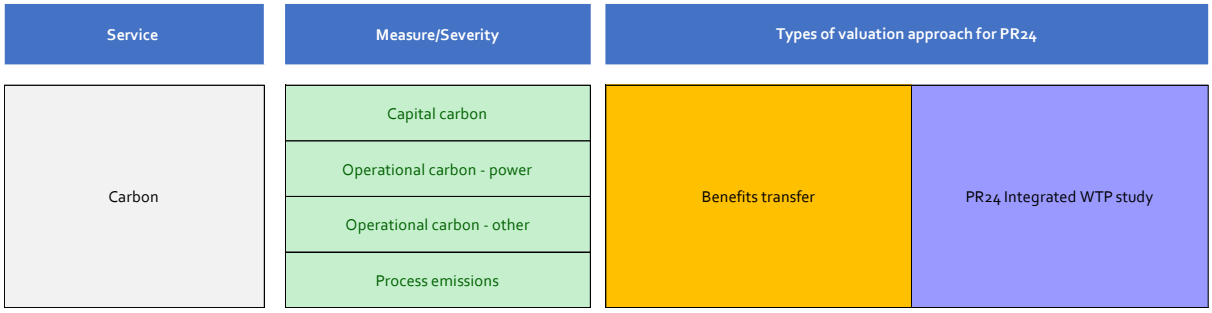

Figure 20-1: Carbon SMF and valuation evidence base

STEP 2.0 - SYNTHESIS OF RESEARCH

The values are sourced from the available value transfer literature. A key source are the latest published values from Department for Business and, Energy and Industrial Strategy (BEIS). These values are also referenced in the HMT Green Book. A further source which these values have been compared to is the AWS PR24 Integrated WTP study.

Table 20-1: Data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR24 integrated WTP study	Stated preference – valuation	Carbon emissions	General value	H Good sample size DCCV methodology	H Definition relevant, new study
BEIS (2021) Valuation of greenhouse gas emissions – referenced in the Defra ENCA	Marginal Abatement Cost (MAC) approach	Carbon emissions	General value	H Standardised value for policy appraisal	H Definition relevant,

STEP 3.0 COMPARING VALUATIONS TO PRODUCE RECOMMENDATION

Step 3a and b: Primary and secondary data & recommended range

Figure 20-2 compares the two sets of values. The BEIS values shown are non-traded values and the integrated WTP value is the combined household and non-household value.

The findings show that the whilst the BEIS central value is higher than the AWS value from the integrated WTP study, the AWS value is within the uncertainty range.

Given the BEIS values are standardised values that are recommended for policy appraisal we are recommending that they are used within the AWS SMF. This also reflects that the definitions are consistent and that carbon emissions have a global impact which may be higher than customer WTP.

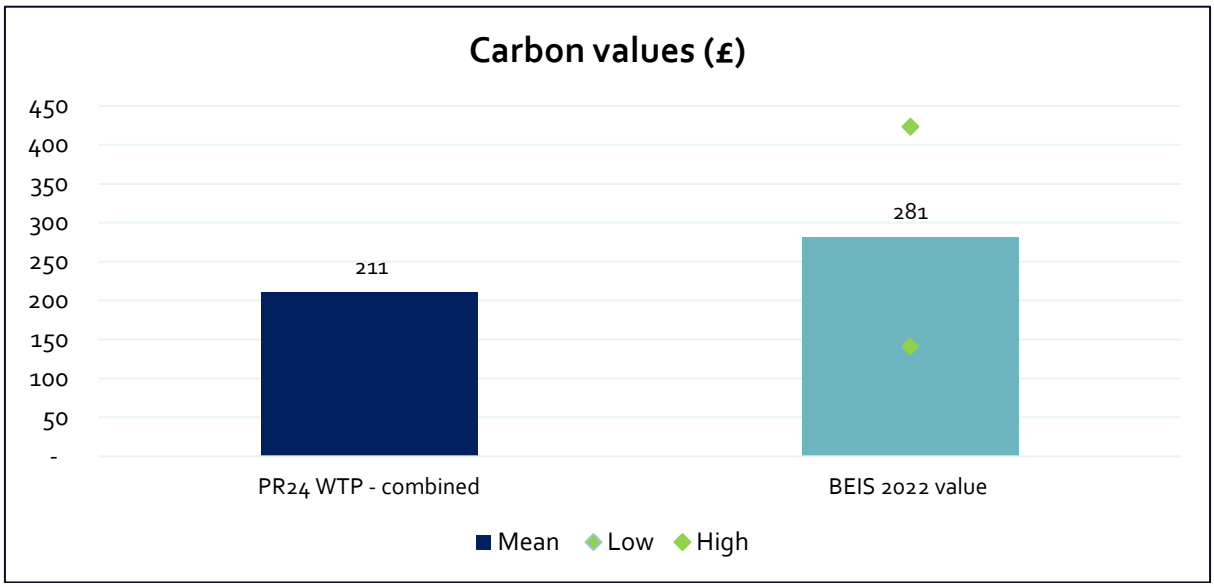

Figure 20-2: Carbon primary and secondary valuations

Step 3c: Applying the values to the wider service measure framework

The AWS service measure framework includes four categories for carbon emissions.

The BEIS values increase in value over time. To account for this change in values over time we have calculated an annualised value. The annualization calculation applies the social rate of time preference over 40 years to the BEIS carbon values starting in 2025 (to match optimisation assumptions).

This value has been applied to the capital, operational and process emissions.

For power emissions, the value has been reduced to reflect the AWS trajectory to achieve zero carbon emissions. The BEIS values have been multiplied by the proportion of energy that AWS expect to source from non-renewable sources. To reflect the phasing of investment over 5 years an average value has been calculated based on emissions starting in each year.

The values are shown in Table 20.2.

Table 20-2: Carbon, £

SMF band	Unit	Lower	Central	Upper
Capital carbon	£/Tonne of CO2	183	366	548
Operational carbon - power	£/Tonne of CO2	13	26	38
Operational carbon - other	£/Tonne of CO2	183	366	548
Process emissions	£/Tonne of CO2	183	366	548

STEP 4.0 ASSESS AND TEST VALUATIONS

The recommended values are the values recommended by the Government. The AWS customer synthesis reports that at both PR19 and PR24 AWS engagement research has found that customers generally support Anglian Water in reducing its carbon footprint although is seen as a low customer priority in terms of importance overall (relative to other water and wastewater priorities). In PR24 priorities research customers ranked it 13th. The research has also found that energy neutrality is ranked as less important.

Future customers are an exception to this – ranking reducing the carbon footprint as the second PR24 priority. Given the long term and global impact of this measure this is consistent with the BEIS values exceeding the customer WTP values.

21 Loss values for anchors

The values presented in Sections 5 to 20 of this report are for gains values only. WTP values for gains are appropriate to apply for investments that improve services while WTP values for losses could be most appropriate for investments relating to maintenance.

The assumptions made in deriving gains values are applicable to developing loss values too. All of the studies remain relevant for estimating loss values, with the exception of the PR19 Water Resources study, which provides gains values only. The table below presents the scaled loss values for the key anchors. Further information on loss values across all service measures is available in the more detailed Service Measure spreadsheet, provided separately.

Table 21-1: Loss values for anchors, £

SMF band	Unit	Lower	Central	Upper
Interruption, 6 to 12 hours	£/property	1,579	2,431	3,274
Severe restrictions	£/expected day/property affected	30.16	59.13	88.20
Leakage	£/MLD	160,421	298,759	437,097
Internal sewer flooding	£/property	139,824	197,332	254,841
Pollution category 3	£/incident	153,771	273,202	392,634
River water quality	£/km to good status	33,519	48,538	63,760
Bathing water	£/site from good to excellent	1,284,162	2,645,505	4,006,848

22 Segmentation analysis

The first purpose of the WTP research has been to produce average valuations across all customers, which we will refer to as 'Average WTP'. However, not all customers may be well represented by the 'average' viewpoint or value. In order to understand how the priorities of customer groups vary, in this section the responses are also assessed by customer characteristics or segmentations.

In doing so, this provides a check for customers who may be more vulnerable, helping identify potentially lower WTP or alternative attitudes.

This section provides a summary of the outputs from the household segmentation analysis undertaken as part of Anglian Water's PR24 Integrated WTP research.

22.1 Segmentation findings

Bespoke modelling analysis was undertaken of the household results from PR24 Integrated WTP research to explore if the estimated coefficients and weights differed across different household segments.

Some of the key segmentation findings from this study are:

- The CAPI sample was observed to be more cost sensitive than the online sample. As a result, WTP estimates for the CAPI sample are lower compared to the online only results, although the differences are minor. It is difficult to be conclusive as to the main factor driving this result – due to the relatively small CAPI sample size – but it could be due to the higher proportion of customers in vulnerable circumstance within the CAPI sample or due to the socioeconomic groups (SEG) and income profile of that sample.
- Segments by income did not have statistical different results for the water services, but lower income segments were observed to be more cost sensitive than higher income segments for wastewater services. The same trend was observed in socioeconomic groups.
- Segments by age and gender did not indicate any statistically significant differences between age groups.

These findings are broadly in line with expectations. Higher income respondents should have less of an income constraint, and therefore have higher willingness to pay values.

22.2 Comparison to ranges

The ranges from the segmentation analysis have been used to test the triangulated values from this report. The comparison shows the extent to which the recommended ranges cover the variation in WTP results from the average WTP for the key segments.

The results for the two key areas where some evidence of a variation has been found - socioeconomic group[42] (which represents low income households) and customers in vulnerable circumstances show that the triangulated lower range is wider than the variance form the average WTP in all but one instance.

The result for internal sewer flooding for the SEG customer segment shows that the lower SEG DE average WTP value is 53% below the average WTP value in the study whereas the triangulated lower range value is 44% below the central value. Further review of the data shows that due the triangulation process, the recommended final triangulated range for internal sewer flooding is lower than the WTP from the PR24 survey and a result the lower value of the recommended range is below

[42] Socioeconomic group and household income tend to be aligned. The socioeconomic group analysis uses a larger sample than income as customers are less likely to provide income data in a survey.

the DE socio-economic group WTP from the PR24 survey. This shows that the triangulated range covers the lower WTP value for the DE SEG customer segment.

The variances in WTP for customers in vulnerable circumstances are comfortably within the range. This is also observed for the water services for the DE socio-economic group. The variance is much closer to the lower triangulated value for the lower socio-economic group (DE) for the remaining wastewater services.

Table 22-1: Comparison of triangulated range to variance from average WTP for lower socio-economic group (Group DE)

SMF band	Triangulated value: % reduction for lower range value	DE socioeconomic group: % reduction compared to 'average' WTP
Interruption, 6 to 12 hours	-50%	-30%
Severe restrictions	-46%	-9%
Leakage	-43%	-8%
Internal sewer flooding	-44%	-53%
Pollution category 3	-48%	-45%
River water quality	-43%	-40%
Bathing water quality	-47%	-31%

Table 22-2: Comparison of triangulated range to the variance from average WTP for customers in vulnerable circumstances

SMF band	Triangulated value: % reduction for lower range value	Customers in vulnerable circumstances: % reduction compared to 'average' WTP
Interruption, 6 to 12 hours	-50%	21%
Severe restrictions	-46%	-13%
Leakage	-43%	13%
Internal sewer flooding	-44%	-5%
Pollution category 3	-48%	6%
River water quality	-43%	-2%
Bathing water quality	-47%	2%

23 Summary and Conclusion

The purpose of this report is to provide the recommended societal values for use in the Anglian Water six capital framework. It draws together the available valuation information that is available to produce a recommended set of values.

For PR24 this process is part of the overall Anglian Water triangulation process. The outputs of this report will form part of a wider triangulation process that will integrate further customer evidence, research and analysis as part of the business planning process.

The report is an update to earlier iterations of the report delivered in November 2022 reflecting that triangulation is an ongoing process as new information becomes available. Further information and analysis that has been included in this updated report are:

- Updated stated preference results to take account of larger samples and further analysis.
- Inclusion of Anglian Water research studies completed since the 1st iteration including investment priorities study, post event study and further integration of operational data through sentiment analysis.
- Additional analysis of secondary values including the development of benefit transfer functions and values for the Anglian Water region.
- Inclusion of the findings from the Ofwat and CCWater PR24 collaborative research.
- Challenge, review and updating assumptions based on the recommendations included in the first iteration report.
- More detailed cross check with the Anglian Water PR24 Customer Engagement Synthesis report.

23.1 Summary of findings

The final gains values are shown in the two tables below. The report is supplemented by a workbook detailing the values for the c.230 measures that make up Anglian Water's societal valuation framework.

Table 23-1: Gain values for anchors, £

SMF band	Unit	Lower	Central	Upper
Interruption, 6 to 12 hours	£/property	480	968	1,736
Severe restrictions	£/expected day/property affected	31.82	58.83	86.72
Leakage	£/MLD	116,334	203,310	284,538
Internal sewer flooding	£/property	77,736	138,766	201,744
Pollution category 3	£/incident	55,818	107,173	164,232
River water quality	£/km to good status	15,354	26,775	37,898
Bathing water	£/site from good to excellent	646,237	1,228,235	1,851,872

Table 23-2: Loss values for anchors, £

SMF band	Unit	Lower	Central	Upper
Interruption, 6 to 12 hours	£/property	1,579	2,431	3,274
Severe restrictions	£/expected day/property affected	30.16	59.13	88.20
Leakage	£/MLD	160,421	298,759	437,097
Internal sewer flooding	£/property	139,824	197,332	254,841
Pollution category 3	£/incident	153,771	273,202	392,634
River water quality	£/km to good status	33,519	48,538	63,760
Bathing water	£/site from good to excellent	1,284,162	2,645,505	4,006,848

Appendix 1: Evaluating evidence

This annex outlines the approach to evaluating evidence sources for relevance and robustness. It provides the basis for the development of the critical questions that are used to assess each source, the final set of critical questions and a review of each valuation source.

A1.1 Critical questions

INTRODUCTION

This annex sets out the critical questions for the triangulation process against which each study is reviewed prior to feeding into the triangulation process. We draw upon three key sources:

- The HMT Magenta Book (supplementary book to the HMT Green Book)
- ICF report for CC Water on triangulation in the water sector
- eftec report for Defra on guidelines for the use of value transfer

HMT MAGENTA BOOK

The HMT Magenta Book provides critical questions that help appraise evidence sources as to its robustness and relevance[43].

This suggests the list of critical questions used to appraise evidence is:

- Does the research provide clear answerable questions?
- Is the population represented?
- Are subgroups studied identified and studied?
- Is the sample size adequate?
- Are there any selection biases in the achieved sample? If so, are they effectively accounted for?
- Is there a formal approach to analysing responses?
- Have appropriate statistical tests been used to analyse responses?
- Has there been a formal assessment of validity, including appropriate comparisons (if any) made with other data sources?
- Is the weight applied to earlier repeat studies appropriate? Most weight should be applied to the most recent research.
- Are weaknesses and issues made clear?
- Are the project findings properly documented?

This is the basis we have adopted for reviewing the valuation evidence recognising wider qualitative research.

43 https://www.gov.uk/government/publications/the-magenta-book

CCWATER TRIANGULATION PROCESS

We have reviewed the CCWater triangulation process[44]. This provides a set of questions for weighing-up evidence:

Table 5.2 Criteria for weighing-up evidence[40]

Principle	Practical questions
Principle 1: contributory evidence	What kind of information does the source tell me about water customers?
	Is this information valuable for business-planning purposes?
	Does this information confirm what I already know about my customers? – If no, what explains the discrepancy? – If no, does it give me an alternative perspective? – If yes, how should I adapt my analysis of customer's preferences?
	Do I already have this kind of information about my customers?
Principle 2: methodological soundness	What sorts of questions does this method appropriately answer?
	Are any of the methods applied less well established, new or innovative? If so, do I need to do any further checks or investigation to establish how sound these methods are?
	How widely has the methodology been tested by the practitioners who generated the evidence?
	Has the methodology been appropriately adapted and refined for the specific purpose for which it has been used?
	Is it clear that good practice was followed?
	Was the methodology peer reviewed? If so, is the extent and depth of the review clear from the research write-up?
Principle 3: rigorous data collection	How was data gathered?
	Was data-gathering in line with best practice for the methods applied?
	Are there lessons that can be learned and applied in other areas of evidence-gathering, to improve my company's evidence base?
	(Building on previous questions) did the research include independent review of evidence?
Principle 4: credible analysis, interpretation	Is the context for the evidence described?
	What was the overall purpose of the research that generated this evidence?
	Have the limitations of the data been identified and recognised?
	Does that purpose influence my interpretation of the evidence?
	How was data gathered?
	Are there biases to be aware of, which have not been mitigated with the methodology? If so, how should I account for these?
	Has the evidence been used selectively? Have all aspects of the evidence being examined been used?
	What degree of confidence can be attributed to the evidence?
	To what degree can results be generalised from one source of evidence to conclude about other areas/customers/preferences?

[Source: ICF (2017) 'Defining and applying 'triangulation' in the water sector.' Report for The Consumer Council for Water.]

This has a significant overlap with the HMT Magenta book, but does include some other aspects that are useful to include in the final list of critical questions. Specifically, CCWater questions ask if the methods applied are established or innovative (and if the latter what checks are undertaken to establish how robust the method is). The CCWater questions ask if there has been peer review where this is needed, which helps with assessing robustness.

[44] ICF (2017) 'Defining and applying 'triangulation' in the water sector.' Report for The Consumer Council for Water.

The questions around testing the evidence, ensuring it is applied in the manner expected, and learning the lessons for future research, are important parts of the triangulation process. However we don't consider them to be part of the critical questions used to appraise evidence in the early steps in the process – but are best used in the latter stages when evidence is tested by practitioners and against the wider evidence base.

GUIDANCE ON VALUE TRANSFER FOR DEFRA

Eftec has reviewed and developed guidance for value transfer for Defra[45]. This source highlights the importance of checking validity (i.e. studies are of a sufficient quality), comparability of goods being valued and the importance of context.

Eftec summarised the guidance as to ensure that:

- The source valuation studies are of sufficient quality (as judged by undertaking quality assessments regarding the validity of source studies against the following three criteria):

  Scope sensitivity: Whether valuations are responsive to the scale (or "scope") of the provision change under assessment. For reasons discussed subsequently, scope sensitivity is a rather weak test. Put simply, because of the possibility that individuals may be satiated by some lower level of provision, the only clear expectation is that total WTP should not fall as the scope of a good increases.

  Tests of theoretically derived expectations: Economic theory provides a number of prior expectations which can be tested for. For example we might expect that WTP might increase with the individual's income and fall as the availability of substitutes increases. Similarly, we would expect average household WTP to decline as the distance from a spatially confined resource increases, as the availability of substitutes increase and the cost of access to the resource increases.

  Procedural invariance: Economic theory suggests that WTP should not vary due to "irrelevant factors" such as whether it is elicited using a payment ladder with a lot of values on it or one with smaller number of values. Similarly the choice between two options should not change when a third option, worse than either of the others, is introduced. Tests of such "procedural invariance" can be useful indicators of whether valuation survey respondents hold the well formed preferences characteristic of valid economic values or are simply "constructing" those preference responses with respect to the ad-hoc heuristics they see in the questionnaire design. There is however a caveat here. While high levels of procedural invariance provide warnings of problems, even purchases of market goods are subject to some procedural influences; indeed this is the premise of effective marketing.
- The good valued in the source studies is identical or highly similar to the policy good under consideration. This includes the nature of the good and its provision change in both quantity and quality terms. For example, in the case of a policy to increase water quality in rivers, ideally the status quo and post-change levels of water quality and the length of river affected at the policy site should match that of the study sites from which valuations are taken; and
- The context is identical or highly similar. Continuing the previous water quality example, the accessibility of rivers, distance to populations, the characteristics of that population, the

[45] Eftec (2010) 'Valuing Environmental Impacts: Practical Guidelines for the Use of Value Transfer in Policy and Project Appraisal.' Technical Report for DEFRA.

availability of substitutes and their quality should be constant across source study and policy cases.

PROPOSED CRITICAL QUESTIONS

Based on the review of all sources, the table below sets out our proposed agreed questions to assess robustness and relevance of each valuation study individually.

Questions to assess robustness and relevance of individual valuation studies

Area	Criteria	Questions	Interpretation (Applicable depending on study and information available)
Robustness	Methodology	• Is the methodology employed robust?	• What method was used? • What types of use and non-use values are captured? • If stated preference, how was the survey undertaken e.g. online, face-to-face. • Is this an established or innovative method? • Was the study peer reviewed, if necessary?
	Sampling/ Representativeness	• Is the sample representative of the population? • Is the sample size adequate?	• Are any selection biases in the achieved sample effectively accounted for? Were quotas applied and, if applicable, were the results weighted? • Are customer subgroups and segments identified and studied? • What was the sample size and is this sufficient for the type of study?
	Estimation	• Is there a robust statistical approach to analysing responses? • Are the results robust?	• Were appropriate statistical tests used to analyse responses? • Were those conducting the analysis are suitably qualified/competent to apply these tests? • Are the results statistically significant according to best practice tests (applicable to methodology)?
	Evaluation	• Is there a formal assessment of validity? • Are any weaknesses and issues made clear – and effectively dealt with? • Is the research part of a set of repeat studies?	• What is the scope of any validity testing? Does it include a) assessment against prior expectations; b) comparisons with other studies, methods, data sources, etc; c) content validity (bias testing - behavioural economics, qualitative testing, understanding of respondents). • If the study is part of a set of repeat studies how have earlier versions been considered and weighted? Does this approach improve robustness? Are these considered in the study &/or weighted or are they assumed to be separate results within the triangulation process?
Relevance	Definition	• Is the definition of the service/good in the study consistent with the definition of the good being assessed?	• Does the definition match? • Is any interpretation required to ensure the study/source is comparable? • Are there any critical assumptions for translating the values into the appropriate units for use?

	Level & range	• Are the status quo and changes in service levels consistent?	• Is the current level of service similar? • What range does the study cover and is this an improvement or avoiding a deterioration? • Are there different values over different ranges?
	Customer base and context	• Is the customer base consistent? • Is the wider context consistent? Are there key factors that could affect the values?	• Comparison for socio-economic structure, business customer base? • Are there significant geographic or contextual differences that could affect the value? For example, availability of substitutes, distance from good?
	Age of research	• How old is the research and does this impact on consistency?	• Have there been any changes that could affect value? E.g. was the research undertaken following an event that could cause bias?

A1.2 Scoring evidence against the critical questions - AWS PR24 studies

PR24 Integrated WTP study – Final Report

Criteria	Findings
Robustness	
Methodology	• Stated preference methodology – captures both use and non-use value. • Discrete Choice Experiment (DCE), an impact exercise (BWS) aligned with the Ofwat/CCWater approach, and Dichotomous choice contingent valuation (DCCV) questions. • A combination of in-person and online interviews were conducted with household and online interviews with non-household customers. • Established method.
Sampling/ representativeness	• A total of 1,078 household customers and 201 non-household (business customers) assigned evenly between water and wastewater. • **Household customer** demographics in line with AWS' sampling strategy (including Hartlepool). Quotas set for age, gender, and socio-economic grouping. Minimum quota set for customers in vulnerable circumstances. 55 digitally disengaged customers were sampled through in-person sampling. All cohorts were within +/- 10% from their quota and sampling weights were applied. • **Non-household** - 201 non-household (business) customers interviews were conducted through online. Representative by industry and weighted to average bill size.
Estimation	• Rigorous approach to statistical analysis of responses. • Analysis completed by economic experts with direct industry experience. • Formal econometric analysis is presented. • All linear DCE coefficient estimates for households show the expected positive sign and are statistically significant (at the 1% level). Only river water quality for non-households was observed to not differ from zero.
Evaluation	• The study the DCE approach and follow up DVVC exercise align with the PR19 approach. Minor updates to reflect changes in the Service Measure Framework (SMF). • Impact exercise aligned with Ofwat/CCWater approach developed for PR24. • The design of the questionnaire is consistent with best practice for stated preference valuation research. • The survey followed a standard structure in line with good practice and fully tested via cognitive interviews with household customers. • A pilot study was undertaken for the survey. • Results align with a priori expectations. • Non household survey coincided with the September mini budget and uncertainty. • Non-linear effects analysis was conducted to test the effects of diminishing marginal benefits for improvements in service and gains/loss values.

	• Analysis undertaken to establish differences by customer segments. • Overall, the results are highly robust.
Relevance	
Definition	PR24 main stage study and service measures designed to reflect the service measure framework (SMF) covering the following: • Supply interruption 6 to 12 hours • Boil water notice • Rota cuts • Leakage • Internal wastewater flooding; • Minor pollution indicents • River water quality • Bathing water, site good to excellent status; and • Carbon emissions.
Level & range	See table below
Customer base and context	• Sample based upon Anglian Water's customer base. • Both non-household and household customer samples include subsets of water only (Hartlepool Water) and wastewater only customers (Affinity Water, Cambridge Water and Essex & Suffolk Water).
Age of research	2022 ICS eftec
Peer review	Based on the 2017 study that was peer reviewed.
Other	
Use in triangulation of values	• Supply interruptions (6-12 hours) (anchor) plus weights for range of interruption durations • Weights for discolouration, taste and odour, boil water and low pressure • Rota cuts and standpipes (anchor) • Hosepipe ban • Leakage • Waste flooding – internal (number of properties) (anchor) • Odour and Flies nuisance (number of properties) (persistent) • Pollution incident – category 3 (anchor) • River water quality non good to good (anchor) • Bathing water, site good to excellent status (anchor) • River water quality improvement – km to good status (anchor) • Weights for minor and serious incident • Carbon emissions
NBs	Study Commissioned by AWS

Attributes and service levels (DCE)

Attribute	Level -2	Level -1	Level 0	Level +1	Level +2
Unplanned interruptions Number of properties affected by unplanned interruption to water supply (6-12 hours) each year	45,000 properties *(1 in 50 properties)*	37,500 properties *(1 in 60 properties)*	32,000 properties *(1 in 70 properties)*	28,000 properties *(1 in 80 properties)*	22,500 properties *(1 in 100 properties)*
Severe water restrictions (Rota cuts) Frequency severe water restrictions could be experienced	Every 50 years *(50% chance in the next 25 years)*	Every 100 years *(25% chance in the next 25 years)*	Every 200 years *(12.5% chance in the next 25 years)*	Every 300 years *(8.33% chance in the next 25 years)*	Every 500 years *(5% chance in the next 25 years)*
Boil Water Notices Number of properties affected by the boil water notice	240 properties *(1 in 9300 properties)*	210 properties *(1 in 10600 properties)*	180 properties *(1 in 12250 properties)*	150 properties *(1 in 14900 properties)*	120 properties *(1 in 18600 properties)*
Leakage Percentage of water lost due to leakage each year	22% *(125 l/p/day)*	18% *(105 l/p/day)*	15% *(85 l/p/day)*	11% *(65 l/p/day)*	8% *(45 l/p/day)*
Internal sewage flooding Number of properties affected by internal sewage flooding each year	430 properties *(1 in 4100 properties)*	330 properties *(1 in 5300 properties)*	230 properties *(1 in 7500 properties)*	130 properties *(1 in 13400 properties)*	30 properties *(1 in 58100 properties)*
Pollution incidents Number of minor pollution incidents that affect rivers and coastal areas each year	300 incidents *(approx. 550km)*	260 incidents *(approx. 850km)*	210 incidents *(approx. 1250km)*	160 incidents *(approx. 1650km)*	100 incidents *(approx. 1900km)*
River water quality Percentage of river length at good status or better each year	8% *(approx. 550km)*	12% *(approx. 850km)*	18% *(approx. 1250km)*	24% *(approx. 1650km)*	28% *(approx. 1900km)*
Bathing water quality Percentage of bathing water sites achieving excellent status each year	45%	55%	65%	75%	85%

Bill levels (DCE)

Attribute	Level -3	Level -2	Level -1	Level 0	Level +1	Level +2	Level +3
Water bill (households) Change in annual water bill from 2025	£45 decrease	£25 decrease	£10 decrease	No change	£5 increase	£15 increase	£40 increase
Water bill (non-households) Change in annual water bill from 2025	10% decrease	6% decrease	3% decrease	No change	3% increase	6% increase	9% increase

Bill levels (Package exercise)

Attribute	Change in annual bill
Water bill (households) Change in annual water bill from 2025	Increase by: No change, £5, £15, £30, £45, £60 and £75
Water bill (non-households) Change in annual water bill from 2025	Increase by No change, 3%, 6%, 9%, 12%, 14% and 17%

Attributes and service levels (Carbon choice task)

Attribute	Level 0	Level +1	Level +2
Reduce carbon emissions Tonnes of carbon remaining and delivery timescale	260,000 tonnes *(Net zero by 2050)*	70,000 tonnes *(Net zero before 2050)*	0 tonnes *(Net zero by 2030)*

Bill levels (Carbon choice task)

Attribute	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
Water bill Option 1 (non-households) Change in annual water bill from 2025	No change	No change	No change	No change	No change	No change	No change
Water bill Option 2 (non-households) Change in annual water bill from 2025	- (-)	£5 increase (2% increase)	£10 increase (4% increase)	£15 increase (6% increase)	£25increase (8% increase)	£35 increase (10% increase)	£50 increase (12% increase)
Water bill Option 3 (non-households) Change in annual water bill from 2025	£3 increase (1% increase)	£5 increase (2% increase)	£10 increase (3% increase)	£15 increase (4% increase)	£25 increase (5% increase)	- (-)	- (-)

Impact exercise service levels

Water service failures	Wastewater service failures
Unplanned water supply interruption - 3 hours	Sewer flooding inside your property - 2 months
Unplanned water supply interruption - 6 hours	Sewer flooding outside your property - 7 days
Unplanned water supply interruption - 12 hours	Minor pollution incident nearby
Unplanned water supply interruption - 24 hours	Storm overflow nearby
Unplanned water supply interruption - 4 days	Significant pollution incident nearby
Unplanned water supply interruption - 20 days	River nearby has deteriorated quality
Planned water supply interruption - 6 hours	River elsewhere in region has deteriorated quality
Low pressure - 24 hours	Small stream nearby has deteriorated quality
Low pressure - long term	Small stream elsewhere in region has deteriorated quality
Boil water notice - 2 days	Odour from wastewater treatment plant or network - 24 hours
Do not drink notice - 2 days	Local disruption from works - 2 days
Discolouration - 24 hours	
Discolouration - long term	
Taste and smell - 24 hours	
Hosepipe ban - 5 months *(Only included in the household survey)*	
Severe water restrictions (rota cuts) - 30 days	

PR24 Post event study – Final Report

Criteria	Findings
Robustness	
Methodology	• The survey uses three different methods to elicit the value for different duration interruptions to customers water supply: • Avertive behaviour values – estimates the value of service failures by observing how customers behave when services are temporarily lost i.e. actions customers take such as purchasing bottled water to mitigate the change in service, which are then used to estimate the value of the change in service. This value is a partial value as it does not capture the full impact on wellbeing. • Stated preference compensation values – the compensation required to off-set the impact of the incident. The approach applied aligns with Ofwat's PR24 central valuation methodology. • Subjective wellbeing values – based on customers reported impact on their wellbeing. Valued using a standard rate published in HMT Green Book.
Sampling/ representativeness	• 298 respondents surveyed from Northampton, Skegness and Kings Lynn, all within the AWS region. • Reasonable sample size but no formal quotas as event survey driven by location of event. • Sample still highly representative of the region for SEG, but with some over representation of older customers. • Household only.
Estimation	• Rigorous approach to statistical analysis of responses. • Analysis completed by economic experts with direct industry experience. • Formal econometric analysis is presented. • Results are statistically significant providing robust results aligned with a priori expectations. • All three approaches conform with the latest guidance.
Evaluation	• Questionnaire designed in consultation with AWS programme steering group including operational employees. • Pilot stage with 10 customers led to changes in avertive behaviour questions to better capture full range of responses and compensation amounts increased in stated preference exercise reflecting feedback. • Soft launch with 58 customers reviewed changes. • Wellbeing valuation approach follows HMT Green Book guidance. • Stated preference compensation values mirrored the approach used by Ofwat in their own central customer research for PR24.
Relevance	

Definition	The avertive approach and subjective wellbeing approach provide values for:
	• Unplanned interruptions;
	  ○ 3-6 hours
	  ○ 6-12 hours
	  ○ 12-24 hours

	○ 24-48 hours ○ 2 days to 4 days The stated preference compensation exercise provides values for • Unplanned interruptions; ○ 3-24 hours
Level & range	As above Based on events that have happened so not sensitive to level of service changes.
Customer base and context	• Sample based upon Anglian Water's customer base. • Household customers all Anglian Water customers who were directly affected by the events.
Age of research	2022-23
Peer review	AWS assurance by Jacobs
Other	
Use in triangulation	• Interruptions to supply anchor for 6 to 12 hours • Wider interruption durations
NBs	Study Commissioned by AWS

PR24 Investment priorities study (wave 3) – Final Report

Criteria	Findings
Robustness	
Methodology	• Conjoint choice experiment based on based on service level scenarios with fixed bill impacts for each investment and service level combination. • Followed by a stated preference CV question to capture the maximum bill impact customers would be willing to pay – captures use and non-use preferences. • Study approach designed to produce forecasts for demand of a programme of investments based on estimated bill impact. • A combination of in-person and online interviews were conducted. Sampling covered household and future customers.
Sampling/ representativeness	• Sample covers Anglian Water including Hartlepool. • Quotas were set aligned with the AWS sampling strategy. • Sample size of 529 allowing robust statistical analysis. • Household and future household customers only.
Estimation	• Analysis completed by experts in commercial data analysis and modelling. • Part-worth utilities (individual preference values) were estimated for each respondent, providing a detailed understanding of preference structures and trade-offs that respondents are willing to make. • Robustness evaluated using confidence intervals to determine statistical significance. • Approach designed for wider strategic planning. Importance weights not independent of bill impact therefore importance weights will be influenced by cost.
Evaluation	• Questionnaire designed in consultation with AWS steering group. • The CV WTP exercise is segmented to test for difference across regions, digitally disadvantaged and customers in vulnerable circumstances. • Study built upon earlier iterations of research as part of a phased programme. This allowed for testing definitions and customer understanding of scenarios.
Relevance	
Definition	The conjoint analysis provides PR24 importance weights for: • River water quality (% rivers to good status) • Resilience to climate change (least or most extreme possibilities) • Lead pipe replacement (% of properties) • Increase in water supply (nr of new reservoirs) • Leakage (% reduction) • Smart meter programme (date of completion for all properties) • Storm overflow investment (spills per overflow, plus remote monitoring)
Level & range	See table below
Customer base and context	• Sample covers Anglian Water including Hartlepool

Age of research	Trinity Mc Queen 2022
Peer review	Part of AWS assurance process.
Other	
Use in triangulation	Values used where there is a direct link to the AWS SMF. As part of triangulation the overall WTP value from the study for the change to all service areas is allocated using the importance weights to produce a value for the overall change for each individual service area. This is divided by the range shown in the study for the following: • River water quality (% in good status and converted to km) • Lead pipe replacement (per property) • Leakage (per % converted to mega litres per day) • Smart meter installed (per property) • Storm overflows (per spill)
NBs	Study Commissioned by AWS

Attributes and service levels (Conjoint choice exercise)

Attribute	Baseline	Enhanced
River quality improvements % of rivers to good status as classified by the Environment Agency	18%	28%
Tackling climate change Resilience to the impacts of extreme weather	Least extreme climate change possibilities	Most extreme climate change possibilities
Replacing lead pipes in homes % of properties with lead pipes which are replaced	0%	1% (25,000 households)
Increasing water supply Number of new reservoirs started	0	2 (Operational by mid to late 2030s)
Reducing leaks % change in level of leakage	0% (maintain leakage at current industry leading levels)	-7% (reduced by a further 7% between 2025 and 2029)
Helping customers reduce water use Date where every customer has a smart meter by	2035	2030
Reducing impact on rivers from storm overflows Number of spills per storm overflow, and presence of early warning monitors	Reducing the number of spills from all high spilling sewer systems to 20 spills per storm overflow	Reducing the number of spills from all spilling sewer systems to 10 spills per storm overflow. Early warning monitors are also installed

Attributes and bill impacts (Conjoint choice exercise)

Attribute	Baseline	Enhanced
River quality improvements % of rivers to good status as classified by the Environment agency	No bill impact	£13.90
Tackling climate change Resilience to the impacts of extreme weather	No bill impact	£7.20
Replacing lead pipes in homes % of properties with lead pipes which are replaced	No bill impact	£5.40
Increasing water supply Number of new reservoirs started	No bill impact	£3.60
Reducing leaks % change in level of leakage	No bill impact	£1.20
Helping customers reduce water use Date where every customer has a smart meter by	No bill impact	£1.20
Reducing impact on rivers from storm overflows Number of spills per storm overflow, and presence of early warning monitors	No bill impact	£6.00

PR24 Water Resource option ranking

Criteria	Findings
Robustness	
Methodology	• Survey designed for Water Resource Planning. • Options preference exercise (BWS approach) to determine importance preferences – covers use and non-use. • Online survey. • For household customers sampling through mailing out to the Anglian Water database through Anglian Water's Down the Plughole newsletter recipients. Customers asked to complete online survey. Sampling was then supplemented through walk in surveys at three locations (Hartlepool, Grantham and Lincoln).
Sampling/ representativeness	• A total of 1,489 household customers and 107 non-household customers surveyed. This includes 384 customers in vulnerable circumstances and 108 non bill payers. • **Household customer** demographics in line with AWS' sampling strategy (including Hartlepool). Quotas set for age, gender, and socio-economic grouping. Minimum quota set for customers in vulnerable circumstances. All cohorts were within +/- 11% from their quota and sampling weights were applied. • **Non-household** - 107 non-household (business) customers interviews were conducted through online panel. Quotas set for business size. Covered a range industry sectors and bill levels.
Estimation	• Analysis completed by experts with direct industry experience. • Rigorous approach to statistical analysis of responses.
Evaluation	• Questionnaire designed in consultation with AWS programme steering group. • The survey materials were reviewed by CCWater and subsequent comments led to amends in the questionnaire. • Video developed to aid customer understanding. • Pilot stage with 21 AWS customers to ensure questions were understood and the survey was effective. This led to some further amendments. • Results tested by customer segment to understand how preferences differ.
Relevance	
Definition	Covers 12 demand and supply options for water resource planning: • Leakge reduction (spearate for compnay and customer side) • Higherwater efificency • Water reuse • Using grey or rain water • Reservoir • Storing water underground • Smart metering • Universal metering • Taking from the sea – desalination • Transferring water

	• Sea tankering
Level & range	See options above -
Customer base and context	Anglian Water customers
Age of research	Emotional Logic March 2022
Peer review	Through AWS assurance process
Other	
Use in triangulation	• Water resource options
NBs	Study Commissioned by AWS

PR24 Insurance data

Criteria	Findings
Robustness	
Methodology	• Analysis of Anglian Water insurance data relating to water main bursts. • Covers closed claims for damage whereby Anglian Water were deemed to have liability from a burst main.
Sampling/ representativeness	• 61 claims met the required criteria of a burst main with liability attributed to Anglian Water via a loss adjustor, with damage. • All recent claims from between 2020 and 2022
Estimation	• Average insurance claim cost. Mainly damage cost value.
Evaluation	• To be considered as a lower bound estimate as claims do not include the value of distress and inconvenience caused.
Relevance	
Definition	Clean water flooding at a property due to a burst water main. Claims considered where flooding is described as 'water ingress' to the property to align with internal flooding definition. Covers a range of severities – extent is not always apparent from claim description.
Level & range	Provides value for internal water flooding at a property.
Customer base and context	All Anglian Water customers, mix of household and non-household.
Age of research	ICS, 2022 All recent claims that are closed from between 2020 and 2022
Peer review	Subject to AWS assurance via triangulation process.
Other	
Use in triangulation	• Internal Flooding
NBs	See appendix 2 for methodology.

AWS Social Capital (covering traffic congestion, noise and amenity) (2020)

Criteria	Findings
Robustness	
Methodology	• Desk top study building on robust valuations already developed during for PR14 and PR19 and the methods developed in the PR14 impact study. • Includes literature review and development of methods for the application of externally sourced values. • Travel cost method is used to value visits to AWS water parks. • Calculations for noise, traffic congestion are based on established methodologies to assess the impact of the disruption and value these using Defra and DfT values.
Sampling/ representativeness	• Application of external values (covered separately in this appendix). • Water Park visitor survey sample 1,542 households. Visitor survey incorporated park sites from across the Anglian region. Surveys conducted on different days/time of year
Estimation	• Analysis completed by economic experts with direct industry experience. • Noise - value transfer uses latest Defra guidance and associated values for noise pollution. Analysis is based on a specified decibel level for each assessed activity and a distance noise decay relationship is calculated. Assumptions made on background noise in differing locations (e.g. urban). The impact of sound levels in excess of the background noise level are assessed. Estimates based on population density by location type in the region. • Congestion – update to the congestion calculator developed at PR14 to incorporate latest traffic statistics. Based on a methodology published by NERA (1998)46 for water companies analysing congestion when assessing the impact of leakage investments. The impact is calculated as the total delay for all motorists multiplied by the value of time. The analysis reflects the approach of the Department for Transport. Uses regional DfT data from the National Road Traffic Survey. Additional GIS analysis undertaken by researchers to establish diversion distances. • Update to the Travel Cost Method applied in the PR14 impact study. Uses visitor expenditure and location data collected through on-site surveys to estimate the value of recreation facilities provided by Anglian Water. Results incorporated the value of time travelling, travel expenses as well as expenditure on site. Input values are inflated, and the costs of transport are updated. • Literature review for amenity sources also used. • No econometric estimates.
Evaluation	• Research builds on earlier studies and established methodologies where available. • Assumptions and sources are detailed in report. • Conservative assumptions such as reduced distances to account for multi-purpose journeys in travel estimates. • Proportionate approach to noise employed as per Defra guidance.

[46] NERA (1998) 'The Environmental and Social Value of Leakage Reduction'. A report for UKWIR.

Relevance	
Definition	• Values developed to align with the AWS six capital framework that underpins PR24. Congestion values produced covering three types of congestion (shutting, narrowing and diversions) for the following road types: • Motorway (diversion and narrowing only) • Major A roads – rural location and dual carriageway • Major A roads – rural location and single carriageway • Major A roads – urban location • Minor roads – rural location • Minor roads - urban location Noise values are produced for 8 hours duration either during the day or at night-time (operational only) in three different locations (urban, rural residential/suburbs with light traffic and rural isolated) for the following activities. Noise from construction (temporary): • Pile driving • Heavy duty bulldozer • Crane/Bulldozer/Chipping concrete • Vibrating road roller • Grinder/ Welding • Rubber tyre crane • Speaking voice Noise from operations (permanent): • Portable generator • Diesel truck • Machine/compressor/generator • Speaking voice Separate visual impact and amenity values are produced for a range of receptors: • Residents with a view from their home or in the local area (visual impact) • Schools (visual impact) • People visiting a site of national or regional importance • People visiting a site of local importance • People's views of a site whilst passing at speed in a vehicle or rail (visual impact) Types of environment assessed are: • Water park/Reservoir • Fresh water & flood plain / blue space / SuDs pond • Park/ desirable space • Open / green space • Street greening (visual impact only) • Woodland • Coastal
Level & range	N/A

Customer base and context	• Methodologies use population statistics relevant to the AWS region where available. • AWS Water Park recreation visitor surveys covered the AWS park sites from across the region. • Wider literature for amenity consists of evidence from across England.
Age of research	2020 ICS
Peer review	No peer review. Builds on previously peer reviewed analysis and published methods.
Other	
Use in triangulation	• Noise for a range of locations • Amenity and visual impact for a range of environments • Congestion • Impact of external flooding on roads
NBs	Study Commissioned by AWS

A1.3 Scoring evidence against the critical questions - Other AWS studies

PR19 Main Stage WTP Survey – Final Report

Criteria	Findings
Robustness	
Methodology	• Stated preference methodology – captures both use and non-use value. • Discrete Choice Experiment (DCE) and Dichotomous choice contingent valuation (DCCV) format. • A combination of in-person and online interviews were conducted with household customers, and online interviews with non-household customers. • Established method.
Sampling/ representativeness	• **Household** – A total of 900 household customers. Household customer demographics were compared to the 2011 census data to ensure the surveys were representative against age, gender, and socio-economic grouping. Other profiling categories were analysed including education, employment and income. • **Non-household** - 501 non-household (business) customers interviews were conducted through a mix of online and CATI-online. Representative by industry and bill size.
Estimation	• Rigorous approach to statistical analysis of responses. • Analysis completed by economic experts with direct industry experience. • Results are highly statistically significant providing robust results aligned with a priori expectations.
Evaluation	• The design of the questionnaire is consistent with best practice, and fully tested via cognitive interviews with 11 household customers over three phases. • Hall test preceded the pilot phase. • Pilot undertaken for the survey • Early stages established expectations for preferences when analysing validity of results. • Linear and gains/loss values were estimated. • All linear DCE coefficient estimates show the expected positive sign and are statistically significant (at the 1% level). • Majority of gains value coefficients statistically significant at the 5% level. Exceptions are discolouration and bathing waters for households and interruptions and discolouration for non-households. • Overall the results are highly robust.
Relevance	
Definition	PR19 main stage study and service measures designed to reflect the service measure framework (SMF) covering the following: • Unplanned interruptions; • Severe water restrictions (rota cuts);

	• Discolouration; • Leakage; • Sewer flooding inside properties; • Sewer flooding to external areas; • Odour from sewage treatment; • Bathing water quality at beaches; • River water quality; • Pollution incidents; and • Customer service (repeat contacts)
Level & range	See table below
Customer base and context	• Sample based upon Anglian Water's customer base. • Both non-household and household customer samples included small subsets of water only (Hartlepool Water) and wastewater only customers (Affinity Water, Cambridge Water and Essex & Suffolk Water).
Age of research	2018 ICS eftec
Peer review	Professor Ken Willis
Other	
Use in triangulation	• Supply interruptions (6-12 hours) (anchor) • Discolouration (informing the PR19 triangulated value) • Rota cuts and standpipes • Leakage • Waste flooding – internal (number of properties) • Waste flooding – external (number of properties) • Odour from sewage treatment works (number of properties) • Pollution incident – category 2 • River water quality non good to good (anchor) • Bathing water, site good to excellent status (anchor) • Customer contact (£ per person) (Repeat/general contacts)
NBs	Study Commissioned by AWS

Attributes and service levels (DCE)

Attribute	Level -2	Level -1	Level 0	Level +1	Level +2
Unplanned interruptions Number of properties affected by unplanned interruption to water supply (6-12 hours) each year	26,000 properties	22,000 properties	18,000 properties	14,000 properties	10,000 properties
Severe water restrictions (Rota cuts) Frequency severe water restrictions could be experienced	Every 25 years	Every 50 years	Every 100 years	Every 200 years	Every 500 years
Discolouration Number of properties affected by discolouration of tap water each year	50,000 properties	40,000 properties	30,000 properties	20,000 properties	10,000 properties
Leakage Percentage of water lost due to leakage each year	22%	19%	15%	8%	6%
Sewer flooding inside properties Number of properties affected by internal sewage flooding each year	460 properties	360 properties	260 properties	160 properties	60 properties
Sewer flooding to external areas Number of properties affected by external sewage flooding each year	7,100 properties	6,100 properties	5,100 properties	4,100 properties	3,100 properties
Odour from sewage treatment Number of properties affected by the odour from sewage treatment each year	4,900 properties	3,900 properties	2,900 properties	1,900 properties	900 properties
Odour from sewage treatment Percentage of bathing water sites achieving excellent status each year	45%	55%	65%	75%	85%
River water quality Percentage of river length at good status or better each year	8%	12%	18%	24%	28%
Pollution incidents Number of minor pollution incidents that affect rivers and coastal areas each year	300 incidents	260 incidents	210 incidents	160 incidents	100 incidents
Customer service Percentage of customer contacts that are resolved the first time each year	60%	65%	75%	85%	95%

Bill levels (DCE exercise)

Attribute	Level -3	Level -2	Level -1	Level 0	Level +1	Level +2	Level +3
Water bill (households) Change in annual water bill from 2020	£40 decrease	£20 decrease	£10 decrease	No change	£5 increase	£15 increase	£30 increase
Water bill (non-households) Change in annual water bill from 2020	10% decrease	5% decrease	3% decrease	No change	2% increase	4% increase	8% increase

Bill levels (Package exercise)

Attribute	Change in annual bill
Water bill (households) Change in annual water bill from 2020	Increase by: £5, £15, £30, £45, £60, £75, £90
Water bill (non-households) Change in annual water bill from 2020	Increase by 2%, 5%, 7%, 10%, 15%, 17% and 20%

PR19 Best Worse Scaling (part of Main Stage WTP Survey – Final Report)

Criteria	Findings
Robustness	
Methodology	• Stated preference methodology – captures both use and non-use value. • Best Worst Scaling (BWS), paired comparison (PC) and Dichotomous choice contingent valuation (DCCV) format. • Tested in parallel with the main stage DCE (previous table) • Online interviews were conducted with household customers.
Sampling/ representativeness	• A total of 453 household customers. • Household customer demographics were compared to the 2011 census data to ensure the surveys were representative against age, gender, and socio-economic grouping. Other profiling categories were analysed including education, employment and income
Estimation	• Rigorous approach to statistical analysis of responses. • Analysis completed by economic experts with direct industry experience. • Results are highly statistically significant providing robust results aligned with a priori expectations.
Evaluation	• The design of the questionnaire is consistent with best practice, and fully tested via cognitive interviews with 11 household customers over three phases. • Hall test preceded the pilot phase. Pilot undertaken for the BWS survey. • Early stages established expectations for preferences when analysing validity of results. • Linear values were estimated. Overall, the results are highly robust.
Relevance	
Definition	PR19 main stage study and service measures designed to reflect the service measure framework (SMF) covering the following: • Unplanned interruptions; • Severe water restrictions (rota cuts); • Discolouration (informing the PR19 triangulated value); • Leakage; • Sewer flooding inside properties; • Sewer flooding to external areas; • Odour from sewage treatment; • Bathing water quality at beaches; • River water quality; • Pollution incidents; and • Customer service (repeat contacts)
Level & range	Same as PR19 Main Study (see previous table)
Customer base and context	• Sample based upon Anglian Water's customer base. • Household customers all Anglian Water combined service.
Age of research	2018 ICS eftec

Peer review	Professor Ken Willis
Other	
Use in triangulation	• Supply interruptions (6-12 hours) (anchor) • Discolouration (number of properties affected) (informing the PR19 triangulated value) • Rota cuts and standpipes • Leakage • Waste flooding – internal (number of properties) • Waste flooding – external (number of areas) • Odour and Flied nuisance (number of properties) (persistent) • Pollution incident – category 2 • River water quality non good to good (anchor) • Bathing water, site good to excellent status (anchor) • Customer contact (£ per person) (Repeat/general contacts)
NBs	Study Commissioned by AWS

Attributes and service levels (BWS)

Same as PR19 Main Study (see previous table)

PR19 – Water Resources Second Stage Study

Criteria	Findings
Robustness	
Methodology	• Stated preference methodology – captures both use and non-use value. • Dichotomous choice contingent valuation, paired comparison and contingent ranking in 2017. • A wider range of valuation techniques were tested in earlier phases prior to selecting the above methods. • Two surveys; Restrictions survey and Options surveys, were both developed with some common questions where responses could be pooled. • Household and non-household survey was conducted online. • Established method.
Sampling/ representativeness	• **Household** – 1,008 online household interviews undertaken. Household customer demographics were compared to the 2011 census data to ensure the survey samples were representative against age, gender, and socio-economic grouping. Other profiling categories were analysed including education, employment and income. • **Non-household** - 408 online non-household interviews completed. Representative by industry. • Segmentation (socio-economic, Anglian Water customer behavioural segmentation) analysis completed to identify different preferences.
Estimation	• Rigorous approach to statistical analysis of responses. • Analysis completed by economic experts with direct industry experience. • Results are highly statistically significant providing robust results aligned with a priori expectations.
Evaluation	• The design of the questionnaire is consistent with best practice. • 250 customers were involved in the iterative survey testing phase for the surveys. • Both the options survey and restrictions surveys included 10 cognitive interviews and a hall test each. • Pilot studies were launched for both surveys. • 2 focus groups were undertaken as part of the study. • Early stages established expectations for preferences when analysing validity of results. • Range of valuation methods tested in early phases to identify which worked best for customers and the service attributes being valued. • Formal econometric analysis is presented in Annex 8 of the Water Resources report which confirms the observed choice behaviour across both surveys was consistent with expectations. • Content validity is confirmed through follow-up questions after the choice exercises. • The approach also included comparisons to PR14 AW values confirming consistency. • 2 post survey focus groups were used to test the validity of valuations produced in an additional step to increase confidence in results.

	• These focus groups confirmed understanding of the restrictions valued along with the ranking outputs of the SP research, validating the study outcomes
Relevance	
Definition	PR19 water resources study and service measures evolved from PR14 creating a high degree of comparability. See below for the water resource option definitions: ***Reducing leakage*** A leak in the street is the result of a burst water supply pipes. Anglian Water replaces these quickly. Smaller leaks, deeper in the ground, take a longer time to find and fix. ***Metering – compulsory and encouraging optional*** Extending the number of households with meters can save water. Metering can be optional or can be compulsory. ***Water saving devices*** Anglian Water can provide customers with water saving devices, such as water butts, water saving shower heads, and water recycling systems (that allow shower and bath water to be quickly treated and used to flush the toilet). ***Educating and incentivising customers to save water*** Anglian Water can provide incentives and education to help customers save water. Incentives include providing vouchers and community investment for reducing water use. Education includes helping homes, gardeners and other water users to use water more wisely. Reservoirs (extend or build new) ***Reuse of treated sewage*** Water is taken from rivers to fill reservoirs, which is then used to provide drinking water. Anglian Water already has several reservoirs in the region. Use sea water (Desalination) ***Transfer from other regions*** Underground water pipes can be built to take water from an area with lots of water to areas where water is needed. Water can be treated or untreated. ***Use sea water (Desalination)*** Water can be taken from the sea and treated. The process of removing the salt from the water is very energy intensive and creates a lot of carbon. ***Store water underground***

	Water is taken from rivers when they are full and stored underground in natural gaps and caverns. These are called aquifers. This can then be used in times of low rainfall. For service attributes see water and wastewater service descriptions definitions table below.
Level & range	Within the restrictions survey five levels of service were tested with respect to the frequency of failure. The duration of failures varied across four levels. For the options survey, 6 bill levels were tested against 11 options. The reliability of each option was also varied as either higher, medium or lower.
Customer base and context	• Study conducted across the Anglian Water region so values reflect the service experienced. • Both non-household and household samples included small subsets of water only customers.
Age of research	2017 ICS and eftec
Peer review	Professor Ken Willis, University of Newcastle
Other	
Use in triangulation	• Supply Interruptions (3 to 6 hours) • Discolouration (number of properties affected) (informing the PR19 triangulated value) • Taste and Odour (number of properties affected) • Rota cuts and standpipes • Hosepipe ban / Temporary Use Ban • Leakage • Reservoir (building new) • Reservoir (extending existing) • Water transfers • Desalination • Recycle & Reuse • Water Storage (ASR) • River restoration • Waste flooding – internal (number of properties) • Pollution incident – category 3
NBs	Study Commissioned by AWS

Water and wastewater service descriptions

Service Area	Current situation
Preventing drought restrictions (rota cuts) – Restrictions Survey Only	In times of dry weather restrictions can apply to water use. Most commonly restrictions are introduced in the form of hosepipe bans. However, in times of severe drought, much stricter restrictions called Rota Cuts are introduced. During a Rota Cut water is turned off to houses and businesses in rotation. Water is only available from taps for a few hours a day resulting in disruption to homes, businesses, schools and communities.
Preventing drought restrictions (hosepipe bans) – Options Survey Only	Hosepipe bans prevent households from using a hosepipe to water the garden, wash the car or fill a pool in times of drought. In times of severe drought, stricter restrictions can apply.
Look and taste of tap water	Sometimes water can look cloudy or brown, or can have an unpleasant taste and smell, such as a strong smell of chlorine. Whilst safe, it can be unpleasant to drink.
Reducing leakage	Water is lost through the network of pipes. Most leaks are from old pipes.
Introducing smart water meters	Smart meters allow households to monitor their water usage online as well as manage it. Meters are read automatically and remotely.
Reliability of water supplies	Unexpected interruptions to water supply occur due to burst pipes or if repairs are needed. This can happen at any time of the day.
Preventing sewer flooding	Very occasionally, when there is heavy rainfall or when sewers block, sewage can enter properties. This can cause considerable damage to furniture and fittings.
Quality of rivers	Pollution incidents occur when sewers block or equipment fails. This can cause pollution to rivers and coastal waters, harming wildlife and preventing recreation.

Service levels for water and wastewater service question

Service Measure in Package	Current situation	+1	+2	Survey
Preventing drought restrictions *Water cut in rotation to households and businesses "Rota Cuts"*	1 in 100 years	1 in 200 years	1 in 500 years	Restriction
Preventing drought restrictions *How often hosepipe ban occurs*	1 in 10 years	1 in 20 years	1 in 25 years	Option
Look and taste of tap water *Properties that complain about the look, taste or smell of tap water*	2600	2000	1000	Both
Reducing leakage *Water put into supply that is lost through leaks*	17%	13%	10%	Both
Introducing smart water meters *Properties with smart meters*	0	50% of households	All households	Both
Reliability of water supplies *Properties affected by interruption to water supply greater than 3 hours*	50,000	25000	12500	Both
Preventing sewer flooding *Properties that experience sewer flooding inside the property*	400	200	100	Both
Quality of rivers *Pollution incidents affecting rivers*	144	80	50	Both
Change in bill (Households) *£/annum*	No change	£2, £5, £7.50, £10, £20, £40, £60, £80	£5, £10, £15, £20, £30, £50, £75, £100	Both
Change in bill (Non-households) *%/annum*	No change	0.5%, 1.3%, 1.9%, 2.5%, 5%, 10%, 15%, 20%	1.3%, 2.5%, 3.8%, 5%, 7.5% 12.5%, 18.8%, 25%	Both

Service Levels (Restrictions)(Frequency)

Restriction	Level 1	Level 2	Level 3	Level 3	Level 4
Hosepipe bans	1 in 5 years	1 in 10 years	1 in 20 years	1 in 50 years	1 in 80 years
Non-essential use ban	1 in 10 years	1 in 20 years	1 in 50 years	1 in 80 years	1 in 100 years
Rota cuts	1 in 50 years	1 in 100 years	1 in 200 years	1 in 500 years	Never
No tap water	1 in 50 years	1 in 100 years	1 in 200 years	1 in 500 years	Never
Change in bill (Households) *£/annum*	No change	Increase by £2	Increase by £5	Increase by £10	Increase by £20
Change in bill (Non-households) *%/annum*	No change	0.5% increase	1.25% increase	2.5% increase	5% increase

Service Levels (Restrictions)(Duration)

Restriction	1	2	3	4
Hosepipe bans	1 month	3 months	6 months	9 months
Non-essential use ban	1 month	3 months	6 months	9 months
Rota cuts	1 day	1 week	1 month	2 months
No tap water	1 day	1 week	1 month	2 months

The reliability of options was presented as higher, medium or lower.

Macroeconomic analysis of drought impacts - 2017

Criteria	Findings
Robustness	
Methodology	• Economic loss value covering non-household impacts of water use restrictions. Covers use values. • Estimate of the amount of economic output that would be lost following water use restrictions. • Study uses the UK regional Gross Value Added (GVA) dataset from ONS, which provides historical output data by industry and region, as a means of valuing the economic output from companies in the Anglian Water region. • Forms assumptions about the proportion of this economic output that would be lost due to prolonged water use restrictions. Many assumptions drawn from other studies. Assumptions on economic loss vary by sector and level of severity of the restriction. • Study applies methodology used in wider Water UK study using Anglian Water region specific data. • Anglian Water also provided details of compensation claims for analysis. Value estimated for direct losses to businesses from the flooding data. Analysis also undertaken on interruptions data.
Sampling/ representativeness	• Sampling is based on GVA for 33 Standard Industry Codes and the NUTS2 level regions served by Anglian Water. • Aligning the geographical region served whilst retaining granular industry level data achieved through assumptions on area overlaps due to the ONS data available. • Proportionate approach but may not be 100% representative due to geographical location of business in areas that overlap with the AWS region. • Compensation claims dataset does not include all information required to understand if relevant. The value for flooding impact includes assumptions.
Estimation	• Analysis completed by economic consultancy with water industry experience. • Compensation data ruled out in relation to interruptions to businesses due to anomalous results showing reasonable judgement applied.
Evaluation	• Qualitative interviews with large businesses in the AW region were also conducted to help validate results of GVA analysis. • Built upon experience from Water UK project and previous studies. • Pragmatic approach used with data available.
Relevance	
Definition	• ***Aligns with Service Measure Framework***
Level & range	Levels of service and range designed to match those in WTP surveys / Service Measure Framework
Customer base and context	Anglian Water specific values with some geographical translation included.
Age of research	2017 Nera
Peer review	No peer review

Other	
Use in triangulation	• Supply interruptions (5 to 20 days) NHH • Rota cuts and standpipes • Hosepipe ban / Temporary Use Ban • Non Essential Use Ban • Developer request for water services • Developer request for water recycling
NBs	Study Commissioned by AWS

Service Levels

N/A

Valuation of the impact of roadworks and flooding using the Wellbeing Valuation method - 2017

Criteria	Findings
Robustness	

Methodology	• New and innovative methodology not used in the water sector at PR14. Recognised in the HM Treasury Green Book discussion paper (July 2011) *Valuation Techniques for Social Cost-Benefit Analysis: Stated Preference, Revealed Preference and Subjective Well-Being Approaches*, the approach is being increasingly incorporated and used in assessment
	• Places a monetary value on the wellbeing impacts estimated for customers living in areas that have experienced service failures.
	• The value of each type of incident calculated by estimating its impact on subjective wellbeing (SWB) for individuals who *experience* this incident in their life.
	• Impact is then converted into a monetary amount, by estimating the equivalent amount of money they would be willing to pay to avoid each type of incident.
	• Merged data used to run multivariate ordinary least squares (OLS) regression analysis to estimate the impact on life satisfaction (the best-practice measure of overall quality of life) of:
	  ○ All types of flooding incident recorded by Anglian Water
	  ○ Water flooding
	  ○ Internal (domestic) sewer flooding
	  ○ External sewer flooding
	  ○ Roadworks
	• Survey respondents potentially affected by a type of incident if there was such an incident within a specified distance of their postcode in a specified time period preceding their survey response are compared with a control group.
	• As the study includes respondents that have experienced an event and the local community it will cover use values and may partially cover non-use values.

Sampling/ representativeness	• The analysis is conducted using the Annual Population Survey (APS), a large continuous household survey which runs from April 2011 to March 2016. • It contains information on wellbeing (including a sample of Anglian Water's customers) and a wide range of socio-economic characteristics. • This data is merged with information on flooding and roadworks incidents (including their type, postcode location, and dates) provided by Anglian Water. • Socio-economic and demographic factors controlled for likely to affect valuations.
Estimation	• Analysis completed by consultancy with subjective well-being valuation experience. • New method making assessment difficult. • However, final models and results were statistically significant.
Evaluation	• Definitions align well. • Results presented with uncertainty around valuations.

	•
Relevance	
Definition	PR19 Study and service measures tailored to create a high degree of comparability. • ***Aligns with Service Measure Framework***
Level & range	Based on actual service failures experienced.
Customer base and context	Anglian Water specific data drives valuation linked to subjective-wellbeing estimates for relevant postcodes.
Age of research	2017 SIMETRICA
Peer review	No peer review on study but SWB approach and the application to water services is covered in PR19 Valuation Completion Report peer review.
Other	
Use in triangulation	• Waste flooding – internal (number of properties) • Waste flooding – external (number of areas) • Congestion (number of incidents) (Level 1)
NBs	Study Commissioned by AWS

Service Levels

N/A

PR19 Relative Preference Focus Group – 2017

Criteria	Findings
Robustness	
Methodology	• Qualitative review of customer preference weights from PR09 water services 2nd stage study, "Anglian Water PR14 – Flooding Second Stage Research" and "Anglian Water PR14 – Environment Second Stage Research" review. • Focus groups were held with customers to review previous studies – namely previous water disruption and flooding studies and the pollution categories from the environment study – to understand if the findings in those studies are still valid and can be used in investment planning in PR19.
Sampling/ representativeness	• Four focus groups undertaken with up to 8 respondents per group. • Sessions took place at two venues in the AW region, in Peterborough and Kettering.
Estimation	• Analysis completed by economic experts with direct industry experience, including of the original study being reviewed. • Anglian Water's societal valuation research has been ongoing for multiple periodic reviews.
Evaluation	• Process checked and verified research from previous periodic reviews with customers prior to use. • Consultants had direct experience of original study so were well positioned to test results.
Relevance	
Definition	See "PR09 Water services 2nd stage study" review, "Anglian Water PR14 – Flooding Second Stage Research" review and "Anglian Water PR14 – Environment Second Stage Research" review.
Level & range	See "PR09 Water services 2nd stage study" review, "Anglian Water PR14 – Flooding Second Stage Research" review and "Anglian Water PR14 – Environment Second Stage Research" review.
Customer base and context	Study conducted across the Anglian Water region so views reflect the service experienced.
Age of research	2017 ICS
Peer review	No peer review. Application covered in the PR19 VCR – see annex 4
Other	
Use in triangulation	• Discolouration (number of properties affected) • Taste and Odour (number of properties affected) • Hardness (number of properties affected) • Waste flooding – internal (number of properties) • Waste flooding relative to water flooding – internal (number of properties) • Loss of facilities • Waste flooding – external (number of areas) • Waste flooding relative to water flooding – external (per area) • Persistent low pressure • Pollution incidents Cat 1 – 3

	• Boil Water Notices • Do not drink notices
NBs	Study Commissioned by AWS

Service Levels

See "PR09 Water services 2nd stage study" review, "Anglian Water PR14 – Flooding Second Stage Research" review and "Anglian Water PR14 – Environment Second Stage Research" review.

UEA, Combining Anglian Water's customers' subjective preferences - 2017

Criteria	Findings
Robustness	
Methodology	• Stated preference methodology – captures use and non-use value. • Discrete Choice Experiment (DCE) integrated with quantitative analysis of subjective preferences (Q method) undertaken in 2017. • Mix of established and innovative. • Combining the two approaches allowed the researchers to explain preferences through an understanding of customers' subjective views.
Sampling/ representativeness	• 62 respondents for Q method. Researcher recognise that small sample can be used for Q method, however, the researcher also notes that this is a limitation. • 200 respondents for the choice exercise. Relatively small sample but robust results achieved. • Sample included water quality specialist, recreational users and non-visitors. Water quality specialists and recreational users are intentionally over sampled in the Q method to allow differences in views to be identified. • Sample covers part of the AWS region. Respondents fairly local to the stretch of river considered for improvement.
Estimation	• University of East Anglia has a strong reputation for economic non-market valuation expertise. • Analysis provides overall WTP values (based on the choice exercise) and a breakdown of variations by the subjective factors/customer groups identified using the Q method (based on a combination of the choice exercise and the Q method). This is accompanied by tests of statistical significance confirming robustness of results. • Researchers indicate the Q method sample size is likely to lead to the specific values for the defined customer groups to be overvalued.
Evaluation	• Evidence of validity testing through examination of response patterns and comparisons to a priori expectations. • Comparisons to other studies also included. • Researchers conclude that to produce a robust transferable valuation model, capable of integrating respondents' subjective preferences, larger Q datasets are required.
Relevance	
Definition	Report commisioned by Anglian Water Services. Covers move to high ecological and recreational quality. This is different to the Service Measure Framework which is good status.
Level & range	There are multiple values from this study. The lower value is a household / general public value living greater than 8km distance from the river for a change to high ecological and recreational quality (which is higher than good quality).
Customer base and context	Provides values based upon households and river use within the Anglian Water region. Study accounts for distance from river and where longer

	distances are assumed implicitly the availability of substitutes is likely to be allowed for.
Age of research	UEA 2017
Peer review	No peer review
Other	
Use in triangulation	• River water quality non good to good (anchor)
NBs	Report commissioned by AWS. Data collected prior to commissioning report.

Service Levels

Not available.

PR19 2nd Stage Environment Study – ORVal analysis (University of Exeter 2016)

Criteria	Findings
Robustness	
Methodology	• The ORVal recreation demand model uses data from the Monitor of Engagement with the Natural Environment (MENE) survey as a basis for analysis. This provides a recreational demand model which is able to predict the number of trips that might be taken to each different recreational site and the welfare value that those trips provide to visitors (disaggregated by socio-economic group), on the basis of the characteristics of the site. • Welfare values provided are estimated through a travel cost method, and the model predicts the number of visitors based on site characteristics, meaning changes to a site can be valued. • Travel cost models are an established method for valuing recreational sites. The predictive element of the model is innovative. • Travel cost methods do not capture wider social & environmental benefits. • The MENE survey has run since 2009 providing a significant time series sample.
Sampling/ representativeness	• Large national survey forms basis of the model, which was applied to Anglian Water sites. • Benefits are broken down by socio-economic groupings driven by predictions of who will visit sites.
Estimation	• Study is produced by a specialist Environmental Economics consultancy in conjunction with Exeter University, providing academic rigour.
Evaluation	• Estimates are compared to actual visitor numbers to examine their accuracy with limitations acknowledged. • Not all characteristics are contained within the model. For instance, sites of historical significance in practice attracted a greater number of visitors meaning the model would undervalue them.
Relevance	
Definition	Definitions are highly aligned as Anglian Sites were examined in significant detail in terms of their physical attributes and scale.
Level & range	The model provides the scope to value changes to the characteristics of a recreational site.
Customer base and context	As AWS sites examined analysis is relevant for visitors to the AWS region.
Age of research	2016
Peer review	
Other	
Use in triangulation	• Used as a sense check at Grafham Water which is part of the Water Parks valuation.
NBs	

Service Levels - Not applicable

PR19 online community research – pollution exercise

Criteria	Findings
Robustness	
Methodology	• Testing the validity of outcomes of AWS PR19 valuation research for pollution incidents with Anglian Water's online community. • Poll on the relevant Environmental Agency pollution category given the definition shown in the valuation survey.
Sampling/ representativeness	• 122 online community members who are Anglian Water customers.
Estimation	• N/a
Evaluation	• No formal assessment of validity required as the source is used as part of assessing wider evidence.
Relevance	
Definition	Aligned to definitions in original PR19 Anglian Water primary research.
Level & range	N/a
Customer base and context	Anglian Water customer specific evidence.
Age of research	2018
Peer review	None.
Other	
Use in triangulation	• Used to validate the allocation of primary PR19 values to EA pollution category.
NBs	

PR19 triangulated values

Criteria	Findings
Robustness	
Methodology	• Triangulated values from PR19 using sources from the PR24 report available at the time of triangulation. • All source values have been assessed for robustness and relevance. Balance within the value reflects its robustness and relevance. • Values produced to be consistent with Total Economic Value as sources assessed for full or partial values (e.g. inclusion of non-use value, inconvenience, etc). • Largely driven by stated preference research, AWS sources were peer reviewed. • Innovative methods were also included, e.g. subjective wellbeing. • Research included a mix of online and face to face methods.
Sampling/ representativeness	• The triangulated values are representative as they are based on AWS specific primary research aligned to the PR19 quotas and sampling strategy. • Robust sample sizes were included for all Anglian Water studies. • Anglian Water took a comprehensive approach to customer segmentation at PR19.

Estimation	• AWS study results included were statistically significant.
	• Studies undertaken by economic researchers with experience of the water industry and primary research peer reviewed.
	• Range of methods incorporated within PR19 triangulated values;
	  ○ Stated preference – DCE, BWS, CV, etc
	  ○ Subjective Wellbeing
	  ○ Revealed preference and avertive behaviour
	  ○ Market data
	  ○ Benefit transfer

Evaluation	• Prior to incorporation in the triangulated values, individual studies strengths or weaknesses were evaluated within the robustness and relevance assessment. • Secondary sources (e.g. other company values and national values) were used for validity checking the primary triangulated values. • As part of the process triangulated values were also checked for consistency with the wider PR19 AWS customer engagement programme.
Relevance	
Definition	Anglian Water triangulated values align with the PR24 service measures.
Level & range	Levels and ranges align with current performance. Changes to the performance within the last 5 years are within the ranges tested.
Customer base and context	Triangulated values relevant to the AWS region. One key change for PR24 has been the wider context of the economy with the current cost of living crisis.
Age of research	2018

Peer review	Two peer reviews: • Professor Ken Willis (Newcastle University) • Dr Paul Metcalfe - AWS PR19 Customer Engagement Forum member.
Other	
Use in triangulation	• Used as comparator for all anchor values. • Also used for discolouration, hosepipe ban, non-essential use ban, Odour nuisance
NBs	

PR14 Main WTP Survey – Final Report

Criteria	Findings
Robustness	
Methodology	• Stated preference methodology – captures both use and non-use value. • Discrete Choice Exercise (DCE) and Contingent Valuation (CV) survey in 2012. • A combination of CATI and online interviews were conducted with household customers, and CATI interviews with non-household customers. • Established method.
Sampling/ representativeness	• **Household** – 2,000 household interviews undertaken, 1,000 online and 1,000 via CATI. Household customer demographics were compared to the 2011 census data to ensure the surveys were representative against age, gender, and socio-economic grouping. Other profiling categories were analysed including education, employment and income. • **Non-household** - 500 CATI non-household interviews completed. Representative by industry and bill size.
Estimation	• Rigorous approach to statistical analysis of responses. • Analysis completed by economic experts with direct industry experience. • Results are highly statistically significant providing robust results aligned with a priori expectations.
Evaluation	• The design of the questionnaire is consistent with best practice, and fully tested via cognitive interviews with 10 households and 5 non-household cognitive interviews. • Prior to this 10 focus groups with household customers and five in-depth interviews with non-household customers were completed. • 2 HH pilots and 2 NHH pilots were also undertaken. • Early stages established expectations for preferences when analysing validity of results. • A split sample within the pilot phase was used to test the cognitive burden resulting in changes to the block structures. • Tests were also carried out on WTP and survey modes to ensure results could be reliably combined. • Respondents understanding of the attribute descriptions and show cards were high and most respondents stated that the choice exercises were easy or relatively easy to complete. • Approach included validity testing and comparisons to PR09 AW values. • Scaled results were recommended. • Diminishing marginal benefits for the highest improvement levels were identified in relation to some attributes in tests for non-linear values.
Relevance	
Definition	PR19 studies and service measures evolved from PR14 creating a high degree of comparability. ***Unexpected 6-12 hour interruptions to supply:***

	Number of properties affected each year by an unexpected 6-12 hour loss of supply • Short term unexpected interruptions to water supplies may happen without warning because of burst pipes or other emergency works • Affected properties would be without tap water for 6 to 12 hours • Anglian Water can reduce the chance of this occuring by replacing aging pipes sooner ***Persistant low water pressure:*** **Number of properties afffected each year by persistent low water pressure** • Low water pressure results in reduced water flow for taps • It takes longer to fill up a kettle or bath, and showers will be less strong • 'Persistent' means that this is a regularly occurring problem • Anglian Water can reduce the number of properties experiencing persistent low pressure by improving the water supply network ***Hosepipe bans:*** **Chance of a 6 month ban occurring** • Hosepipe bans may occur after long dry spells to help conserve water supplies • Under a ban, customers cannot use hopepipes to; – water a garden, clean a car or van – fill or maintain a swimming or paddling pool or ornamental fountain – clean outdoor surfaces (e.g. paths or patios) • Anglian Water can reduce the need for bans by investing in new sources and water saving measures ***Taste & Odour of Tap Water:*** **Number of properties affected each year by an unpleasant taste and/or odour of tap water** • Some customers experience incidents of an unpleasant taste or smell of their tap water • Properties can be affected over a period of time (e.g. a week) and running the tap does not remove the taste or smell • Anglian Water can invest to reduce the number of properties affected by unpleasant taste or smell of tap water ***Discoloured Tap Water:*** **Number of properties affected each year by discolouration of their tap water** • Some customers experience discolouration of their tap water • When this happens the tap water is usually brown in colour

	• Discoloured water is normally safe to use for drinking, preparing food, cleaning teeth, washing & bathing • Anglian Water can invest to reduce the number of properties affected by incidents of discoloured tap water ***Boil Water Notices:*** **Number of properties affected each year by 'boil water' notices** • A boil notice is issued as a precaution if there is risk that tap water contains bacteria that could make people ill from drinking tap water • Tap water can still be used for washing, bathing and toilet flushing • Tap water may only be used for drinking and cooking after boiling • Boil notices generally last about 3 days • Anglian Water can invest to reduce the chance of boil notices being issued ***Sewer Flooding Inside Properties:*** **Number of properties affected each year by a 1 in 10 year chance of internal sewer flooding** • Blocked or overloaded sewers can very occasionally flood the inside of properties with sewage & dirty water • Affected properties would typically experience this type of flooding once every 10 years • Impacts include: foul smells that need to be removed; floors & walls need to be cleaned & sanitised; carpets ruined & need replacing • Anglian Water can invest to reduce the chance of internal sewer flooding occuring ***Sewer Flooding to External Areas:*** **Number of properties affected each year by a 1 in 10 year chance of external sewer flooding** • This occurs when sewage & dirty water escapes from blocked or overloaded sewers & gets into gardens or other outside areas of properties • Affected areas would typically experience this once every 10 years • Roads, parks, children's play areas and woods may also be affected • Impacts include: outdoor plants may be ruined; grass might need re-turfing • Anglian Water can invest to reduce the chance of external sewer flooding occurring ***Nuisance from Sewage Treatment Works:*** **Number of properties affected each year by nuisance from sewage treatment works** • Sewage treatment works or pumping stations can produce strong odours, similar to those of rotting egg, cabbage or gas • Flies may also be present in large numbers

	• Properties close to works are most affected and the smell may be worse on a warm or windy day • Anglian Water can invest to reduce the number of properties affected by improving treatment works & pumping stations ***Pollution Incidents:*** **Number of pollution incidents each year** • Pollution incidents can be caused by failures or blockages in the sewer system, as well as heavy rain. This can result in the discharge of raw sewage to rivers or the wider environment • In most cases the impacts are minimal and localised. For example fewer than 10 fish will typically be killed and the impacts will last a few days at most • Anglian Water can invest in the sewerage network to reduce the number of pollution incidents ***Coastal Water Quality:*** **Number of coastal waters achieving 'excellent' quality** • Coastal waters are ranked against European Union standards as either 'poor', 'sufficient', 'good' or 'excellent'. 'Sufficient is the minimum standard that must be achieved • 'Excellent' coastal waters can be awarded 'Blue Flag' status. This is for beaches that achieve highest quality in water, facilities & safety • Anglian Water can invest to help improve the quality of coastal waters in the Anglian region ***River Water Quality:*** **River water quality assessments meeting 'good' or better** • All rivers in Europe are required to meet environmental standards monitored by the Environment Agency • Rivers that meet 'good' or better support a wide range of wildlife & are suitable for recreation • Rivers below good are less suitable for recreation and support less wildlife & plants • Anglian Water can upgrade its treatment works to improve sewage treatment and help to improve the quality of rivers in the region
Level & range	Each service attribute had one of five options – two levels of deterioration, status quo and two improvement levels and an associated bill impact. **See service levels table below.**
Customer base and context	• Identical customer base to present (and the PR19 main stage study) with only difference being time so potential differences driven by economic trends. • Both non-household and household sample included small subsets of water only and wastewater only customers.
Age of research	2012 ICS and eftec
Peer review	Professor Ken Willis, University of Newcastle

Other	
Use in triangulation	• Supply interruptions (6-12 hours) (anchor) HH • Persistent low pressure • Boil water notice • Discolouration (number of properties affected) • Taste and Odour (number of properties affected) • Hosepipe ban / Temporary Use Ban • Waste flooding – internal (number of properties) • Waste flooding – external (number of areas) • Odour and Flied nuisance (number of properties) (persistent) • Pollution incident – category 3 • River water quality non good to good (anchor) • Bathing water, site good to excellent status (anchor)
NBs	Study commissioned by AWS

Service Levels

Attribute	Level -2	Level -1	Level 0	Level 1	Level 2
Unexpected 6-12 hour interruptions (No. properties affected per year)	20,000	16,000	12,000	8,000	4,000
Persistent low water pressure (No. properties affected per year)	1,000	750	500	250	0
Hosepipe bans (Chance of event occurring in any given year (duration 6 months))	25% (1 in 4 years)	15% (1 in 7 years)	10% (1 in 10 years)	5% (1 in 20 years)	3% (1 in 33 years)
Taste and odour of tap water (No. properties affected per year)	3,500	2,750	2,000	1,250	500
Discoloured tap water (No. properties affected per year)	50,000	40,000	30,000	20,000	10,000
'Boil water' notices (No. properties affected per year)	6,000	3,000	1,500	750	0
Sewer flooding inside properties (No. properties affected per year)	550	425	300	175	50
Sewer flooding to external areas (No.	6,000	4,700	3,400	2,100	800

properties affected per year)					
Nuisance from sewage treatment (No. properties affected per year)	9,500	7,250	5,000	2,750	500
Pollution incidents (No. incidents per year)	900	700	500	300	100
Coastal water quality (No. improvements from 'sufficient' to 'excellent' quality)	18 excellent out of 46 (40%); 9 move from excellent to sufficient/ good	23 excellent out of 46 (50%); 4 move from excellent to sufficient/ good	27 excellent out of 46 (60%); no change	32 excellent out of 46 (70%); 5 move from sufficient/ good to excellent	37 excellent out of 46 (80%); 10 move from sufficient/ good to excellent
River water quality (assessments meeting 'good' or better quality)	70% achieve good quality or better	75% achieve good quality or better	480okm of river assessed: 80% achieve good quality or better	85% achieve good quality or better	90% achieve good quality or better
Water bill (household)	Decrease by £20	Decrease by £10	No change	Increase by £10	Increase by £20
Water bill (non-household)	Decrease by 6%	Decrease by 3%	No change	Increase by 3%	Increase by 6%

PR14 Environmental Study: River Quality and Pollution – Final Report

Criteria	Findings
Robustness	
Methodology	• Stated preference methodology – captures preference weights that reflect both use and non-use preferences. • Paired comparison/Discrete choice experiment (DCE) survey in 2013. • Anchored to PR14 main stage study meaning only relative weights required to generate values. • Household interviews mix of online and CATI. Non-household interviews completed via CATI to online
Sampling/ representativeness	• **Household** – 602 interviews (even split between online and CATI) household customer demographics were compared to the 2011 census data to ensure the surveys were representative against age, gender, and socio-economic grouping. Other profiling categories were analysed including education, employment and income. • **Non-household** – 300 interviews. Representative by industry and bill size.
Estimation	• Rigorous approach to statistical analysis of responses. • Analysis completed by economic experts with direct industry experience. • The results produced were a set of relative weights that can be linked to the WTP values from the Main WTP study.
Evaluation	• The design of the questionnaire is consistent with best practice. • The draft questionnaire was tested in cognitive interviews with two groups in both Norwich and Colchester. • Pilot survey included household and non-household samples as part of development. • Focus groups also used to develop the final survey. • Early stages of survey (pilot) established expectations for preferences when analysing validity of results. • Results statistically significant derived using recognised methods. • Peer review input during development and final evaluation positive. • Respondents understanding of attribute descriptions and show cards were high as confirmed by feedback questions following choice experiments. • Results conformed to a priori expectations. • Both scaled and unscaled results were provided. • Preference weights re-tested in the PR19 focus groups – see annex 2.
Relevance	
Definition	PR14 Study and service measures evolved from PR09 as Anglian Water continued to keep pace with developments valuation methods. Definitions mainly aligned with PR19. Change to pollution descriptions – see Anglian Water PR14 WTP survey assessment. The weights from this study are linked to the PR19 values.
Level & range	Levels tested often represented the full range possible, i.e. low quality to good quality. Where the number of pollution incidents were tested this went from 20 down to 1 in a five year period.

Customer base and context	Identical customer base to present with only difference being time so potential differences driven by economic trends.
Age of research	2013 ICS and eftec
Peer review	Professor Ken Willis, University of Newcastle
Other	
Use in triangulation	• Pollution incident – category 1-3 • Fish and other animals: bad to moderate and moderate to good • Plant life: bad to moderate and moderate to good - • Water level and flow: bad to moderate and moderate to good • Overall WFD: bad to moderate and moderate to good Low flow – length of river affected • Litter.
NBs	Study commissioned by AWS

Service Levels (Pollution)

Attribute	Levels
Pollution incident	1. Minor incident (Category 3) 2. Moderate incident (Category 2) 3. Major incident (Category 1)
River quality before the pollution incident (and after recovery)	1. Low quality 2. Medium quality 3. Good quality
Number of incidents over 5 years	1. One incident (1) 2. Three incidents (3) 3. Five incidents (5) 4. Ten incidents (10) 5. Fifteen incidents (15) 6. Twenty incidents (20)
Location	1. Within 15 miles 2. Elsewhere

Service Levels (River Quality)

Attribute	Levels
Location	1. Within 15 miles 2. Elsewhere
Fish and other animal life	1. Low quality 2. Medium quality 3. Good quality
Plant life	1. Low quality 2. Medium quality 3. Good quality
Water levels and flow	1. Low quality 2. Medium quality 3. Good quality

Litter and debris	1. Low quality (lots of litter & debris) 2. Medium quality (some litter & debris) 3. Good quality (no litter & debris)

PR14 – Flooding Second Stage Research

Criteria	Findings
Robustness	
Methodology	• Stated preference methodology – captures preference weights that reflect both use and non-use preferences. • Paired comparison/Discrete choice experiment (DCE) survey in 2013. • Estimation of scalar values for different types, severities and frequencies of flooding and estimation of scalar value of different sewer flooding solutions. • Anchored to PR14 main study. • Online surveys used for both household and non-household.
Sampling/ representativeness	• **Household** – 618 interviews. Household customer demographics were compared to the 2011 census data to ensure the surveys were representative against age, gender, and socio-economic grouping. Other profiling categories were analysed including education, employment and income. • **Non-household** – 300 interviews. Representative by industry and bill size. • Segmentation analysis completed to identify different preferences.
Estimation	• Rigorous approach to statistical analysis of responses. • Analysis completed by economic experts with direct industry experience. • Results are broadly statistically significant providing robust results aligned with a priori expectations. • All the domestic customer flooding coefficients are highly statistically significant, with the exception of frequency of flooding with respect to agricultural land. • For non-domestic customers all the coefficients are highly statistically significant, with the exception of four: (frequency of flooding in a public building, frequency of flooding on agricultural land, AW WTW, and AW STW).
Evaluation	• The design of the questionnaire is consistent with best practice. • A large number of customers were involved in the iterative survey testing phase for the surveys. • This included focus groups, cognitive interviews, and a pilot study completed by 100 household and 100 non-household customers. • Early stages established expectations for preferences when analysing validity of results. • Content validity is confirmed through follow-up questions after choice exercises. • Approach built on PR09 but extended into new areas in more detail making external comparisons harder. • Peer review for this study endorses the weights and results provided. • Preference weights re-tested in the PR19 focus groups – see annex 2.
Relevance	

Definition	PR19 Study and service measures evolved from PR14 creating a high degree of comparability. Consistent with PR19 definitions. The weights from this study are linked to the PR19 values. The PR14 study has provided valuations for flooding, split by: • Water and wastewater flooding • Internal and external • Property types, such as domestic, public buildings, care homes, agriculture, producers, etc. • Severity: loss of facilities, wet patch/seepage, flooding. • Frequency of impact **PART A** - Respondents were presented with the various levels of service failures that occur within a single year. Each respondent answered a series of 8 choice tasks pertaining to one of three blocks randomly selected from an experimental design of 24 choice occasions in total. Each option was described in terms of the type of flooding (water or waste), location (internal or external), property type, severity and frequency. Each choice occasion was composed of 3 flooding scenarios, and respondents had to choose the one they found least acceptable. **PART B** – This extended the format or Part A, but included Anglian Water assets (water and wastewater treatment works) in the choice experiment. A further 3 choice tasks pertaining to one of ten blocks randomly selected from an experimental design of 30 cards was considered introducing Anglian Water assets (water and wastewater treatment works). **PART C** - The options to reduce flooding choice exercises introduce three intervention options (including the basic description of the option and the significance on the environment and local disruption impacts). Respondents then identify options that are acceptable and those that are not. A discrete choice exercise (DCE) was administered in which respondents were presented with a scenario of flooding risk (i.e. properties at risk) and for each option in a random order the impact on their water bill from implementing the option (a random amount varied over different options). Respondents indicated if the option was acceptable or not (yes/no); with no indicating that the solution was not put in place and the flooding risk would continue. Respondents were presented with 6 options (2 for each solution).
Level & range	Within the survey a range of bill increases and service impacts were tested from high frequency events to more exceptional risks such as 1 in 100 year incidents. (See below).
Customer base and context	Study conducted across the Anglian Water region so values reflect the service experienced. Only disposable income changes over time need to be considered. Both household and non-household samples included small subsets of water only customers.
Age of research	2013 ICS and eftec

Peer review	Professor Ken Willis, University of Newcastle
Other	
Use in triangulation	• Waste flooding – internal (number of properties) anchor and all weights • Waste flooding relative to water flooding – internal (number of properties) • Loss of facilities • Waste flooding – external (number of areas) anchor and all weights • Waste flooding relative to water flooding – external (per area)
NBs	Study commissioned by AWS

Service Levels

Part A - Flooding Types

Property Types:

- Household
- Public building
- Care home
- Retailer
- Manufacturer
- Office
- Agriculture
- Public Open Spaces

Location:

- Inside (Internal)
- Outside (External)

Severity of flooding

- Low
- Medium
- High

Frequency:

- Once every year
- Once every other year
- Once every 10 years
- Once every 30 years
- Once every 50 years
- Once every 100 years

Type of flooding

- Water
- Sewer

Constraints: Public Open Spaces can only be associated with Outside/External Flooding. No other constraints.

Part B - Including AW Sites

This is a repeat of the Part A but allows for two extra properties types from water flooding.

Property Types:

- Household
- Public building
- Care home
- Retailer
- Manufacturer
- Office
- Agriculture
- Public Open Spaces
- AW Water Treatment Works
- AW Sewage Treatment Works

Location:

- Inside (Internal)
- Outside (External)

Severity of flooding

- Low
- Medium
- High

Frequency:

- Once every year
- Once every other year
- Once every 10 years
- Once every 30 years
- Once every 50 years
- Once every 100 years

Type of flooding

- Water
- Sewer

Constraints: Each of the cards must contain at least one of the AW sites – this is only associated with 'Inside/Internal' and Severity 'High' and Type 'Water'.

Public Open Spaces continues to be only associated with Outside/External Flooding.

Part C – Flooding Solutions

3 Options:

- Sewer Construction
- Surface water drainage
- Customer Solutions

Each has a description that does not change.

Amount of properties affected:

- 10
- 20
- 50
- 100

Bill amount:

- £5
- £10
- £15
- £25
- £35
- £50

Constraints: Each respondent sees each option multiple times. There are no restrictions on the combinations of options, water bill amount, or number of properties affected by investment.

PR14 Valuation Completion (covering recreational visits to Water Parks, Customer contacts and Noise)

Criteria	Findings
Robustness	
Methodology	• Stated/Revealed preference (Travel cost method) and value transfer. • Values estimated for recreational visits to AWS Water Park sites using visitor survey data and value transfer. • Values estimated for customer contacts using value transfer and AWS data. • Values estimated for changes to noise levels associated with nuisance using value transfer and Defra noise guidance. • Congestion values estimated using a congestion calculator.
Sampling/ representativeness	• Water Park visitor survey sample 1,542 households • Visitor survey incorporated park sites from across the Anglian region • Surveys conducted on different days/time of year • Call data provided from by AWS from 2011/12 and 2012/13
Estimation	• Analysis completed by economic experts with direct industry experience. • Travel Cost Method uses visitor expenditure and location data collected through on-site surveys to estimate the value of recreation facilities provided by Anglian Water. Results incorporated the value of time travelling, travel expenses as well as expenditure on site. • Customer contact estimate is based on AWS customer call data, opportunity cost of time forgone plus call costs. • Noise value transfer uses latest Defra guidance and associated values for noise pollution. Report sets out details of how this guidance has been applied. • Congestion – Based on a methodology published by NERA (1998)[47] for water companies analysing congestion when assessing the impact of leakage investments. The impact is calculated as the total delay for all motorists multiplied by the value of time. The analysis reflects the approach of the Department for Transport. Uses regional DfT data.
Evaluation	• Conservative assumptions such as reduced distances to account for multi-purpose journeys in travel estimates. • Literature used to estimate population effected by typical activities such as generators running for noise nuisance. • Proportionate approach to noise employed as per Defra guidance. • No econometric estimates.
Relevance	
Definition	The PR24 and PR19 service measures evolved from PR14 creating a high degree of comparability. The approach is aligned with the PR24 framework through the AWS 2020 Social Capital project.
Level & range	N/A
Customer base and context	• Visitor survey covered the park sites from across the region. • Customer contact estimate based on average call duration at AWS call centres.

[47] NERA (1998) 'The Environmental and Social Value of Leakage Reduction'. A report for UKWIR.

	• Population densities within noise estimate based on data for the east of England.
Age of research	2012 ICS
Peer review	No peer review
Other	
Use in triangulation	• Input to the AWS 2020 Social capital project which produces values for visits to water parks (as part of the set of amenity values), traffic congestion and noise. • Customer contacts
NBs	Assessment only covers the values used from the report. It does not cover other assumptions. In the PR19 Valuation Completion Main Report the values are updated with latest value information, e.g. updated Defra noise values, fuel prices etc. Study commissioned by AWS

Service Levels

N/A

PR14 industry avertive behaviour study (Eftec ICS, The Household Value for Tap Water: A Revealed Preference Study of Avertive Behaviours – 2013)

Criteria	Findings
Robustness	
Methodology	• Avertive behaviour revealed preference – captures avertive expenditure. Does not cover damage costs, public good or altruism. • National survey conducted obtaining expenditure on avertive behaviours such as buying water filters and bottled water. • Econometric techniques applied to survey data which also included questions on the opinion of tap water at home and motivations for purchases. • Estimated proportion of avertive spend attributable to tap water characteristics including discolouration, hardness and taste.
Sampling/ representativeness	• Values used in PR19 triangulation based on data from the AW region • Nationally 30% of households stated that they used/purchased substitutes due to a dislike of the taste, smell or appearance of tap water. • This subset then drives the values estimated. • 616 respondents came from the Anglian Water region within a national sample of 4,638. • Sample drawn from YouGov's online panel against quotas for age, gender and SEG. • A basic profile for national sample, in terms of respondent gender, age and socio-economic group is presented.

Estimation	• The study was an experimental approach.
	• Study conducted by economic consultants with considerable experience of working in the water industry.
	• The study successfully estimated statistically significant values with respect to:
	  ○ Taste
	  ○ Odour
	  ○ Hardness

Evaluation	• Study conducted with academic rigour with references prevalent. • Study was well received by the regulator Ofwat. • Two separate peer reviewers. • Particularly strong correlation between hardness of tap water and avertive expenditure.
Relevance	
Definition	Service levels were defined to match against the Drinking Water Inspectorate definitions for water quality and aesthetics. Survey targetted general population asking about views on water quality. It did not target customers affected by events.
Level & range	Existing service levels were established through Drinking Water Inspectorate data at Water Resource Zone levels matched to the postcodes of respondents.

Customer base and context	Industry project which provided valuations to each participant based upon from their region. Anglian Water specific values provided. This is relevant given the hardness of the water in the east of England.
Age of research	2013 eftec ICS
Peer review	Prof. Diane Dupont (Brock University, Canada) Prof. Ian Bateman (University of East Anglia, UK)
Other	
Use in triangulation	• Discolouration (number of properties affected) • Taste and Odour (number of properties affected) • Hardwater (number of properties affected)
NBs	

Service Levels

Existing service levels were accounted for through individual postcode information and DWI data.

PR09 Water Services 2nd Stage Study - 2008

Criteria	Findings
Robustness	
Methodology	• Stated preference choice experiment – captures preference weights that reflect both use and non-use preferences. • Contingent valuation (PC-CV, Mid CV, DC-CV) and Discrete Choice Experiment (DCE). • CAPI (Computer Aided Personal Interview) household interviews undertaken.
Sampling/ representativeness	• 400 CAPI interviews. • The sample was broadly representative of the socio-demographic makeup of Anglian Water's customer base. • Customers profiled by SEG, age and income.
Estimation	• Rigorous approach to statistical analysis of responses. • Analysis completed by economic experts with direct industry experience. • Most modelled coefficients statistically significant providing robust results aligned with a priori expectations.
Evaluation	• The design of the questionnaire was consistent with best practice at the time. • Small pilot of 30 respondents used to test survey. • Testing process less detailed due to age of study. • Early stages established expectations for preferences when analysing validity of results. • Sample included extra interviews from areas experiencing boil water notices to capture additional sensitivities and reweight results. • Range of estimation models tested. • Formal econometric analysis is presented within the report confirms the observed choice behaviour across both surveys was consistent with expectations. • Content validity is confirmed through follow-up questions after choice exercises. • Preference weights re-tested in the PR19 focus groups – see annex 2.
Relevance	
Definition	PR09 water services second stage study and service measures close enough to consider within the triangulation process, hence retesting in focus groups in 2017. The weights from this study are linked to the PR19 values. See below for the detailed definitions.
Level & range	See tables below
Customer base and context	Study conducted across the Anglian Water region so values reflect the service experienced.
Age of research	2008 ICS
Peer review	Professor Ken Willis (Newcastle University)
Other	

Use in triangulation	• Boil Water Notice • Do not drink notice • Discolouration (number of properties affected) • Taste and Odour (number of properties affected) • Supply interruptions all durations (weights)
NBs	Study commissioned by AWS

Service Levels

Attribute	Levels
Quality and safety of your tap water supply	0. Your tap water looks perfect and is safe to use in the normal way 1. Your tap water is brown or milky but is safe to use in the normal way 2. Boil your tap water first before drinking, cooking or preparing food until further notice 3. Don't drink, cook or prepare food with water from your tap until further notice 4. Don't use water from your tap until further notice
Interruption to your water supply	0. No interruption 1. Less than 3 hours 2. 3 to 6 hours 3. 6 to 12 hours 4. 12 to 24 hours 5. 24 hours to 4 days 6. 5 to 20 days 7. 3 weeks or more
Warning in advance of the interruption to your water supply	0. No 1. Yes

A1.4 Scoring evidence against the critical questions – Value transfer data

HMT Greenbook Damage costs - 2022

Criteria	Findings
Robustness	
Methodology	• The HMT Green Book provides social damage costs for a number of measures including flood risk.
Sampling/ representativeness	• National values
Estimation	• Detail on calculations not provided but as they are provided by HMT it is reasonable to assume appropriate analysis supports the estimates.
Evaluation	• Highly reputable Government source, providing values specifically for use in policy appraisal.
Relevance	
Definition	• Values are for general flooding not sewer flooding. • Aligns with the Service Measure Framework as flooding per property.
Level & range	Mix of low central and high values available for flooding at different depths.
Customer base and context	National average values.
Age of research	2022
Peer review	The content of the HMT Green Book is peer reviewed by the Government Chief Economists Appraisal Group.
Other	
Use in triangulation	○ Internal water flooding
NBs	

Service Levels

Internal flooding 30cm deep and internal flooding >100cm.

Health and Safety Executive (2022), Costs to Britain of workplace fatalities and self-reported injuries and ill health, 2019/20

Criteria	Findings
Robustness	
Methodology	• Value transfer • CBA values for workplace injuries mapped to service levels. • Provides information on the impacts of workplace accidents so companies can evaluate investment decisions related to the wellbeing of their employees and the wider public. • Translation for RIDDOR specified injury based upon sentencing guidance.
Sampling/ representativeness	• Values from data considered representative for the UK.
Estimation	• Values are comprehensive accounting for harm to individuals as well as private costs. Costs covered are: • 'Financial' costs incurred - either in terms of payments made for services or income/ production that is lost due to injury or ill health. These include productivity costs, health and rehabilitation costs, administration and legal costs, and Employers Liability Compulsory Insurance costs (ELCI). • 'Human' costs – the monetary value of the impact on quality and loss of life of affected workers. This is often the greatest impact of ill health and injury. Estimating these costs in monetary terms allows them to be represented alongside other costs, to give a more complete indicator of the total economic burden of workplace injuries and work-related ill health. • Uses over 70 data sources for costs.
Evaluation	• Definitions align well. • Reliable Government valuation source.
Relevance	
Definition	• HSE 2022 published values cover all service measures with the exception of RIDDOR specified injury value. • RIDDOR specified injury value has been mapped as 10 times more than a RIDDOR >7 day Reportable Injury. This factor is based upon sentencing guidance. • ***Aligns with Service Measure Framework***
Level & range	Based on actual service failures experienced.
Customer base and context	National values
Age of research	2022 (Values are 2020)
Peer review	Government process that has been subject to a series of reviews and challenges.
Other	

Use in triangulation	• H&S (£ per person affected)
	  ○ Minor lost time accident
	  ○ RIDDOR >7 day Reportable Injury
	  ○ Diseases - (eg Hand/arm vibrations, hearing loss etc)
	  ○ RIDDOR Specified Injury
	  ○ Workplace Fatal Accident
	• Lead

NBs	Values provided for human and financial costs. Human costs included in societal values and financial costs included in AWS private costs.

Service Levels

N/A

DWI Long-term Strategies to Reduce Lead Exposure from Drinking Water - 2021

Criteria	Findings
Robustness	

Methodology	• This DWI study looks to extend the work of the previous 1997 research, this time by examining the case for removing lead from drinking water in England and Wales altogether.
	• Covers a in depth review of evidence on the impact of lead exposure.
	• The study finds there is sufficient scientific evidence to quantify the adverse human health effects of chronic low-level exposure to lead. The health impacts of lead exposure are categorised as:
	  ○ impaired neurodevelopment,
	  ○ impaired renal function, and
	  ○ cardiovascular dysfunction.
	• The study values health impacts in terms of lifetime earnings, deaths (mortality) and/or quality of life (morbidity).
	• A series of scenarios are assessed using cost benefit analysis that draws upon data from water companies. The DWI study evaluates the case for removing lead pipes to the property boundary, and also to the tap separately for England and Wales.

Sampling/ representativeness	• Separate analysis for England and Wales. • A number of water companies provided their data, selected to ensure the economic analysis included a mix of the key features that define lead exposure risk from drinking water.
Estimation	• Research is undertaken by experts working together with the water industry. • The benefits of reducing lead exposure in tap water for each of the health end-points are characterised in terms of dose-response relationships between the health measures and BLL (Blood Level in Lead). This draws upon a large body of literature. • Lifetime discounted values are developed to estimate the benefit of health impacts associated with investment responses.
Evaluation	• Highly detailed study, making use of both water company data on lead pipes and the latest literature to evaluate the health risks. • The study acknowledges the uncertainty and difficulty in valuing changes to service levels in this area, however it is unlikely the approach could have been more thorough. • QALY values are used to estimate the benefit of health impacts associated with different investment responses. • Benefit values for programme level change for England and Wales separately.
Relevance	
Definition	Values and dose response relationships are provided for: • Average IQ impairment by age 10 • Decrease in proportion of population with stage 3 Chronic Kidney Disease • Change in mortality risk from Cardiovascular Diseases • Change in pervalance of Hypertension due to Cardiovascular Diseases

Level & range	In the study values from the DWI study are used to estimate the benefit of health impacts associated with different investment responses.
Customer base and context	• All assumptions from the study reflect the national average, not the AWS region.
Age of research	2021
Peer review	No direct peer review of this study. However, study considers presence of peer review within its evidence base drawing on many studies which have been peer reviewed. WRc also conducted modelling to predict the prevalence of lead pipes by housing types in 1998. This modelling was peer reviewed by University of Sheffield and used again within this study on behalf of the DWI.
Other	
Use in triangulation	Information from study used in lead value calculation. Specific data used are: • Values for benefits of reducing lead exposure in tap water for each of the health end-points. • Dose response relationships with the health end-points. Values produced use the DWI data combined with population statistics to better reflect the Anglian Water region Analysis is for a property that has lead in their tap water.
NBs	

Service Levels

Data for change in 1 mg/dL blood lead level.

BEIS valuation of greenhouse gas emissions - 2021

Criteria	Findings
Robustness	
Methodology	• Uses a marginal abatement cost approach. The value of carbon is set at the level that is consistent with the level of marginal abatement costs required to reach the targets that the UK has adopted at a UK and international level.
Sampling/ representativeness	• N/A
Estimation	• Analysis completed by a renowned global consultancy. • Designed to be consistent with both UK and International climate targets. • Informed by internal BEIS modelling as well as international evidence from the Intergovernmental Panel on Climate Change (IPCC)
Evaluation	• Reliable Government valuation source. • Compared to a social cost of carbon approach. Approach used is assessed as more credible as it is more transparent and relies on fewer unobserved factors and uncertain estimates about the damage caused. • Uncertainty is assessed and ranges provided.
Relevance	
Definition	• Marginal abatement cost approach • Values for policy appraisal.
Level & range	Central, upper and lower values are provided from 2020 to 2050.
Customer base and context	All carbon prices are national values applied to local emissions.
Age of research	2021 Department for Business, Energy and Industrial Strategy.
Peer review	Government process that has been subject to a series of reviews and challenges.
Other	
Use in triangulation	• Carbon emission values
NBs	

Defra, Welsh Government, Natural Resources Wales, Environment Agency: A method for monetising the mental health costs of flooding - 2020

Criteria	Findings
Robustness	
Methodology	• Reviewed available data concerning impacts of flooding (in particular the Public Health England study). • Covers the benefits of avoiding the mental health costs of flooding., particularly 'cost of illness' for anxiety, depression and post-traumatic stress disorder. • Cost of illness covers the cost of treatment and days of work lost based on median full-time wage. • Partial value as only covered mental health impacts of flooding. Intended to be added to damage costs. • The quality of life impacts from stress are not evaluated.
Sampling/ representativeness	• Draws upon a wider range of studies • Cost of illness based on a study that examines the future costs of mental health in England from 2008. It looked at the future profile of people by age and gender with mental health conditions to produce a weighted average cost of treatment.
Estimation	• Research conducted by the Flood Hazard Research Centre at Middlesex University. • Developed for use in flood and coastal erosion risk management (FCERM) economic appraisals. • Developed in partnership between Defra, Flood Hazard Research Centre and in light of discussions with Public Health England. • Method uses data from PHE study into the effects of flooding during the 2013 to 2014 floods.
Evaluation	• Reliable Government valuation source. • Focus on flooding only. The research did not consider impacts of coastal erosion. • Physical health impacts have been excluded due to lack of England specific data. • Requires assumptions on the average cost of treatment as severity of the mental health condition not available. Based on probable diagnosis only. • The research does not consider costs to children or animals.
Relevance	
Definition	• The 'cost of illness' includes information on: anxiety, PTSD, and depression. • Cost of internal flooding inside the home per adult per flood event is shown to vary with internal depths. Severities covered are up to 30 cm, to a depth more than 1 m deep. • Estimates provided per person per flood.
Level & range	N/a
Customer base and context	National values.

Age of research	2020 Defra, WAG, NRW and Environment Agency.
Peer review	Government process that has been subject to a series of reviews and challenges.
Other	
Use in triangulation	Value used internal sewer flooding comparison: • Value is adjusted to a per household value and combined with Green Book value for damage costs for water flooding. Value used in dam failure analysis alongside estimates of property replacement and accomodation costs.
NBs	Commissioned by Environment Agency.

Service Levels

Internal flooding 30cm deep and internal flooding >100cm.

Shellfish - Marine Management Organisation, UK Sea Fisheries Statistics 2020

Criteria	Findings
Robustness	
Methodology	• Market data. • The Marine Management Organisation publish statistics on the value and quantity of fish landed in the UK and abroad into ports. • Data shows statistics for different shellfish for different regions
Sampling/ representativeness	• Southern North Sea data covers the AWS region plus Kent
Estimation	• Figures are based on mandatory reporting of first sales of fish
Evaluation	• The introduction of mandatory reporting has been followed by an increase in landings, suggesting accuracy is increasing. • Government source which reports statistics that are highly detailed and matched to fishing quotas.
Relevance	
Definition	• Source provides market values for all shellfish landed from vessels. Does not include shellfish harvested by other means) • ***Aligns with Service Measure Framework***
Level & range	Annual data set.
Customer base and context	Southern North Sea data used as covers the AWS region
Age of research	2020 data
Peer review	Part of the National Statistics All MMO statistics are subject to an assurance process.
NBs	
Other	
Use in triangulation	• Input to the calculation of the Shellfish Water deterioration value
NBs	

Service Levels

N/A

ONS Natural Capital Accounts, Leakage - 2020

Criteria	Findings
Robustness	
Methodology	• The ONS Natural Capital Account provides values for the services provided by nature to the economy. A framework is used to classify and value natural capital and the associated services. These include provisioning services, regulating services and cultural services. • For water abstraction the accounts provide estimates of the volume and value of water abstraction for the UK (excluding groundwater) over a time series. • The "Resource rent" value is the value of raw water abstraction for public water supply. • Accounts have been compiled in line with the guidelines recommended by the United Nations (UN) System of Environmental-Economic Accounting (SEEA) Central Framework and the UN SEEA Experimental Ecosystem Accounting principles.
Sampling/ representativeness	• Based on national data
Estimation	• Analysis undertaken by the ONS. • The abstraction value is based on dividing the average annual monetary flow of resoruce rent over 2013-17 by the physical flow of water. • The resource rent is calculated as the surplus value after all costs and normal returns have been considered.
Evaluation	• The approach is relatively new with the 2020 Accounts classified as experimental statistics. • The Defra ENCA notes that the robustness of the research is under review as in concept this value calculated is the value for the return to the ecosystem not to water treatment. This aligns with the development of societal values separate to private costs. • Conceptually, the approach represents the value of the raw material input to water utilities who then treat the water for public consumption. However, the ONS acknowledge in its methodology guide that as calculated the value does include an element of processing value. This may therefore over estimate the societal value (which due to application in addition to private costs should exclude production costs). • There is also recognition that resource rent methods of valuing raw water abstraction will tend to be influenced by the regulatory price regime.
Relevance	
Definition	Value per Mega litre per day
Level & range	Based on historic data and therefore performance range.
Customer base and context	Values are a national average.
Age of research	2020

Peer review	All outputs from the Office of National Statistics will go though assurance processes. Referenced in the Defra ENCA as the value for leakage using a resource rent approach.
Other	
Use in triangulation	• Leakage
NBs	ONS value is referenced in the Defra ENCA. Analysis commentary based on mix of ONS methodology and Defra ENCA commentary.

Environment Agency 2015 and 2016 winter floods

Criteria	Findings
Robustness	
Methodology	• Estimates the economic costs of winter flooding. • Values for household and non-household properties are based on insurance claim data. Excludes the costs of temporary accommodation. • Value for area flooding of farms on low-lying flood plains focused on production and costs of production.
Sampling/ representativeness	• The study focusses on the areas hit by the flooding of winter 2015/16, primarily the north of England, presenting national figure in cases and regional figures. • National values more relevant to service failure being valued which are used in estimates. • Individual case studies are also included.
Estimation	• Analysis completed by the Environment Agency so data should be reliable. • Costs per hectare based on ADAS research carried out for Defra for the winter 2013 to 2014 floods and supplementary interviews.
Evaluation	• The study comments on the lack of primary data on flood damages, especially for major impact categories such as residential and business properties. • Uncertainty estimates are designed to take account of the availability of primary data. • Compares the findings to the 2007 and 2013 to 2014 floods (see separate summarises for these studies). ○ The scale of the economic damages from the 2015 to 2016 winter floods is considered similar to the 2013 to 2014 winter floods and the 2007 floods are, by some margin, the largest in terms of economic damages of the 3 flood events. • It is noted that business property damages were significantly larger than household property damages for the 2015 to 2016 floods – this is described as a pattern not normally expected.
Relevance	
Definition	General flooding - overland
Level & range	N/a
Customer base and context	Regional values included in study but better information available from out of area so consider values national.
Age of research	2018 EA
Peer review	No peer review
Other	
Use in triangulation	Values for internal water flooding. Compared to internal sewer flooding value.
NBs	

Eftec, Targeting investments to protect and improve natural capital in England - 2016

Criteria	Findings
Robustness	
Methodology	• Values used are market impact assessment based on yield estimates. • The lower and central values are based on average yield estimates from Nix (John Nix Farm Management Pocketbook 2015 http://www.thepocketbook.biz/) following a bottom-up approach. • The higher estimate is based on average yield estimates from Defra (Total Income from Farming 2014 – 1st estimate, United Kingdom, 2015) following a top down approach. • The 'typical' estimates are based on the per hectare value of different types of agricultural land uses contributing to the estimate in proportion to its relative land cover across England.
Sampling/ representativeness	• May be susceptible to variations in agricultural crops grown / changing market conditions.
Estimation	• Well respected economic consultants behind study.
Evaluation	• No information.
Relevance	
Definition	• Agricultural land yield estimates. Based on national land cover.
Level & range	N/A
Customer base and context	Values applicable to England
Age of research	eftec 2016
Peer review	None
Other	
Use in triangulation	Values for water flooding and compared to sewer flooding values for external (per area) Agricultural/Open land.
NBs	

Service Levels

Not available.

Department for Transport, Provision of market research for value of travel time savings and reliability - 2015

Criteria	Findings
Robustness	
Methodology	• Values travel time across several modes of transport. • The approach uses a combination of stated preference research and revealed preference research. • Stated preference research completed through a mixture of telephone interviews and intercept face to face recruitment. • The study allows the value of time to vary by considering a range of journey types - commuting, non-work, employees business and employers business.
Sampling/ representativeness	• National sample, purchased to be broadly geographically representative of England as per 2011 census. • Sample sizes are robust and focus on balancing trip types and duration. • Sample size for car journeys stated preference n = 3,025. • Specific business recruitment adhered to quotas on company size, industry grouping and region.
Estimation	• Rigorous approach to statistical analysis of responses. • Analysis completed by economic experts with relevant experience. • The modelling work carried out to derive the behavioural values made use of state-of-the-art approaches and included a number of innovations compared to existing methodology. • SP experiments offered an abstract choice using 'unlabelled' alternatives (i.e. A vs. B). Where possible, the approach 'pivoted' attribute levels around travellers' current trips. The current trip was identified either through interception of the traveller in the course of a trip, or through telephone interview where the respondent was asked to think back to a recent trip. • The work has produced meaningful behavioural outputs for all estimated models.
Evaluation	• Approach developed over two phases with the input from recognised consultancies. • Government study with peer review. • Experiments evaluated the value of time, time and reliability as well as time and quality. • Revealed preference research was used to validate and challenge the stated preference findings, although this was confined to rail travel. • Study triangulates evidence from multiple sources including previous WTP studies, wage rates, and cost saving approaches. It concludes that the evidence converges to be consistent and justifies recommending the values from the stated preference dataset.
Relevance	
Definition	Value of time lost as a result of delays or changes in journey times.
Level & range	Values available for • Commuting

	• Other non-work travel • Employees' business travel • Employers' business travel
Customer base and context	National study covering domestic and business.
Age of research	2015 Arup, Institute for Transport Studies, Accent, University of Leeds
Peer review	All study reports were reviewed by the Department's Project Board, comprising representatives of key divisions potentially affected by revisions to Value of Travel Time guidance. In addition, the Department commissioned the SYSTRA/Imperial College London/Technical University of Denmark consortium to undertake an independent peer review and audit of the data collection and modelling work.
Other	
Use in triangulation	• Congestion • External flooding of roads • Customer contacts
NBs	

Defra Noise Pollution Economic Analysis - 2014

Criteria	Findings
Robustness	
Methodology	• Values cover quantified impacts on health, wellbeing, productivity and the natural environment. • Health effects cover the impact of noise on heart attacks, strokes and dementia. • Amenity impacts cover sleep disturbance and annoyance.
Sampling/ representativeness	• N/a
Estimation	• Government assessment. Thorough research into the impacts of noise drawing together the latest research available. • Health impacts and annoyance are assessed in DALYs (disability-adjusted life years) and the recommended Department of health monetary value for a QALY is applied. • Productivity cost based on a literature review of the costs due to sleep disturbance.
Evaluation	• Detailed assessment of omitted values and potential for double counting. • Study reviews potential areas missing from the value. These include distraction, fatigue and interruption communication noise. The impact on the natural environment, such as how noise may alter bird breeding patterns, disturb wildlife and damage sensitive ecosystems have not been valued. The effects of night noise, school attainment and other factors such as the value of quiet areas have not been fully quantified.
Relevance	
Definition	Value used as an input to the AWS 2020 Social Captial value project. Study provides values for different decibel levels for road, rail and aircraft and for night time and day time noise. The range of circumstances are relevant to the Anglian Water region. ***Aligns with Service Measure Framework. See 2020 Social Capital Value Study for application.***
Level & range	N/A
Customer base and context	National values
Age of research	2014 Defra
Peer review	No peer review
Other	
Use in triangulation	Noise values (temporary and permanent) – see 2020 Social Capital Value study for application.
NBs	

Service Levels

N/A

Sen, A., Harwood, A. R., Bateman, I. J., Munday, P., Crowe, A., Brander, L., Raychaudhuri, J., Lovett, A. A. Foden J. and Provins, A., Economic Assessment of the Recreational Value of Ecosystems in Great Britain - 2014

Criteria	Findings
Robustness	
Methodology	• Novel methodology for spatial and ecosystem-sensitive estimation of recreational visit numbers and their values across Great Britain. • Using a spatially explicit survey of current recreational behaviour, data are combined with highly detailed information on population characteristics, transport infrastructure and GIS generated measures of the availability of potential substitutes and complements. • Analysis yields a readily transferable model of visit behaviour which is valued using a meta-analysis of the recreation valuation literature.
Sampling/ representativeness	• Trip generation function (TGF) is used to predict the number of trips to different locations. • TGF uses an in-house survey to gather base data. • MENE survey responses for the period from March 2009 to February 2010 (inclusive) were provided to this study amounting to some 48,514 household Interviews covering the entirety of England. • These data contained some 20,374 non-zero visit records to more than 15,000 unique destinations across England. • Postcode information was used to reconcile SEG differences by the application of weights. • Meta-analysis comprised almost 300 relevant valuation studies.
Estimation	• Analysis completed by academic experts and consultants with water industry experience and particular expertise in environmental valuation.
Evaluation	• Definitions align well. • TGF accounts for potential substitutes/complements through incorporated GIS data. • TGF also accounts for distance and potential travel time. • The TGF is then combined with trip valuation meta-analysis model also developed in this study. • This step of the study analyses nearly 300 previous estimates of the value of a recreational visit, examining the determinants of those values which include the influence of the ecosystem type of visited sites. • The two step methodology meets the required economic protocols.
Relevance	
Definition	Study provides a £/visitor value for recreation at freshwater and flood plain, coastal, green belt and urban fringe, grassland and woodland sites • ***Aligns with Service Measure Framework. See 2020 Social Capital Value Study for application.***
Level & range	The value is an average of the values for the habitats considered. Value used exclude the mountains, moors and heathlands value provided as these are not suitable for Anglian Water region.

Customer base and context	National values provided from extensive data and valuation evidence.
Age of research	2014 Sen et al.
Peer review	No peer review
Other	
Use in triangulation	• Amenity
NBs	Not used for AW Water Parks where AWS site values are used.

Service Levels

N/A

National Environment Water Benefits Survey - 2013

Criteria	Findings
Robustness	
Methodology	• Stated preference methodology – captures both use and non-use value. • Discrete Choice Experiment (DCE), Dichotomous Choice Contingent Valuation (DCCV) and Payment Card Contingent Valuation (PCCV). • Covers household customers. • National survey. • Refresh of 2007 study.
Sampling/ representativeness	• 1487 interviews were conducted, lasting an average of 32 minutes in 50 locations across England and Wales. • The analysis sample was weighted to match sample to population by age, sex and region, based on the 2001 UK Census which may not be fully representative today.
Estimation	• It was conducted by economic consultant with extensive experience of working in the water industry. • Some questions raised within peer review, but EA supports the use of the values. The challenge queried the validity of combining Payment Card Contingent Valuation estimates with Dichotomous Choice Contingent Valuation estimates of WTP.
Evaluation	• No information
Relevance	
Definition	The study provides WTP estimates for improvements in water quality on a per km basis which can be scaled upto catchment level improvements. ***Translation within values*** The values were originally given for Low to Medium and Medium to High quality, corresponding to Bad to Poor/Moderate and Poor/Moderate to Good/High. The EA has applied an assumption, however, that the value of an improvement from Bad to Poor is worth two thirds of the Low to Medium value, that the value of an improvement from Poor to Moderate is worth one third of the Low to Medium value plus one third of the Medium to High value, and that the value of an improvement from Moderate to Good is worth two thirds of the Medium to High value.
Level & range	The descriptions on the showcards, and the illustrations on the four water body type example cards used in the study, were informed by a stakeholder survey, close work with a team of EA and WRc scientists, and a series of 12 focus groups involving members of the public. The resulting showcards described the quality of habitats of fish, plants, animals; the clarity of the water, the presence or absence of visible pollution, the flow conditions (for rivers), and the suitability of the water for contact activities. These descriptions were aligned to levels (see section above) and tested against bill impacts from £5 up to £200.
Customer base and context	National environmental values based on stated preference research conducted across England and Wales. Values provided at a catchment level for the Anglian region.

Age of research	2012 Dr Paul J. Metcalfe.
Peer review	Professor Nick Hanley of the University of Stirling, Professor Ståle Navrud of the Norwegian University of Life Sciences and Robin Smale of Vivid Economics.
Other	
Use in triangulation	• River water quality non good to good (anchor) • WFD values
NBs	Values updated in 2012 but study released in 2013. One peer review was supportive but the other two cited some criticisms. On balance the Environment Agency recommends the use of lower bound WTP estimates recognising the need to balance academic rigour against practical solutions[48].

Service Levels

[48] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291464/LIT_8348_42b259.pdf

Attribute[a]	Definition[b]	Levels[c]		
		Current[d,e]	CV	DCE[f,g]
HighL8	Proportion at High quality in Local area at time=8 (in 2015)	9.0%	95%	*HighL0* + 0.75(*MediumL0* - Δ*LowL8*)
			75%	*HighL0* + 0.5(*MediumL0* - Δ*LowL8*)
				HighL0 + 0.25(*MediumL0* - Δ*LowL8*)
				HighL0 + 0.1(*MediumL0* - Δ*LowL8*)
LowL8	Proportion at Low quality in Local area at time=8 (in 2015)	58.6%	0	0
				0.25*LowL0*
				0.5*LowL0*
				0.75*LowL0*
HighN8	Proportion at High quality in National area at time=8 (in 2015)	15.0%	95%	*HighN0* + 0.75(*MediumN0* - Δ*LowN8*)
			75%	*HighN0* + 0.5(*MediumN0* - Δ*LowN8*)
				HighN0 + 0.25(*MediumN0* - Δ*LowN8*)
				HighN0 + 0.1(*MediumN0* - Δ*LowN8*)
LowN8	Proportion at Low quality in National area at time=8 (in 2015)	44.0%	0	0
				0.25*LowN0*
				0.5*LowN0*
				0.75*LowN0*
High20	Proportion at High quality in Local and National areas at time=20 (2027)	As now[h]	95%	95%
				75%
Cost	Permanent increase in water bill and other household payments (£/hh/yr)	N/A	£5	£5
			£10	£10
			£20	£20
			£30	£30
			£50	£50
			£100	£100
			£200	£200

*Notes: **a** The quantities of High, Medium and Low quality always sum to 1, so Medium quality is omitted. **b** "Local area" refers to the area within 30 miles of the location of the respondent's interview and "National area" refers to the whole of England and Wales. **c** All environmental status levels were rounded to the nearest whole percentage point in the choice sets used. **d** Current condition levels shown here are those based on data used for the survey itself, rounded to one decimal place. Data are weighted for age, sex and region based on the 2001 UK Census. Further details on the weights used are available from the authors on request. More recent data may suggest a different picture of current conditions in the water environment. **e** For attributes HighL8 and LowL8, current levels are sample mean values. **f** Terms ending in 0 refer to quality levels at time=0, i.e. current levels. **g** ΔLowL8 ≡ LowL8 -LowL0, and ΔLowN8 ≡ LowN8 -LowN0. **h** Although "As now" was how the survey presented current conditions to respondents, a numeric value was needed to enter this attribute into the DCE choice models. This essentially involved a choice between HighL0 and HighN0. We chose to use HighL0 for statistical reasons.*

The levels of the payment vehicle, Cost, for both the DC and the DCE questions were £5, £10, £20, £30, £50, £100 and £200, per household per year in extra water bills and other household payments.

The amounts shown in the payment card for the PV question ranged from £0 to £1,000.

FHRC and Environment Agency, Flood and Coastal Erosion Risk Management - A Manual for Economic Appraisal - 2013

Criteria	Findings
Robustness	
Methodology	• Values used are Weighted Annual Average Damage costs – does not capture inconvenience or public good values. • Information limited in public arena.
Sampling/ representativeness	• Not applicable.
Estimation	• Primarily based on the damage costs resulting from flooding. • Estimates provided for households and non-households.
Evaluation	• Insufficient information to assess but probably safe to assume reasonable methods applied given regulator involvement.
Relevance	
Definition	Estimates provided per household and per business flooded. Water flooding
Level & range	Not available.
Customer base and context	Values should be treated as national figures.
Age of research	2013 FHRC and EA.
Peer review	None.
Other	
Use in triangulation	• Compared to sewer flooding - internal (number of properties)
NBs	

Service Levels

Not available.

Triantafyyllidou and Edwards - 2012

Criteria	Findings
Robustness	
Methodology	• Triantafyyllidou and Edwards (2012) Lead (Pb) in Tap Water and in Blood: Implications for Lead Exposure in the United States is not an economic paper, but a scientific study. The research summarises the health implications of lead from tap water and other sources. • The research looks at the links between lead exposure and the resulting impact on levels of lead in the blood. • The research also considers the health implications resulting from lead exposure.
Sampling/ representativeness	• Literature review within the article covers a number of earlier US studies. Sample sizes are typically small.
Estimation	• The study informs assumptions made on the health impacts resulting from exposure to lead from tap water. • Health impacts resulting from different levels of exposure are then valued using UK Health and Safety CBA values.
Evaluation	• Well researched academic paper in an area where the volume of literature available is limited (being so niche).
Relevance	
Definition	Definitions in the study align with the quantification of the impacts in the Service Measure Framework.
Level & range	As a US study baseline positions could be different in terms of the physical network properties. However, the study makes assessments based on Blood Lead Levels (BLL) which align to UK measurement.
Customer base and context	Scientific evidence is from the United States.
Age of research	2012
Peer review	No.
Other	
Use in triangulation	• Information from study used in lead value calculation to allocate risk between children and adults within the household.
NBs	

Shellfish - Centre for Environment Fisheries and Aquaculture Science, Aquaculture statistics - 2012

Criteria	Findings
Robustness	
Methodology	• Summarises market data showing the weight and value of aquaculture for each country in the UK.
Sampling/ representativeness	• Data for England • No regional data included. • Underlying sample sizes must be sufficient to meet reporting requirements.
Estimation	• Statistics are collected by the regulatory bodies responsible for authorising aquaculture production businesses as required under aquatic animal health legislation. • In England, statistics are collected by CEFAS
Evaluation	• Government source reports statistics which are very closely monitored to meet EU regulations, so outputs are reliable.
Relevance	
Definition	• Source provides market values for all shellfish harvested from aquaculture. • ***Aligns with Service Measure Framework***
Level & range	Level and range is limited in that market data is for latest year available.
Customer base and context	Data used for England
Age of research	2012 data published in 2015 – latest data available for aquaculture as more recent academic publications still refer back to this.
Peer review	Statistics published produced by a Government source to meet reporting requirements under EC regulations.
NBs	
Other	
Use in triangulation	• Input to the calculation of the Shellfish Water deterioration value • Values shellfish from aquaculture
NBs	

Service Levels

N/A

Holzinger Study for The Wildlife Trusts - 2011

Criteria	Findings
Robustness	
Methodology	• Benefit value transfer is applied through an Ecosystems Services framework to generate values. • Early application of the Ecosystems Services approach to valuation. • Values used for amenity and aesthetic appreciation. • Wetland value uses a value transfer function based on the findings of Brander et al. (2008)[49]. • Woodland value uses a benefit transfer of the findings of Scarpa, R. (2003)[50] which uses a range of contingent valuation studies for recreation benefits.
Sampling/ representativeness	• Values are for Birmingham and the Black Country. Sample sizes within the value transfer vary. • For wetlands studies cover assessment of visitors to 127.7 hectares. The value is based on a meta-analysis involving more than 260 studies. Allows for explanatory factors for study type, ecosystem type, socioeconomic and geographical context. • For woodlands, the met analysis develops a WTP values that vary by distance.

Estimation	• Values are produced by an Environmental Economics consultancy.
	• A conservative approach to value transfer has been applied.
	  ○ For wetland, analysis makes assumptions about access – 30% of wetland is accessible. The value transfer function developed.
	  ○ For woodland, analysis uses the visitor rates for the area sourced through questionnaires.

Evaluation	• Study acknowledges data gaps and estimates are presented as a baseline position, i.e. conservative. • Similarly cautious approach employed to avoid double counting of benefits when applying value transfer.
Relevance	

Definition	• Definitions align with use in triangulation for amenity provided in different sites of woodlands or wetlands.
	• Value used are a subset of the total ecosystem value calculated in the study.
	• Wetland value covers recreation & aesthetical appreciation.
	  ○ Conversion required from the total value to a per hectare value. 50% of the value is used to align with the service measure framework which splits values between visual impact and amenity.
	  ○ Value is based on non-consumptive recreation (i.e. excludes hunting except fishing).

[49] Brander, L. M., A. Ghermandi, O. Kuik, A. Markandya, P. Nunes, M. Schaafsma, and A. Wagtendonk. 2008. Scaling up ecosystem services values - methodology, applicability and a case study.

[50] Willis, Kenneth, Guy Garrod, Riccardo Scarpa, Neil Powe, Andrew Lovett, Ian J. Bateman, Nick Hanley, and Douglas C. Macmillan. 2003. Social & Environmental Benefits of Forestry Phase 2: The Social and Environmental Benefits of Forests in Great Britain. Report to Forestry Commission. Edinburgh: Centre for Research in Environmental Appraisal & Management University of Newcastle. Available from .

	• Woodland value covers recreation. ○ Conversion required from the total value to a per hectare value.
Level & range	Values provided based on green infrastructure in Birmingham and the Black Country at the time of the study.
Customer base and context	Other region – Birmingham and the Black Country.
Age of research	2011 by Consultancy for Environmental Economics and Policy
Peer review	Ian Trueman, Emeritus Professor in Plant Ecology, University of Wolverhampton.
Other	
Use in triangulation	• Used for amenity values - woodland and wetland creation
NBs	See 2020 Social Capital Value Study for application alongside other amenity value literature.

Service level
N/a

Environment Agency, The costs of the summer 2007 floods in England - 2010

Criteria	Findings
Robustness	
Methodology	• Based on damage costs. • Information limited in public arena.
Sampling/ representativeness	• Household sample from three difference sources. Size ranges from 48,000 to 132,000 households • Business sample from three difference sources. Size ranges from 7,300 to 35,000 businesses
Estimation	• Primarily based on the damage costs resulting from flooding. • Estimates provided for households, non-households and agriculture.
Evaluation	• Insufficient information to assess but probably safe to assume reasonable methods applied given regulator involvement. • Insurance claims adjusted for VAT and assessment of the percentage of economic losses covered by insurance.
Relevance	
Definition	Estimates provided per household, per business flooded and per hectare of agricultural land.
Level & range	Not available.
Customer base and context	Values should be treated as national figures.
Age of research	2010 EA
Peer review	None
Other	

Use in triangulation	Values for water flooding and compared to sewer flooding values:
	• Internal (number of properties)
	  ○ Domestic Property (anchor)
	  ○ Non-domestic Property
	• External (number of properties)
	  ○ Agriculture/open land

NBs	

Service Levels

Not available.

Mourato et al. – 2010

Criteria	Findings
Robustness	
Methodology	• Mourato et al use a range of methods to evaluate the cultural services provided by nature. • The value used is taken from the findings for physical and mental health effects from exercise and more passive forms of contact with nature. • Analysis draws on geo-located data from a national survey that estimated the physical functioning and emotional wellbeing associated with use of and proximity to natural spaces.
Sampling/ representativeness	• Generally national approach • Geo-located survey data to estimate the physical and mental health effects associated with UK broad habitats, domestic gardens, managed areas and other natural amenities – large sample size of 1,851
Estimation	• Rigorous approach to statistical analysis of responses. • Analysis completed by academic with extensive experience. • An OLS model is used to estimate changes in physical functioning, emotional wellbeing and health utility, explained by time in green spaces. The model has controls for factors such as age and income. • QALYs are used to evaluate changes linked to use of green spaces of varying types. • Found strong positive relationships between green views from the home and emotional wellbeing and health utility; and between regular use of gardens and green spaces and all three health measures.
Evaluation	• Range of approaches employed, tailored to make best use of available evidence. • Review of evidence presents values for more passive forms of contact with nature. • A more direct link with health benefits from exercise due to provision of the green space was not found to be robust.
Relevance	
Definition	Health benefits for contact with nature used.

Level & range	• Having a view over green space from your house
	  ○ No view to any view
	• Use of own garden
	  ○ Less than weekly to weekly or more
	• Use of non-countryside green space
	  ○ Less than monthly to monthly or more

Customer base and context	National values
Age of research	2010
Peer review	None
Other	
Use in triangulation	• Used for amenity values – green space

NBs	See 2020 Social Capital Value Study for application alongside other amenity value literature.

A1.5 Scoring evidence against the critical questions – Other company studies

This section provides details for the other company studies and sources where information is available. These studies are part of the secondary evidence that is used in the Value Triangulation Report.

HMT Greenbook/Defra ENCA Water company WRMPs - 2021

Criteria	Findings
Robustness	
Methodology	• Value transfer of average incremental social cost of producing an additional 1 million litres / day for public consumption. • Economic cost (including environmental and social costs) of replacing a marginal mega litre of water. • Based on companies 2014 Water Resource Management Plans.
Sampling/ representativeness	• Values from water companies across England and Wales. • Companies vary in water scarcity as well as other characteristics (e.g. income).
Estimation	• Value provided is the marginal value for reducing leakage.
Evaluation	• Opportunity cost as opposed to demand-based value reducing the robustness of the values. • Highly reputable Government source, providing values specifically for use in policy appraisal.
Relevance	
Definition	• Definition aligned. • Values for Megalitre per day.
Level & range	• Based on WRMP 2014 therefore relevant to the change in performance from those plans.
Customer base and context	National value meaning differences to the socio-economic profile compared to Anglian Water region.
Age of research	Latest HMT Greenbook refers back to PR14 WRMPs.
Peer review	The content of the HMT Green Book is peer reviewed by the Government Chief Economists Appraisal Group.
Other	
Use in triangulation	• Leakage
NBs	

Service Levels

N/a.

Comparative review of PR19 WTP results, Accent and PJM Economics - 2018

Criteria	Findings
Robustness	
Methodology	• Study collating and comparing values from thirteen water companies' PR19 WTP research. Values from eleven companies are presented. • Large number of stated preference valuations included. • Source company kept anonymous.
Sampling/ representativeness	• Various. • All studies likely to include quotas for SEG, gender and age based upon regional demography. • Several companies submitted more than one set of results, covering different parts of their overall supply area and/or obtaining results via a different methodology. • Sample modes and sizes provided for each study showing generally robust sample sizes.

Estimation	• Consultants have converted the values to common definitions for some measures e.g. leakage.
	• Additional transformations have been applied to the values to show household and non-household values, and values from different sub-company areas, on a 'standardised' basis.
	  ○ This recognises that studies have used broadly two different approaches to presenting changes to service when deriving results for household and non-household customers (Approaches lead to results that either: a) sum to the total value for the whole company; or b) results where total is a weighted average of the values for different customer groups).
	  ○ To show values on as comparable basis as possible, the consultants have chosen to present all values such that the weighted average of sub-company groups is equal to the total value.
	• Report has not attempted to explain the causes of the differences in values.

Evaluation	• Not possible to independently assess validity testing etc. so in part reliant on the judgement of consultant executing the meta study. • Researchers found that the design and analysis methodologies used for the studies have diverged in comparison to the situation at PR14 where most companies had followed the UKWIR (2011) methodology. • A general issue identified as affecting WTP values is whether or not values have been 'package scaled'. The consultants clearly identify the studies this affects and makes this clear in the report.
Relevance	
Definition	Various. See report.
Level & range	There are multiple values from this study.
Customer base and context	Various. Mix of scaled and unscaled values identified in the study.

	Research identifies methodology
Age of research	Accent meta study conducted in 2018 but primary research likely to have been conducted in 2017 or 2018. . Five of the companies' PR19 studies were conducted by Accent and PJM
Peer review	Involvement from participating companies.
Other	
Use in triangulation	• Unexpected interruption values for 9 companies • Discolouration for 8 companies • Occasional pressure for 1 company • Persistent pressure for 3 companies • T&O for 9 companies • Rota cuts • Hosepipe for 8 companies • Leakage for 7 companies • Internal flooding for 7 companies • External flooding for 6 companies • Pollution for 7 companies for minor pollution • 2 for significant pollution • River water quality for 8 companies • Bathing waters values for 4 companies from good to excellent or to excellent
NBs	ICS has sought to identify the company for each source using publicly available information, e.g. published research reports and/or summaries.

Service Levels

See original studies for details where available.

Water UK Water Resources Long Term Planning Framework - 2016

Criteria	Findings
Robustness	
Methodology	• Study combining stated preference values for water resources. • Covers Temporary Use Bans (TUBs) and severe water restrictions. • Study uses information from outside of the public domain with the agreement of water companies but does not show direct sources so there are some limitations for analysis.
Sampling/ representativeness	• Sample sizes range from 302 to 1,101 for the values included within the recommended range of values for the measures considered above. • The range for TUB is based on 7 studies. • The range for severe water restrictions is based on 9 studies. • This should be sufficient for this type of study.
Estimation	• Study conducted by recognised economic consultancy with industry experience. • The study presents a range of stated preference values from across the water industry but crucially only includes those with comparable definitions in its valuation summaries. • The researchers had direct contact with the companies values being analysed making them well informed to make these judgements.
Evaluation	• Insufficient information to assess but probably safe to assume only robust results would be included.
Relevance	
Definition	Exact definitions not available but only compatible definitions were included within the valuation ranges selected.
Level & range	Not available.
Customer base and context	Values should be treated as national figures coming from a range of water companies. As such water stress and likelihood of restrictions could differ which would be reflected in values contained in the meta estimates.
Age of research	2016 NERA
Peer review	None
Other	
Use in triangulation	• Hosepipe ban / Temporary Use Ban HH only • Rota cuts and standpipes HH only
NBs	

Service Levels

Not available.

Accent, Study of PR14 Values - 2015

Criteria	Findings
Robustness	
Methodology	• Study collating and comparing values from a number of water companies' PR14 WTP research. • Large number of stated preference valuations included. • Source company kept anonymous.
Sampling/ representativeness	• Various. • All studies likely to include quotas for SEG, gender and age based upon regional demography. • This may vary from Anglian Water region without being able to identify in which direction.
Estimation	• Values selected checked to ensure they were statistically significant.
Evaluation	• Not possible to independently assess validity testing etc. so in part reliant on the judgement of consultant executing the meta study. • Large number of studies will have followed UKWIR valuation guidance.
Relevance	
Definition	Various. See report.
Level & range	There are multiple values from this study.
Customer base and context	Various. Expected to be a mix of scaled and unscaled values and the exact method is not reported. This has been inferred from the knowledge of the methodologies used by different researchers.
Age of research	Accent meta study conducted after PR14 but primary research likely to have been conducted in 2012 or 2013.
Peer review	Involvement from participating companies.
Other	
Use in triangulation	Average values used for comparison in secondary source evidence: • Supply interruptions (6-12 hours) (anchor) HH & NHH • Supply interruptions 3-6 hours • Persistent low pressure • Discolouration (number of properties affected) • Taste and Odour (number of properties affected) • Leakage • Waste flooding – internal (number of properties) • Waste flooding – external (number of areas) • Odour and Flied nuisance (number of properties) (persistent) • Pollution incident – category 1-3 • River water quality non good to good (anchor) • Bathing water, site good to excellent status (anchor) • Customer contact (£ per person) (Repeat/general contacts)
NBs	

Service Levels

See original studies for details where available.

Appendix 2: Mapping customer values

This appendix provides additional details for the approach to mapping customer values to indirect service measures that are not valued directly by customers.

A2.1 Lead in drinking water

The Anglian Water service measure framework includes the impact of lead in drinking water.

Customers can be exposed to lead in drinking water as a result of water travelling through lead pipes within the water company network, and pipes owned by the customer up to the recognised sampling point, typically the kitchen tap.

Our primary source for health impacts and valuations data is the DWI (2021)[51] study on the impacts of lead exposure.

OVERVIEW OF APPROACH

Our approach assesses the health impacts of lead exposure via tap water and values the resulting impacts.

The DWI study outlines three main health impacts of lead exposure and the associated approach to measure the health end-points. These are set out in the table below:

Table A2.1: Health impacts of lead exposure and end-point measure

Health impact	Health end point measure
Impaired neurodevelopment	• Intelligence Quotient (IQ) at age 10
Impaired renal function	• Prevalence of Stage 3 or worse Chronic Kidney Disease (CKD) (defined as an eGFR < 60ml/min)
Cardiovascular dysfunction	• Prevalence of: c) hypertension (defined as measured by Systolic Blood Pressure (SBP) ≥ 140mmHg at rest) d) mortality due to Cardiovascular Diseases (CVD), defined in terms of lost life expectancy

The benefits of reducing lead exposure in tap water for each of the health end-points is characterised in terms of dose-response relationships between the health measures and Blood Lead Level (BLL).

These dose-response relationships are of varying complexity as described in DWI (2021) and is not possible to replicate the modelling undertaken by WRC.

Where possible we have extracted simplified dose-response relationships to allow the calculation of an overall benefit £ per property from reduced lead exposure in tap water. The key assumption made

[51] DWI (2021) Long-term Strategies to Reduce Lead Exposure from Drinking Water, Report Reference DWI1372.2, 26 January 2021

in these simplified relationships is that they represent the incremental impact on the end-point measure for a 1 mg/dL reduction in BLL.

This means that the benefit values below are defined as £ per property per 1 unit reduction in BLL.

We use a five-step approach to calculate the benefit value for the service measure framework:

- Step 1: Collate data on likelihood (proportions) of health impacts from drinking tap water containing lead.
- Step 2: Collate Population Data including the prevalence of health end points.
- Step 3: Collate Dose-response relationships for each health-endpoint.
- Step 4: Calculate health impacts of reducing in lead in drinking water
- Step 5: Calculating the benefit values for reduction in health impacts
-

STEP 1: DATA ON LIKELIHOOD (PROPORTIONS) OF HEALTH IMPACTS FROM DRINKING TAP WATER CONTAINING LEAD

Step 1 involves setting assumption for the proportion of customers who will experience negative health impacts following exposure to tap water containing lead.

The DWI (2021) report that both the World Health Organisation and the European Food Safety Authority concluded there is no lower level of lead in tap water which cannot cause harm to humans. Triantafyllidou, S. and Edwards, M. (2012) agreed with this finding stating that "emerging clinical evidence is therefore strongly reinforcing the notion that no safe level of lead exposure exists"[52].

This establishes that all lower bound estimates of the likelihood of health effects must be greater than zero.

Children are more likely to develop health problems from drinking tap water containing lead due to their neurological development being incomplete, making them more likely to have their IQ impaired as a result.

We have adopted the assumptions in the table below to quantify the proportion of the population experiencing health impacts.

Table A2.2: Proportion of population exposed to lead in tap water developing health impacts

Impact	Lower bound	Upper bound
Adults that develop health effects, %	5%	20%
Children that develop health effects	10%	50%

Source: Willis, K.G (2012): Valuing health benefits from reductions in the lead content of tap water: a value transfer analysis. Report for Yorkshire Water

[52] Triantafyllidou, S. and Edwards, M. (2012): Lead (Pb) in Tap Water and in Blood: Implications for Lead Exposure in the United States, Critical Reviews in Environmental Science and Technology, 42:13, 1297-1352.

STEP 2: COLLATE POPULATION DATA INCLUDING THE PREVALENCE OF HEALTH END POINTS

Step 2a: Anglian Water Population Data

Step 2a collates information on the Anglian Water population. We use this to calculate the impacted population for 1,000 properties[53]. All figures are for the East of England taken from or calculated from the 2021 census.

Table A2.3: Anglian Water population assumptions

Assumptions		Source
Average occupancy per household	2.41	Families and households from 2021 Census, March 2022. Table 5, Households by size, average occupancy for the East of England
Proportion of population under 16 - calculated	18.73%	Calculation based on 2021 Census for East of England - ts009
Proportion of under 16 population that is up to 10 years old	68.12%	Calculation based on 2021 Census for East of England - ts009
Adult population (%)	81.27%	Calculation based on proportion of population under 16.
% of Adult Population = Male	48.53%	Calculation based on 2021 Census for East of England - ts009

The table below calculates the number of people in each category for 1,000 properties in the Anglian Water region, using the above assumptions. 1,000 properties are equivalent to 2,410 people based upon an average occupancy of 2.41 people per property.

This population of 2,410 is then apportioned by age to the categories using the population assumptions. For instance, for every 1,000 properties, it is estimated that there are 1,959 adults.

Table A2.4: Numbers of adults and children per 1,000 properties

Category at risk	Number
Properties	1,000
People	2,410
Adults	1,959
Children up to 10	308
Children up to 16	451

[53] 1,000 properties are used to scale up the impacts for presentation purposes. The final value is divided by 1,000 to remove this effect.

Step 2B: Health end-points population data

Step 2B sets out the prevalence of health end-points as a baseline position prior to any potential intervention, i.e. to what extent are adverse health impacts experienced by Anglian Water customers for the conditions outlined in the DWI study (2021) where lead in drinking water is a contributing factor.

Data for the health baseline is based on a mix of regional and national publications, split by gender. This is to recognise the significant differences between the sexes in the prevalence of the different health conditions.

Table A2.5: Health baseline position

Health Impact	%	Source and notes
Proportions of Adult Populations with at least Stage 3 CKD		
Male	4.7%	Public Health England, 2014. Chronic kidney disease prevalence model. Figure for England. [54]
Female	7%	
Prevalence of CVD Diagnosis in Adult Population, Aged 35 and over		
Male	22.48%	NHS Digital Health Survey for England 2017. East Region, Table 3. [55]
Female	18.35%	
Prevalence of Hypertension in Adult Population		
Overall	14.40%[56]	Office for Health Improvement & Disparities, Public health profiles, Data for East Region, 2021/22
Male	17.28%	Statista, Distribution of hypertension categories in England in 2019, by gender. All with Hypertension[57]
Female	12.00%	

STEP 3: COLLATE DOSE-RESPONSE RELATIONSHIPS FOR EACH HEALTH ENDPOINT

Step 3 establishes the dose-response relationships for each health endpoint. The consequences of a 1 mg/dL BLL change are taken from the DWI 2021 study.

Changes in the cardio vascular disease mortality risk are weighted across populations with high, medium and low vulnerability to give a reduction in mortality risk of -0.15% per 1 mg/dL BLL reduction.

It was not possible to identify from the details in DWI (2021) in the resulting change in the prevalence of Hypertension (SPB > 140mmHG) per 1 mg/dL BLL reduction. We have therefore assumed a similar reduction risk as used for mortality.

54 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/612303/ChronickidneydiseaseCKDprevalencemodelbriefing.pdf

55 https://digital.nhs.uk/data-and-information/publications/statistical/health-survey-for-england/2017

56 Public health profiles - OHID (phe.org.uk)

57 https://www.statista.com/statistics/376077/hypertension-categories-by-gender-in-england/

Table A2.6: Dose-response relationships for each health endpoint

Category of Heath Impact	Number
IQ: Average Impairment (points) by Age 10 associated with 1 mg/dL BLL	-3
Renal: Decrease in Proportion of Population with Stage 3 CKD per 1 mg/dL BLL reduction	-6.25%
CVD: Change in Mortality Risk per 1 mg/dL BLL reduction	-0.15%
CVD: Change in prevalence of Hypertension (SPB > 140mmHG) per 1 mg/dL BLL reduction	-0.15%

STEP 4: CALCULATE HEALTH IMPACTS OF REDUCING IN LEAD IN DRINKING WATER

Step 4a: Baseline health impacts per 1000 properties from drinking tap water containing lead

Step 4a combines the data from Step 1, and Step 2 to estimate the health impacts per 1,000 properties from drinking tap water containing lead currently.

For example, the lower bound number of adults that are estimated to develop health effects is calculated as the number of adults per 1,000 properties (1,959) multiplied by the lower bound % of adults which become ill (5%) = 97.9.

The number of people in the major illness categories are calculated by applying the relevant gender proportion from Step 2a and health end-points baseline proportion from Step 2b.

The number of adults experiencing minor illness per 1,000 properties is calculated as the difference between the overall incidence of health impacts less the major adult illness categories.

Table A2.7: Estimated health impacts per 1,000 properties

Impact	Lower bound (Number of people)	Upper bound (Number of people)
Adults that develop health effects	97.9	391.7
Major Illness		
Renal: Male	2.2	8.9
Renal: Female	3.7	14.9
CVD: Male	10.7	42.7
CVD: Female	9.2	37.0
Hypertension: Male	8.2	32.9
Hypertension: Female	6.0	24.2
Minor illness	57.8	231.1
Children that develop health effects:	30.8	153.8

Step 4B: Calculate total reduction in health impacts for affected populations per 1000 properties

Step 4b multiplies the relevant data from Step 3 and Step 4a to produce the total reductions in health impacts across the affected population per 1000 properties on the basis of a 1 mg/dL BLL reduction.

Major and minor illness reductions are number of cases, and children developing health effects are shown as the resulting change in number of IQ points.

Table A2.8: Reductions in health impacts for per 1000 properties

Impact	Lower bound (Number)	Upper bound (Number)
Adults that develop health effects		
Major Illness		
Renal: Male	-0.14	-0.56
Renal: Female	-0.23	-0.93
CVD: Male	-0.02	-0.06
CVD: Female	-0.01	-0.06
Hypertension: Male	-0.01	-0.05
Hypertension: Female	-0.01	-0.04
Minor illness	-58	-231
Children that develop health effects		
Reduction in Total IQ Impairment by Age 10	-92	-461

STEP 5: CALCULATING THE BENEFIT VALUES FOR REDUCTION IN HEALTH IMPACTS

Step 5a: Source benefit values for serious illness / minor illness

Step 5A involves selecting benefit values to be used to evaluate the impact of the health effects alleviated from a 1 mg/dL BLL reduction. The values in the table below have all been sourced from the DWI (2021) with the exception of "Minor lost time accident - Ill health up to 6 days" which is taken from the HSE (2020) appraisal values.

All values have been uplifted to September 2022 prices using CPI.

Table A2.9: Benefit values for serious illness / minor illness

Impact category	Unit	Price Base	Unit Value £	Sept 2022 prices
Adults that develop health effects				
Value of Avoided CKD (QUALY for move from Stage 3 to 2)				
Male	£ per case	Assumed to be 2020/21 prices	£40,800	£46,297
Female	£ per case	Assumed to be 2020/21 prices	£63,200	£71,715
Value of Avoided Hypertension Prevalence				
Male	£ per case	Assumed to be 2020/21 prices	£2,918	£3,311
Female	£ per case	Assumed to be 2020/21 prices	£2,020	£2,292
Value of Avoided CVD Mortality				
Male	£ per case	Assumed to be 2020/21 prices	£264,000	£299,571
Female	£ per case	Assumed to be 2020/21 prices	£153,000	£173,615
Minor ill health up to 6 days	£ per case	2020 prices	£970	£1,105
Children that develop health effects				
Lifetime Earnings Reduction from Total IQ Impairment by Age 10	£ per IQ point	Assumed to be 2020/21 prices	£10,293	£11,680

Sources: DWI (2021): Long-term Strategies to Reduce Lead Exposure from Drinking Water, Report Reference DWI1372.2, 26 January 2021. HSE (2020): Appraisal values or 'unit costs', full cost to society[58].

[58] The minor illness value applied is different to the main triangulated Health and Safety value which covers the human cost only due to the financial cost being captured in AWS private costs. The full value is applied in this calculation as the impacts are indirect and will not be covered in the AWS private cost

STEP 5B: BENEFIT VALUES PER 1000 PROPERTIES FOR A REDUCTION OF LEAD IN DRINKING WATER

Step 5B multiplies the unit values in Step 5a by the reductions in health impacts for per 1000 properties from Step 4b to calculate the total value of the reduction.

For example, the lower bound value for Avoided CKD at 1,000 properties is calculated by multiplying the respective values for males and females from Step 5b by the lower bound number of male and female renal cases removed in Step 4b, then aggregated to give a value of £23,180.

The values for all the impacts are then aggregated to estimate the lower bound and upper bound values of a 1 mg/dL BLL reduction for 1,000 properties.

The upper and lower bound values for a 1,000 properties are then divided by 1,000 to give per property values.

Upper and lower values are averaged to give a central value per property.

Table A2.10: Valuations per unit (Sept 22 prices) per 1000 properties

Impact Category	Lower bound, £	Upper bound, £	Central Average, £
Adult health effects:			
Avoided CKD	£23,180	£92,720	
Avoided Hypertension	£62	£246	
Avoided CVD Mortality	£7,208	£28,833	
Minor illness	£63,825	£255,298	
Child health effects			
Avoided IQ Impairment	£1,077,687	£5,388,435	
Total for 1,000 properties	£1,171,961	£5,765,532	
Total value per 1 property	**£1,172**	**£5,766**	**£3,469**

Final summary of values

Below is the final summary of values, presented as both full benefit values over the life time of the population and the annualised benefit values (which accounts for discounting and time preference).

Table A2.11: Final benefit unit values

Impact Category	Lower bound, £	Central average, £	Upper bound, £
Full value	£1,172	£3,469	£5,766
Annualised	£53	£156	£260

Other benefits outside of this valuation

The values above are built upon the alleviation of harms to human health from the reduction of lead in drinking water.

There are however other benefits outlined in the DWI study. It is assumed that these will be captured by the wider service measure framework or through the cost implications of interventions.

Benefits identified by the DWI 2021 study include:

- Reduction in leakage.
- Carbon costs and benefits associated with investments
- Cost savings due to the removal of the need for phosphate dosing
- Income from the scrap value of lead recovered.

A2.2 Civic centre multiplier

In order to understand the impact of events on other property types within the AWS Service Measure Framework, a multiplier is used to translate between impacts on households and impacts on significant civic centres. Civic centres are defined as schools, hospitals and prisons and care homes in the region.

The approach uses a four-step process:

- Step 1: Estimate the population per site type (e.g. by school, prison, etc)
- Step 2: Adjust population estimates for time
- Step 3: Weight the population estimates by the number of facilities
- Step 4: Calculate the final multiplier to convert between households and civic centres

STEP 1 – ESTIMATE THE POPULATION PER SITE

Step 1 involved estimating the average population per site for each organisation type for the region. To maintain a proportionate approach, data for England has been sought and the Anglian Water region is assumed to be no different to the national average.

This results in the estimates below.

Table A2.12: Estimated average population by site

	Average population per site
Schools	408
Hospitals	2996
Prisons	721
Care homes	35

Inputs and calculations for the average population per site are set out as follows.

School population

School population in Step 1 is the headcount for all pupils, plus the FTE of all workforce in England divided by the number of schools in England.

Table A2.13: School population inputs

Inputs	Number	Year	Source
Headcount of all pupils in state-funded nursery, primary, secondary and special schools, non-maintained special schools, pupil referral units, general hospital schools and independent schools at January 2022 in England	9,000,031	2022	Schools, pupils and their characteristics, Academic Year 2021/22 – Explore education statistics – GOV.UK (explore-education-statistics.service.gov.uk)
Number of schools in England	24,454	2022	Schools, pupils and their characteristics, Academic Year 2021/22 – Explore education statistics – GOV.UK (explore-education-statistics.service.gov.uk)
FTE of all workforce in England	968,079	2021	School workforce in England, Reporting Year 2021 – Explore education statistics – GOV.UK (explore-education-statistics.service.gov.uk)

Hospital population

The population of an average hospital is calculated using the inputs below. 76% of the number of beds are divided by the number of hospitals to estimate the number of patients in an average hospital. This assumes 24% headroom within a hospital.

This is then combined with the number of staff in a single example hospital, scaled back to 25% to allow for shifts or holiday.

Table A2.14: Hospital population inputs

Inputs	Number	Year	Source
Number of hospitals in England	854	2022	Hospital Facts | How many hospital beds in the UK | Interweave Healthcare (interweavetextiles.com)
Number of hospital beds in England	135574	2022	Hospital Facts | How many hospital beds in the UK | Interweave Healthcare (interweavetextiles.com)
Number of staff in a hospital	11500	2021	Overview - Southampton General Hospital - NHS (www.nhs.uk)
Number of staff in a hospital - adjusted	2875	2021	N/A - Assumes 25%[59] in at any one time to account for shifts and holiday

[59] Based on 168 hours in a week and a working week of 40 hours.

Prison population

The average number of prisoners is calculated from government prison population statistics. This is then combined with the average number of prison staff, which are scaled back to 25% in at any one time to account for shifts and holiday.

Table A2.15: Prison population inputs

Inputs	Number	Year	Source
Average number of prisoners	670	2022	Prison population figures: 2021 - GOV.UK (www.gov.uk)
Total number of prison staff	23,746	2015	Fewer prison officers and more assaults: how UK prison staffing has changed | Prisons and probation | The Guardian
Average number of prison staff per prison	201	N/A	Calculated from prison population statistics cited above.
Average number of prison staff per prison adjusted	50	N/A	N/A - Assumes 25% in at any one time to account for shifts and holiday

Care homes

The average population of a care home is based on the total number of residents in England care homes, combined with the adjusted number of staff, divided by the total number of care homes in England. Staffing numbers are assumed to be 25% of the workforce to account for shifts and holidays.

Table A2.16: Care home population inputs

Inputs	Number	Year	Source
Total number of residents in England	360,792	2022	Care home stats: number of settings, population & workforce - carehome.co.uk advice
Total number of care homes in England	14,535	2022	Care home stats: number of settings, population & workforce - carehome.co.uk advice
Total care home workforce in England	595,000	2022	Care home stats: number of settings, population & workforce - carehome.co.uk advice
Estimated care home workforce in England on site at any one time	148,750	N/A	N/A - Assumes 25% in at any one time to account for shifts and holiday
Average population on site	35	N/A	

STEP 2 – ADJUST POPULATION ESTIMATES FOR TIME

In step two the population estimates for schools are scaled back to 20.3% of their original amount. This scaling factor accounts for 13 weeks where schools are closed and an assumed 17.5 hours per day

when a school would be closed. During these times the population impacted by an event would be zero.

This results in the estimates below.

Table A2.17: Estimated average population by site adjusted

Civic centre type	Average population per site
Schools	83
Hospitals	2996
Prisons	721
Care homes	35

STEP 3 - WEIGHT POPULATION ESTIMATES BY THE NUMBER OF FACILITIES

The likelihood of a civic centre experiencing a service failure increases with the number of sites, which varies by civic centre type. To account for this, we have weighted the population estimates for an average school, hospital, prison and care home by the number of sites for the combined total. This in effect increases the importance of schools and care homes within the combined figures.

This is shown in the table below.

Table A2.18: Weighting population by number of sites

Civic centre type	Count of facilities	Weighting by site nr	Weighted population
Schools	24,454	61%	51
Hospitals	854	2%	64
Prisons	118	0%	2
Care homes	14,535	36%	13

STEP 4 - CALCULATE THE FINAL MULTIPLIER TO CONVERT BETWEEN HOUSEHOLDS AND CIVIC CENTRES

The final step averages the weighted populations in Step 3 to produce an average population per civic centre of 32.

This is divided by the average population of a household (2.41) to produce a multiplier of 13.4. Meaning the impact of an event on a civic centre is equivalent to the same impact on 13.4 households in the Anglian Water region.

A2.3 Discharge compliance

The service measures relating to discharge compliance are valued within the SMF using the triangulated customer values for pollution incidents. Following discussion with AWS it was agreed that pollution incident categories are the best representation of the environmental impact of non-compliance incidents.

To understand how the discharge compliance values should be derived, we have analysed AWS Pollution Data and the AWS Compliance Classification Scheme (CCS) data. The CCS data is submitted to the Environment Agency.

The aims of the analysis are to evaluate:

- the proportion of Category 1, Category 2, Category 3 and Category 4 incidents that resulted from the different compliance measures; and
- to assess the likelihood that a compliance failure would have an impact.

This information is then applied to the customer pollution values already in the SMF to derive a set of discharge compliance values.

WRC QUALITY AND VOLUMETRIC COMPLIANCE

Step 1: Review of CCS incidents

The initial assessment of AWS supplied historic data covers 9 years of CCS incidents from 2013 to 2021. For WRCs and Storm tanks we have categorised each entry into one of the following reasons:

- Final effluent failure
- Dry Weather Flow (DWF) failure
- Storm overflow compliance
- Bathing waters
- Not applicable e.g. monitoring, signage or descriptive consent

Using the reason for classification, final effluent failures are further categorised into whether the report relates to a single sample fail (OSM), last sample fail or failing works (including upper tiers).

This categorisation is used to analyse all relevant entries against the allocated incident classification (e.g. category 1, 2, 3 or 4) to provide a profile of pollution categories against failure type (sample, failing works, Dry Weather Flow).

The results of this categorisation analysis are presented below.

Table A2.19: Proportion of failures by pollution category

Failure type	Pollution category (%)			
	Category 1	Category 2	Category 3	Category 4
OSM & Last sample	0%	34%	63%	3%
Failing works	7%	74%	14%	5%
Dry Weather Flow	0%	38%	59%	3%
Flow to Full Treatment	6%	53%	41%	0%

Step 2: Review of pollution category data

We have assessed 10 years of pollution data supplied by AWS. The data has been checked for trends across the time period and analysed for links to works compliance failures.

The level of detail available within the pollution database limited the analysis to a cross check on the outputs of the CCS analysis.

Step 3: Final methodology for compliance values

Although the CCS database is a smaller dataset, the data could be consistently assessed at failure type level. Consequently, this data set is used for valuation purposes with the pollution category data as an additional check.

The CCS split by failure type and pollution category in the table above is used to determine the maximum value for each failure type using proportions for pollution categories 1 to 4.

These maximum values are then adjusted (using a scalar) to better reflect the likely environmental impact of all compliance failures. This approach recognises that the CCS dataset is a subset of all compliance failures and so it is reasonable to assume that breaches that are not recorded may not always have the same impact.

The approach for each area of the SMF is set out below:

WRC quality compliance

The category weightings based on CCS data assessment are used to calculate the values for a failing works and the OSM/last sample failure.

The scalar assumptions and mapping to the service measure categories are set out in the table below. Key assumptions underpinning the rationale are that:

- Look up table (LUT) compliance is theoretically designed to achieve c.95% compliance/5% non-compliance over a 12-month period. This can range to c.8-10% depending on the number of samples taken.
- A failing works is non-compliant for 25% time over one year (3 samples of 12 is 25%, 4 samples of 24 is 16% but range may be higher as number of failed samples to breach consent is minimum not maximum).

Table A2.20: Final benefit unit values

Failure type	Scalar	Approach to setting the scalar
Measuring Point Failure	4%	Set to one fifth of the OSM sample fail scalar. Based on the assumption that 1 in 5 measuring point failures result in an OSM sample fail.
Lab Sampling	20%	Set equal to OSM sample fail as same environmental impact.
OSM Sample Fail	20%	We assume that a WRC with an OSM sample failure is non-compliant 5% of the year[60]. The scalar is therefore 20% relative to a failing works (calculated from 5% of year for an OSM/25% of year for a failing works).
Last Sample Failure	40%	We assume that a WRC with a last sample failure status is non-compliant 10% of the year. The scalar is therefore 40% relative to the failing works (calculated from 10% of year for a last sample fail/25% of year for a failing works).

[60] The range is dependent on sample fails and number of samples taken e.g. 1 sample in 24 is 4%, 1 in 12 is 8%).

Failing Works	100%	Each failed WRC is assumed to have environmental impact as the consent has been breached. 100% of the weighted pollution incident value applies for a failing works.

Dry Weather Flow compliance

The category weightings based on CCS data assessment from the table above are used to calculate the Dry Weather Flow compliance value.

A 100% scalar is applied to each weighting as DWF non-compliance is a full year effect.

Flow to Full Treatment (FFT) compliance

Valuing Full Flow to Treatment compliance uses the same approach as for WRC sample failure.

CSS data shows a considerably higher pollution category profile than analysis of the pollution incident database provided by AWS. Whilst it is not possible to clearly identify incidents or events as due to hydraulic restrictions rather than one-off events for either data set, we assume CCS data is more appropriate for estimating valuations as the descriptions mention discharge during dry conditions (although this may be due to one-off equipment failure).

Category weightings are based on CCS data assessment outlined in the table above. A 100% scalar is applied to each weighting as FFT non-compliance is a full year effect.

Summary of final weightings and scalars

Below is a summary of the final weightings and scalars used in the valuation calculations for WRC quality compliance and WRC volumetric compliance.

Table A2.21: Weightings by pollution category and associated scalars

Failure type	Pollution category (%)				Scalars
	Category 1	Category 2	Category 3	Category 4	
Measuring Point Failure	0%	34%	63%	3%	4%
Lab Sampling	0%	34%	63%	3%	20%
OSM Sample Fail	0%	34%	63%	3%	20%
Last Sample Failure	0%	34%	63%	3%	40%
Failing Works	7%	74%	14%	5%	100%
Dry weather flow	0%	38%	59%	3%	100%
Flow to full treatment - persistent	6%	53%	41%	0%	100%

Taking Measuring Point Failure as an example, the final values are calculated by the summation of each pollution weighting multiplied by the respective value in the SMF for a pollution incident for

Category 1 to 3 pollution incidents (Category 4 incidents are not valued). The combined weighted value is then multiplied by the scalar of 4%.

Summary of final values

Below is a summary of the final values for WRC quality compliance and WRC volumetric compliance when the weightings and scalars have been combined with the respective pollution values.

Both gain and loss values are included. The loss values are more relevant for compliance failures because the targets are full compliance and current performance is generally close to full compliance.

Table A2.22: £/incident values for WRC Quality Compliance and WRC Volumetric Compliance

Failure type	Scaled gains values			Scaled loss values		
	Upper	Mean	Lower	Upper	Mean	Lower
Measuring Point Failure	2,840	5,453	8,357	7,824	13,902	19,979
Lab Sampling	14,201	27,267	41,784	39,122	69,508	99,894
OSM Sample Fail	14,201	27,267	41,784	39,122	69,508	99,894
Last Sample Failure	28,403	54,534	83,567	78,245	139,016	199,787
Failing Works	98,804	189,707	290,705	272,189	483,593	694,998
Dry weather flow	72,893	139,957	214,469	200,808	356,772	512,737
Flow to full treatment - persistent	90,544	173,849	266,404	249,436	443,168	636,901

WTW DISCHARGE COMPLIANCE AND OVER ABSTRACTION

Values for WTW compliance and over abstraction have been estimated using the same approach as for WRC described previously – AWS pollution data covering a 10-year window and CCS data covering 9 years were analysed plus sample failure data.

Only relatively small data set is available for this period. Pollution Category weightings based on CCS data assessment are shown below.

Table A2.23: Proportion of failures by pollution category (WTW compliance)

Failure type	Pollution category (%)			
	Category 1	Category 2	Category 3	Category 4
WTW compliance	0%	12%	64%	24%
Over abstraction - Annual licence breach	0%	0%	100%	0%

For WTW compliance we have applied an 80% scalar to the weighted value. This scalar is based on expert judgement taking following findings into account from analysis of the pollution incident

database and CCS data. We have selected the lower end of the range recognising that it is a small dataset as not all sample failures have been categorised as pollution incidents:

- Pollution incident compliance categorisation indicates 75%-100% of incidents are non-compliant.
- 91% pollution incidents, where classified under CCS, indicate a consent compliance breach.
- 80% pollution incidents related to containment and control, so also likely to impact on consent compliance.

The final values are calculated by the summation of each pollution weighting multiplied by the respective value in the SMF for a pollution incident for Category 1 to 3 pollution incidents (Category 4 incidents are not valued). The combined weighted value is then multiplied by the scalar of 80%.

Summary of final values

The final values are presented in the table below. Both gain and loss values are included. The loss values are more relevant for compliance failures because the targets are full compliance and current performance is generally close to full compliance.

Table A2.24: £/incident values for WTW Discharge compliance and abstraction

Failure type	Scaled gains values			Scaled loss values		
	Upper	Mean	Lower	Upper	Mean	Lower
WTW Discharge compliance	38,637	74,184	113,679	106,438	189,107	271,776
Over abstraction - Annual licence breach	55,818	107,173	164,232	153,771	273,202	392,634

A2.4 First time sewerage

The first-time sewerage measure is used for properties that do not currently have a sewer connection. To develop a value for this measure we have used AWS questions completed by customers applying for first time sewerage connections (AWS Section 101A database).

The questionnaires are designed to capture information on the existing properties and the impacts that they have observed. AWS provided a dataset covering 10 locations surveyed during 2021/22 and 2022/23.

The frequency and duration of different service failures experienced by properties eligible for connection within this dataset provides the basis for the customer valuation for first time sewerage.

STEP 1 – UNDERSTANDING DATA AND OVERLAPS

The review of the dataset identified 121 eligible properties for first time sewerage. These are properties where there is a septic tank, the sewerage system is unknown and/or there is no existing foul system.

We then assessed the eligible properties for the following service impacts:

- External flooding (excluding surface water only flooding)
- Odour

- Amenity problems (reduced ability to use drainage within the property)

The incidences of properties reporting these impacts provides the percentage of eligible properties affected by service impacts. The six properties with odour issues but no flooding have been split from those experiencing both odour and flooding. This is to avoid any double counting of benefits as it is reasonable to expect that the customer value for external flooding includes the impact of odour on the property.

As the dataset also provides information on duration, the average duration for each the impacts is also collated.

Table A2.25: Analysis of impacts

Impact	Number	% affected	Total Weeks	Average weeks	Average Days
Odour - no flooding	6	5%	269	44.8	314
Odour - with flooding also	26	21%	252	9.7	68
Amenity	23	19%	299	13.0	91
Flooding	28	23%	226	8.1	56

This split between the two odour categories shows that properties experiencing odour issues and no flooding, experience this problem almost all the time (45 weeks a year on average). The persistent nature of this issue was less clear when the data was combined. The average duration for customers experiencing odour alongside flooding is similar to the duration reported for flooding. This suggests that these impacts may be linked.

STEP 2- REMOVING DOUBLE COUNT

Prior to applying the customers values a further adjustment is made to avoid the potential double count between odour and external sewer flooding. To calculate the duration of additional odour impacts over and above those associate with flooding the average number of weeks where flooding occurs (8.1) is subtracted from average number of weeks customers experience both odour and flooding (9.7). This leaves 1.6 weeks on average for where customers experience additional odour flooding.

Table A2.26: Summary of impacts

Impact	Percent of properties affected	Average duration - Weeks	Average duration – Days
Odour - no flooding	5%	45	314
Additional Odour (Where property has flooding also)	21%	2	11
Amenity	19%	13	91
Flooding	23%	8	56

STEP 3- APPLY VALUES

To produce a value for a property requiring first time sewerage investment the appropriate benefit values are identified for each impact identified in step 2. The value applied is outlined in the table below.

Table A2.27: Valuation mapping

Impact	Value mapped	Notes
Odour - no flooding	Daily odour value * 314 days	
Additional Odour (Where property has flooding also)	Daily odour value * 11 days	
Amenity	Loss of facilities value for 30 days	30 days is applied instead of 91 days from the assessment to reflect that loss of amenities for first time sewerage properties is lower impact than the full loss of facilities, e.g. impact involves some restricted use that can often be managed by phased timing of facility use.
Flooding	External flooding value (domestic) * scalar for repeat incidents.	The PR14 scalar for repeat flooding on an annual basis is 9.24. This is also similar to the duration in weeks from the analysis.

Summary of final values

The values identified in the previous section are multiplied by the likelihood that a first-time sewerage property will be affected by the impact (taken from the percentage of properties affected).

Below is a summary of the final values for first time sewerage.

Table A2.28: £/property values for first time sewerage

Impact	Combined		
	Upper	**Mean**	**Lower**
Odour – no flooding	2,633	6,238	9,896
Additional Odour (Where property has flooding also)	400	947	1,503
Amenity	3,054	5,464	7,950
Flooding	11,790	21,098	30,701
First time sewerage total	**17,878**	**33,748**	**50,050**

A2.5 River water update

The main River water quality anchor value covers the change in value from a non-good river to a good status river.

Relative customer preference weights from the PR14 Environment Study are used to map this value to range of river water quality categories that are relevant for the SMF. These categories cover:

- Fish and other animals
- Plant life
- Water level and flow
- Litter

For the first three categories the weights cover changes in quality status between bad/poor, moderate and good.

At PR14 a methodology was developed to adjust (scale) the weights, so they were expressed relative to an average assessment moving from non-good to good using the frequencies in each quality status category. This allows the anchor value for river water quality to be linked to the relative weights and a break down of the value to be allocated.

To update this mapping, we have analysed the WFD cycle 3 assessment data to produce a profile for the waterbody quality assessments in the AWS region.

Table A2.29: Valuation mapping

Quality category	WFD cycle measure
Fish and other animals	Fish
Plant life	Macrophytes and Phytobenthos Combined
Water level and flow	Invertebrates

For each quality category data is summarised for the following locations:

- Anglian River Basin
- Lough, Grimsby and Ancholme catchment
- Skerne catchment
- Tees Lower and Estuary catchment

The data is summarised below for each quality category to provide a frequency of each assessment by quality band for the Anglian Water region.

Table A2.30: Fish quality summary

WFD quality status	Count	Value mapped
Good/High	94	37%
Moderate	62	25%
Poor/Bad	97	38%

Table A2.31: Macrophytes and Phytobenthos Combined summary

WFD quality status	Count	Value mapped
Good/High	101	31%
Moderate	139	43%
Poor/Bad	85	26%

Table A2.32: Invertebrate summary

WFD quality status	Count	Value mapped
Good/High	367	67%
Moderate	125	23%
Poor/Bad	56	10%

The frequencies are multiplied by the customer preference weights from the PR14 study for the same categories to produce an average weight for a good assessment and a non-good assessment. This is completed separately for households and business customers. The difference between the two is set equal to the main customer value for a change to good river water quality status (the main anchor value).

A2.6 Flooding insurance data

Anglian Water flooding insurance claim data for flooding from water mains is used to support the triangulation of flooding values. The data set provided by AWS covers a range of water flooding claims between 2020 and 2022.

The analysis is based on the following:

- Closed claims to ensure the full value is captured.
- Claims with a loss adjuster appointed.
- Accident type code description is 'burst main' (this excludes more minor issues e.g. relating to meter boundary boxes).
- Accident source description is 'water ingress' which indicates that water has affected a property inside (as opposed to an external space).
- Excludes zero value claims to avoid including incidents that did not lead to a positive claim.
- A review of the claim descriptions to identify whether the claim covers a domestic or business property for segmentation.

The outputs are the average total claim value and value range for domestic and business properties that have been flooded.

Table A2.33: Summary of insurance data for water main flooding

Statistic	Domestic	Business
Number of claims	58	3
Average	£16,438	£60,370
Minimum	£283	£14,701
Maximum	£128,607	£144,077

Appendix 3: Transferring other company values

This appendix provides an overview of the approach to producing an AWS specific transfer value from other company values from PR19.

A3.1 Background and overview

The AWS approach to triangulating values utilises secondary evidence as a validity check. A key secondary source has been the values produced by other water and sewerage companies during PR19.

The approach to transferring the values for validity testing uses a dual approach:

- Approach 1: using the values from the Accent study unadjusted for size of region.
- Approach 2: applying a benefit transfer function approach to adjusts the values.

This appendix presents the approach and models for approach 2 for household customer values. Approach 2 develops the relationship between the other company values and potential regional explanatory characteristics using regression analysis. A benefit transfer function approach uses the relationship developed to transfer values from one context to another, rather than transferring absolute values, it is the explanation of the values that is transferred enabling values to be generated in the second context.

Key sources of other company data are:

- Accent and PJM Economics study of PR19 values[61]. This study provides information on a number of companies' values from PR19. In the report companies are anonymised, and values are presented as regional values (i.e. the £/unit value multiplied by the number of customers). To produce the report the Accent study team worked with water companies to collate values and present the data using a common definition where appropriate. Where this is not the case all the definitions are provided.
- Company PR19 business plan submissions table (App 1) which reports marginal benefit values for households.

Where possible we have identified companies in the Accent report using information from public domain including PR19 business plan submissions and reports published as part of this process.

A3.2 Approach

- The approach to the regression analysis draws upon the Defra guidance on benefit transfer[62].
- Prior to interrogating the data potential explanatory factors were identified based on both economic theory and a previous meta-analysis of stated preference data completed by UKWIR in 2010[63].

The full suite of likely explanatory variables was not available through the Accent report or public domain information (e.g. the status quo level of service and the change in level of service offered in

[61] Accent (2014) Comparative Review of Willingness to Pay Results. Final Report.

[62] eftec (2009) Valuing Environmental Impacts: Practical Guidelines for the use of value transfer in policy and project appraisal. Report submitted to Defra.

[63] UKWIR (2010) Review of Cost-benefit analysis and benefit valuation (RG07). Milestone D (Quantitative Analysis Working paper. Authors Carlo Fezzi, Ken Willis, Allan Provins, Chelsea Thomson (Cascade, eftec and ICS Consulting)

each study) and so the results of this analysis are likely to have a lower confidence level than full benefit transfer but provide a useful additional triangulation data source.

-
- Explanatory factors tested for include company size (connections, network length), service risk, bill level (water or sewerage), service levels (absolute and normalised), density, customer income (both before and after housing costs), whether a company's findings were scaled or unscaled. This allows values to be produced that are based on the characteristics of the AWS region and their customer base.

  The regression analysis tests correlation between different potential explanatory variables and the value for five anchors:

  - Interruptions to supply
  - Rota cuts
  - Leakage
  - Internal flooding
  - Pollution incidents

  In some cases, the independent variable (values) in the final models have been divided by property numbers regression analysis. This is the case where the property numbers were found to be a significant explanatory variable. This approach was used to reduce the number of explanatory variables (and improve the degrees of freedom).

  The relationships between the explanatory variables have been tested for co-linearity.

  The results presented in this appendix are shown in the same price base as the raw input data (2017/18 prices). They are inflated and minor adjustment to reflect the proportion of household customers in the region prior to using in triangulation.

A3.3 Model details

This section sets out the models for each of the five areas.

INTERRUPTIONS TO SUPPLY PER PROPERTY (LOG-LOG MODEL)

The fitted model used 11 observations.

The model uses the natural logarithm of the inputs. The resulting value is also expressed as a natural logarithm. This is converted into a value in £ per property using the exponent.

The overall regression was statistically significant ($R2 = 0.88$, $F(4, 6) = 11.030$, $p = < 0.006$).

Table A3.1: Interruption to supply model summary

Coefficient name	Coefficient value	Inputs used Natural log (input value)	Product
Intercept	-81.1608***		-81.16
Household income before housing costs	14.27376***	6.41 (608.26)	91.50
Density (Connected properties/km of mains)	-5.60522**	4.05 (57.15)	-22.68
Scaled (Dummy variable = 0 for scaled)	-2.52329**	1 (0)	-2.52
Service levels (Minutes per property - 2017-18)	0.47904	1.76 (5.82)	0.84
Total (Ln £)			**-14.01**
Total (£ per household)			**0.0004**
Total (£ all households)		2,077,374	**920**

Notes: * denotes statistically significant at the 10% level; ** denotes statistically significant at the 5% level; *** denotes statistically significant at the 1% level.

ROTA CUTS PER PROPERTY PER DAY (MIXED MODEL)

The fitted model used 7 observations.

The model uses a mix of natural logarithm of the input for total connected properties and the unadjusted value for the service level. The resulting value is expressed as a natural logarithm. This is converted into a value in £ per day using the exponent.

The overall regression was statistically significant ($R2 = 0.86$, $F(2, 4) = 12.594$, $p = < 0.019$).

Table A3.2: Rota cuts model summary

Coefficient name	Coefficient value	Inputs used Natural log (input value)	Product
Intercept	9.94192**		9.94
Total connected properties (HH +NHH)	-0.53406**	14.90 (2,195,719)	-7.80
Service levels (Chance of a rota cut)	-70.3682*	N/a (0.005)	0.01
Total (Ln £)			**2.15**
Total (£ per household per day)			**8.58**
Total (£ all households per day)		2,077,374	**17,829,547**
Total (£ per household per property affected per day)		2,182,633	**8.17**

Notes: * denotes statistically significant at the 10% level; ** denotes statistically significant at the 5% level; *** denotes statistically significant at the 1% level.

LEAKAGE PER MLD (LOG-LOG MODEL)

The fitted model used 12 observations.

The model uses the natural logarithm of the inputs. The resulting value is also expressed as a natural logarithm. This is converted into a value in £ per Megalitre per day using the exponent.

The overall regression was statistically significant (R2 = 0.60, F (2, 9) = 6.8911, p = < 0.015).

Table A3.3: Leakage model summary

Coefficient name	Coefficient value	Inputs used Natural log (input)	Product
Intercept	15.941625***		15.94
Service level (% chance of a temporary use ban)	0.9995646**	-2.30 (0.10)	-2.30
Scaled	-0.6888254	1 (0)	-0.69
Total (Ln £)			12.95
Total (£ all households per MLD)			421,349

Notes: * denotes statistically significant at the 10% level; ** denotes statistically significant at the 5% level; *** denotes statistically significant at the 1% level.

INTERNAL FLOODING PER PROPERTY (LINEAR MODEL)

The fitted model used 8 observations.

The overall regression was statistically significant (R2 = 0.75, F (2, 5) = 7.657, p = < 0.030).

Table A3.4: Internal flooding model summary

Coefficient name	Coefficient value	Inputs used Natural log (input value)	Product
Intercept	-0.11174**		-0.11
Household income after housing cost	0.000174**	559.97	0.10
Sewerage Bill	0.00019*	242.00	0.05
Total (£ per household)			**0.03**
Total (all households)		2,681,851	**85,255**

Notes: * denotes statistically significant at the 10% level; ** denotes statistically significant at the 5% level; *** denotes statistically significant at the 1% level.

POLLUTION PER INCIDENT (LOG-LOG MODEL)

The fitted model used 10 observations. These are a mix of values for minor and significant incidents.

The model uses the natural logarithm of the inputs. The resulting value is also expressed as a natural logarithm. This is converted into a value in £ per incident using the exponent.

The overall regression was statistically significant (R2 = 0.77, F (2, 7) = 12.026, p = < 0.005).

Table A3.5: Pollution model summary

Coefficient name	Coefficient value	Inputs used Natural log (input value)	Product
Intercept	-1.796246714		-1.80
Sewerage Bill	2.544922906**	5.49 (242.00)	13.97
Pollution type (Dummy variable = 0 for minor incident)	-0.741015379*	1 (0)	-0.74
Total (Ln £)			**11.43**
Total (£)			**92,195**

Notes: * denotes statistically significant at the 10% level; ** denotes statistically significant at the 5% level; *** denotes statistically significant at the 1% level.

Attributes and bill impacts (Conjoint choice exercise)

Attribute	Baseline	Enhanced
River quality improvements % of rivers to good status as classified by the Environment agency	No bill impact	£13.90
Tackling climate change Resilience to the impacts of extreme weather	No bill impact	£7.20
Replacing lead pipes in homes % of properties with lead pipes which are replaced	No bill impact	£5.40
Increasing water supply Number of new reservoirs started	No bill impact	£3.60
Reducing leaks % change in level of leakage	No bill impact	£1.20
Helping customers reduce water use Date where every customer has a smart meter by	No bill impact	£1.20
Reducing impact on rivers from storm overflows Number of spills per storm overflow, and presence of early warning monitors	No bill impact	£6.00

Assurance

Document Assurance

Version	Author	Approval	Review
1.1	Amanda Markwardt Martin Baker	Amanda Markwardt	Kerry Grafton
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