Anglian Water

12H. VALUATION COMPLETION REPORT

RESPONSIBLE BUSINESS OF THE YEAR 2017
BUSINESS IN THE COMMUNITY

THE QUEEN'S AWARDS FOR ENTERPRISE: SUSTAINABLE DEVELOPMENT 2015

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Anglian Water

Valuation Completion Report

June 2018

Final Stage

DOCUMENT INFORMATION

Document title	Valuation completion report
Project	Valuation completion
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Document version	7.0
Version date	June 2018
Circulation	Members of CITWG steering group

Contents

Executive Summary

Introduction
The purpose of this report is to provide the recommended societal values for use in the PR19 business planning and WRMP appraisal processes. It draws together the available valuation information that is available to produce a recommended set of values. This process is part of the overall Anglian Water triangulation process. The report represents the final stage, updating the interim report. This reflects that triangulation is an on-going process as new information becomes available.

Why triangulate?
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.

Triangulation is not a new concept in developing business plans in the water sector. Anglian Water has developed business plans over multiple periodic reviews using high-level triangulation principles to combine all the evidence from customers, stakeholders, regulators and the business. Ofwat also has a history of using triangulation, particularly around cost assessment in draft and final determinations. However, for PR19 more innovation and visibility of the process of triangulation and more transparency of the application of the triangulation process are required by all stakeholders.

The societal valuation framework
The range of values available produced in this report is driven by the Anglian Water societal valuation programme, the aim of which is to derive useable values for economic, social and environmental benefits for strategic investment decision-making. This builds on the validation and synthesis process developed in PR14, by broadening the scope whilst taking into account recent key insights provided by Ofwat and CCWater. The range of sources for PR19 covers a mix of traditional and innovative valuation approaches, and the process developed has included focus groups to test findings. Using a range of sources will assist in meeting regulatory expectations that companies' investment programmes are informed by robust cost benefit analysis.

The valuation completion report helps to deliver this aim by ensuring that the PR19 valuation studies and other relevant valuation evidence is translated into recommended societal values through applying a credible and robust approach to triangulating the customer valuation evidence.

Whilst the business plan is presented to customers and stakeholders summarised by Outcome and Performance Commitments (PCs), the detailed investment planning process involves understanding risks and the impacts on customers at a greater level of detail. This report covers a total of 178 service measures. These measures take account of the breadth and range of the different severity of impacts that could occur. The societal valuation programme developed a strategy (see NERA, 2017) to ensure prioritization of obtaining new societal valuation evidence, according to factors such as size of potential investment area, customer and stakeholder importance, and sensitivity to cost benefit analysis.

The triangulation process
The report provides an overview of the triangulation process. It is important to note that triangulation is an ongoing process and this report builds on an earlier version to provide recommended values for use in business planning. In this report the interim values provided previously have been updated to account for further valuation research that has been completed and to take account of wider customer research findings and testing undertaken by Anglian Water. 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.

Further information and analysis that has been included in this updated report are:

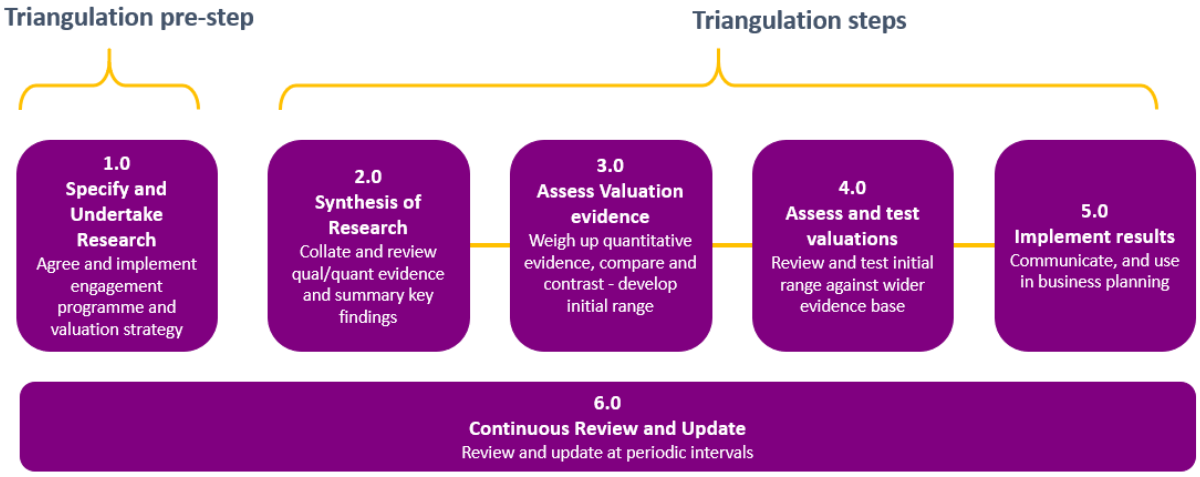
- Updated stated preference results to take account of larger samples, further analysis and trialling different approaches (Best-worst scaling results)
- Segmentation analysis drawing on the stated preference results by key customer segments
- Further engagement with customers to test the interpretation of the valuations
- Challenge, review and updating assumptions
- More detailed cross check with the Anglian Water PR19 customer engagement synthesis report.

The Anglian Water valuation triangulation process has been developed in accordance with the various requirements and guidance set out in Section 2. It also reflects Anglian Water's requirements. The process is set out in Figure ES.1.

The valuation completion report focuses on undertaking Steps 2.0 and 3.0 for the available evidence. It also includes some wider qualitative evidence on preferences from focus groups and the findings of the detailed cross check with the Anglian Water PR19 customer engagement synthesis report which are part of Step 4.0.

Step 4.0 also includes testing the recommended valuations in the decision support tools and wider business planning process. This has been completed separately by Anglian Water using the interim valuations and is not covered in this report.

Figure ES.1: Anglian Water Valuation Triangulation Process



STEP 1: SPECIFY AND UNDERTAKE RESEARCH: This is a pre-step to the triangulation process. The research has been undertaken by Anglian Water in accordance with its customer engagement programme, which includes the Societal Valuation Framework (SVF). The SVF sets out the approaches to sourcing and estimating customer, wider societal and environmental valuations including, strategic objectives and outlines the PR19 research programme.

STEP 2: SYNTHESIS OF RESEARCH: This step collates relevant studies, research and customer insight; documents the results of the research including key information on the study and synthesises the findings including assessing each source for robustness and relevance. This step confirms 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, deciding on the service levels provided in the business plan, etc).

STEP 3: ASSESS VALUATION EVIDENCE: This step compares the data to produce a recommended range. It aims to compare values on a like for like basis as much as is possible. This includes understanding the units of measurement and definitions for the service measures, inflating the values to a common price base[1], aggregating values so they are comparable for the Anglian Water region and size of customer base. The values and customer preference data are then compared to develop an appropriate recommended range that reflects the valuations' scope, taking into account how robust and relevant each source is.

This report focuses on triangulating a number of key measures or 'anchor' measures. These are where valuation data tends to be more widely available. The triangulated anchor measures are then used to populate the wider framework. A key source for doing this are customer preference studies that have quantified how customers view different measures relative to each other and developed weightings to apply.

The data from the range of evidence is separated into two key groups - primary/core (AW customer data) from which the recommended values are mainly derived and secondary evidence (other company/area data) which provide a crosscheck on the recommended values. These sources are compared where they are available for all measures. The evidence and information sources include stated preference, subjective wellbeing, macroeconomic analysis, market prices, avertive behaviour, damage costs, insurance costs, and other revealed preference methods such as travel cost models.

STEP 4: ASSESS AND TEST THE VALUATIONS: This step covers a number of different 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. This latter part arises as some of 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.

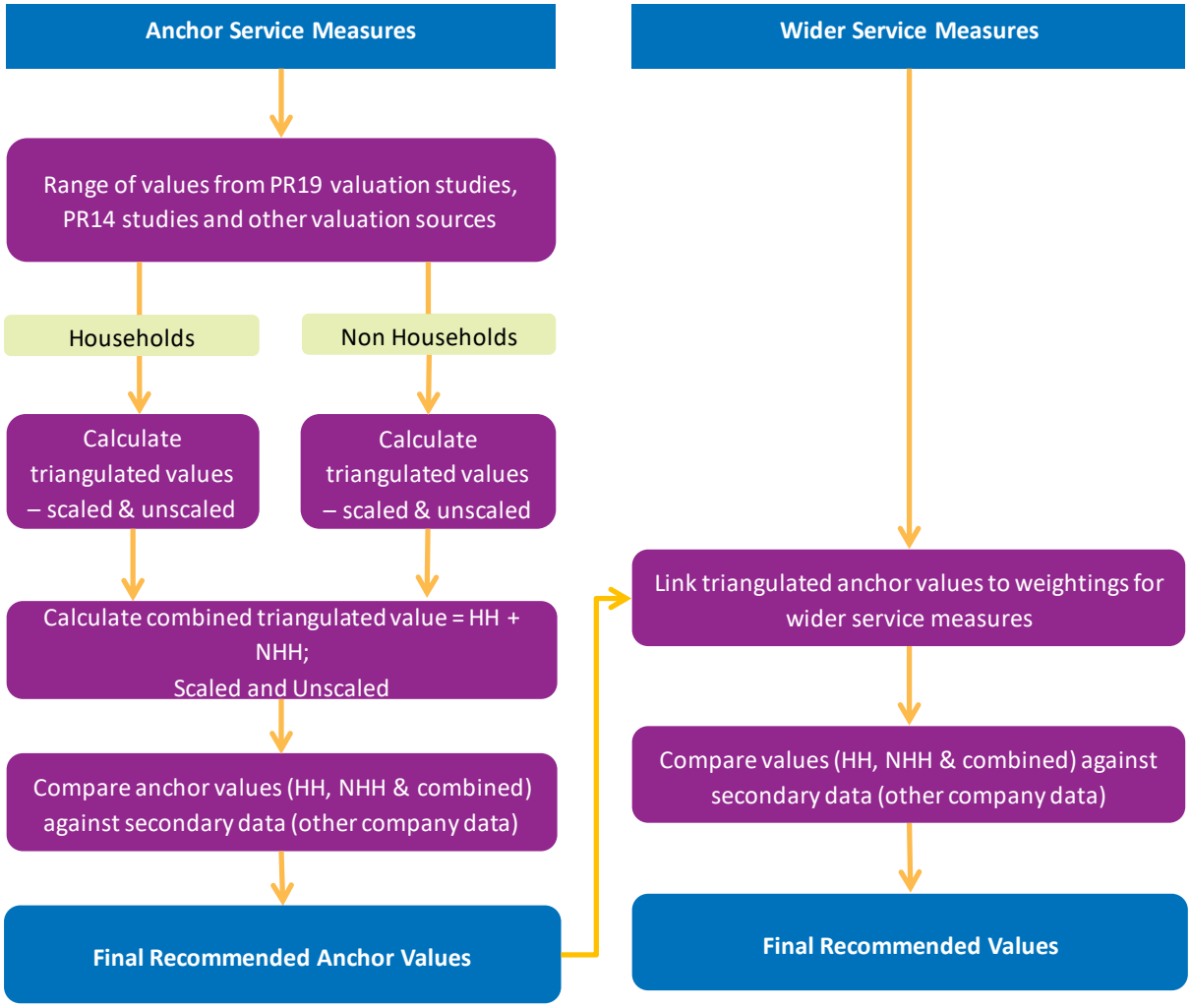
STEP 5: IMPLEMENT RESULTS: This step involves documenting and communicating the results. These can then be used in business plan development.

STEP 6: 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.

The steps in this report – Steps 2.0. 3.0 and 4.0 are explained in detail in the report. A summary of these steps are summarised in the figure overleaf:

[1] September 2017

Figure ES.2: Triangulation steps 2.0, 3.0 and 4.0 - activities



Key findings

The valuations for the key 'anchor' measures are shown in the two tables below. This report is supplemented by a workbook detailing all of the values in Anglian Water's societal valuation framework.

The tables below set out the values for improvements in services from the current situation. The value ranges are shown for scaled and unscaled values. These values represent different techniques that can be applied in stated preference studies. A summary of the difference is provided below. Stated preference values are available for all of the measures in the tables. This means that the different stated preference information has been used to consistently inform all of the rows in the tables. Where other sources are available the stated preference scaled and unscaled values and ranges presented have been adjusted depending on a case by case basis.

The scaled and unscaled values address the 'package' effects that are observed when large improvements to service are implemented. In the PR19 and PR14 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 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. Based on discussions with Anglian Water and the peer reviewer the preferred approach is to test the scaled values first and then to test the unscaled values as part of the business plan testing or sensitivity testing process.

Table ES.1: Scaled Gains Values, Anchors, £

SMF band	Unit	Lower	Central	Upper
Interruption, 6 to 12 hours	£/property	353	902	1,508
Hosepipe ban	£/expected day/property affected	0.45	0.55	0.66
Severe water restrictions	£/expected day/property affected	42	59	89
Discolouration	£/property	268	484	748
Leakage	£/MLD	106,193	172,405	231,765
Internal sewer flooding	£/property	41,353	98,805	116,331
External sewer flooding	£/area	1,782	10,234	22,863
Odour nuisance	£/property	1,922	6,551	11,205
Bathing water	£/site from good to excellent	166,181	747,802	1,397,225
River water quality	£/km to good status	7,383	16,972	26,561
Pollution category 2	£/incident	89,331	150,780	212,229
Repeat customer contacts	£/customer	18	57	193

Table ES.2: Unscaled Gains Values, Anchors, £

SMF band	Unit	Lower	Central	Upper
Interruption, 6 to 12 hours	£/property	2,128	5,232	8,783
Hosepipe ban	£/expected day/property affected	0.46	0.66	0.87
Severe restrictions (Rota cuts and standpipes)	£/expected day/property affected	66	106	174
Discolouration	£/property	579	1,423	2,612
Leakage	£/MLD	320,120	717,232	1,114,339
Internal sewer flooding	£/property	180,709	375,047	626,443
External sewer flooding	£/area	9,885	29,785	57,800
Odour nuisance	£/property	10,639	38,530	66,629
Bathing water	£/site from good to excellent	1,442,329	4,245,457	7,339,945
River water quality	£/km to good status	52,047	104,575	157,103
Pollution category 2	£/incident	359,731	774,728	1,189,724
Repeat customer contacts	£/customer	85	331	1,161

Peer review

The process and application has been subject to peer review by Professor Ken Willis. In response to questions posed, Professor Willis provided guidance on the integration of traditional stated preference valuations with alternative sources. The advice provided has included considering studies on a case by case basis and identifying the circumstances when it is appropriate for stated preference values to be amended or to use studies to influence the range for sensitivity testing.

The peer review recognises that scaled and unscaled values are appropriate in different contexts and decisions may not just be conceptual but should also consider the relative validity of the different sources.

Summary and conclusions

This report draws together a range of valuation evidence set out in the Anglian Water societal valuation framework to produce a set of recommended societal values for use in the PR19 business planning and WRMP appraisal process. This value evidence includes traditional value methods used in the water industry such as stated preference surveys and integrates these with sources that are more innovative or have had less focus in the past. Overall this has provided a robust set of final triangulated recommended values that have been taken through sensitivity testing and compared to wider customer evidence. The values can be taken forward by Anglian Water to understand the societal impacts and implications for strategic investment business planning.

PART 1

1 Introduction

The purpose of this report is to provide recommended societal values for use in the PR19 business planning and WRMP appraisal processes. A key aim of the societal valuation programme is to derive useable values for economic, social and environmental benefits for strategic investment decision-making. This will assist in meeting regulatory expectations that companies' investment programmes are informed by robust cost benefit analysis. The valuation completion report helps to deliver this aim by ensuring that the PR19 valuation studies and other relevant valuation evidence is translated into recommended societal values through applying a credible and robust approach to triangulating the customer valuation evidence.

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.

Triangulation is not a new concept in developing business plans in the water sector. Anglian Water has developed business plans over multiple periodic reviews using high-level triangulation principles to combine of all the evidence from customers, stakeholders, regulators and the business. Ofwat also has a history of using triangulation, particularly around cost assessment in draft and final determinations. However, for PR19 more innovation and visibility of the process of triangulation and more transparency of the application of the triangulation process are required by all stakeholders.

In developing the approach to triangulation in PR19, Anglian Water has built on the validation and synthesis process developed in PR14, whilst taking into account recent key insights provided by Ofwat and CCWater. The PR14 business plan was underpinned by a range of stakeholder and customer engagement activities. This produced a set of societal valuations (customer and environmental) that were aligned to both the Performance Commitments and Service Measure Framework, and were sourced from a range of customer studies. Whilst this provided a rich and detailed picture of customer values, the scope of the task for PR19 is much broader and has been extended to capture more sources of customer insight to support the business plan.

The Anglian Water PR19 triangulation process is aligned with expectations from Ofwat, CCWater and other stakeholders that demand innovation and development in this area. For example, Ofwat's Customer Policy Statement published in May 2016 calls for companies to use:

> ***"A robust, balanced and proportionate evidence base to develop a genuine understanding of their customers' priorities, needs, requirements and behaviours. For example, cross-checking and sense-checking evidence drawing on a range of techniques (such as stated and revealed preference willingness-to-pay techniques, and experiments) and a range of sources (including information obtained through day-to-day interaction with customers, for example complaints)"***

And:

> ***"…it will be important for companies to cross-check or triangulate findings against other data sources or research insights. Proportionality and triangulation will become even more important as companies start to explore new and innovative techniques or as they refine and improve existing or previously applied research methodologies."***

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 PR19 business plan. This breadth of customer insight has been interpreted and validated via a triangulation process to present the common understanding of customers' requirements and priorities, providing the narrative for a business plan that is driven by customer engagement.

This report summarises the valuation triangulation process and application in Anglian Water, and presents the second iteration of the valuation set to be used in business plan development. 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 valuation evidence outlined in the Anglian Water valuation framework and producing a recommended set of values for use in business planning. It is an update to an earlier iteration to account for further valuation research that has been completed and to take account of wider customer research findings and testing undertaken by Anglian Water. 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.

As part of the process an interim set of values was provided for the draft Water Resource Management Plan. This was completed due to the timings of when the plan was submitted. A full audit trail of the interim values as well as the updated final values are provided in Annex 3.

1.1 Report outline

The structure of the document is as follows:

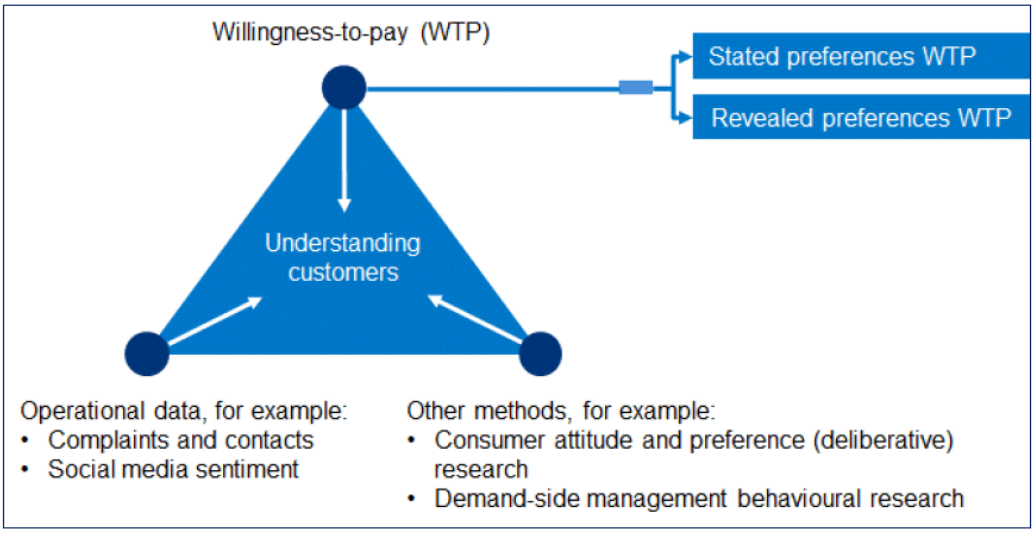
- Section 2 summarises the principles of triangulation
- Section 3 summarises the triangulation process, as applied to Anglian Water
- Section 4 contains the key information on the valuation sources
- Sections 5 – 23 contain the triangulated gain findings and associated assumptions for service measure areas, such as flooding, interruptions, carbon and bathing water quality
- Section 24 summarises the loss values, using the same assumptions
- Section 25 sets out the findings from the segmentation analysis
- Section 26 contains the summary and conclusions
- Annex 1 contains the critical questions used to appraise valuation evidence, and a critique of each valuation study against these questions
- Annex 2 contains the summary of the findings of the focus groups used to test assumptions used in the triangulation process
- Annex 3 contains the interim values provided for the draft WRMP and the detailed set of final values for water resource options and water restrictions
- Annex 4 contains the peer review comments, carried out by Professor Ken Willis
- Annex 5 contains a list of assumptions and calculations used in the valuation completion report.
- Annex 6 compares the findings from this report to the key messages presented in section 2 of the Anglian Water Customer Research & Engagement Synthesis.
- Annex 7 summarises the findings from a review by Anglian Water of the wider research and insights available from Anglian Water's Customer Research & Engagement Synthesis report and company operational data for each of the main service areas that have been valued in this report.

2 TRIANGULATION PRINCIPLES

2.1 Data sources

Figure 2.1 presents Ofwat's characterisation of the different types of customer engagement and research methods that can inform business plan decisions. This recognises a variety of customer preferences research (revealed and stated preference), behavioural and deliberative methods that can provide insight alongside day-to-day operational contact data from customers. This breadth of evidence needs to be compiled over a period of time, feeding into the business planning process.

Figure 2.1: Ofwat characterisation of triangulation of customer insight



It is useful to summarise the range of data and evidence that may be compiled, which following Figure 2.1 split broadly into three categories:

Willingness to pay (quantitative methods)

- Stated preference studies
- Revealed preference studies
- Subjective wellbeing studies
- Value transfer applications (use of secondary sources of evidence)
- Market data and macroeconomic data analysis

Operational data

- Customer contacts
- Social media sentiment
- Customer tracking research
- Customer segmentation analyses
- Key findings from incentive schemes and pilot schemes (e.g. incentivising customers to reduce consumption, smart meters, etc)

- Geographic information systems (GIS) / System level analyses to understand service levels and service provision:
    - Examining local populations (e.g. affected by service issues or improvements)
    - Examining 'hotspots' of service failure, nuisance, satisfaction, etc.
    - Estimating levels of service risk pre- and post-investment (e.g. numbers of customers affected by resilience investment to reduce single source customers)
- 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

Other methods

- Customer priorities research to support the development of Outcomes, Performance Commitments (PCs), and Outcome Delivery Incentives (ODIs)
- Deliberative and qualitative methods (e.g. focus groups, workshops)
- Quantitative methods (e.g. customer surveys)
- Acceptability testing surveys
- Stakeholder engagement sessions

These sources of data inform the business planning process; a subset of these inform the societal valuations which form one part of the business planning process. Understanding these sources allows a genuine and detailed understanding of customers' priorities, preferences and valuations.

2.2 Objectives of triangulating valuations

The list of data sources given above helps to triangulate all aspects of both the business plan and Water Resource Management Plan (levels of service, pace of change, solutions to meet requirements, ODIs, etc). This report is concerned with the triangulation of societal valuations to feed into investment appraisal for changes in risk and performance.

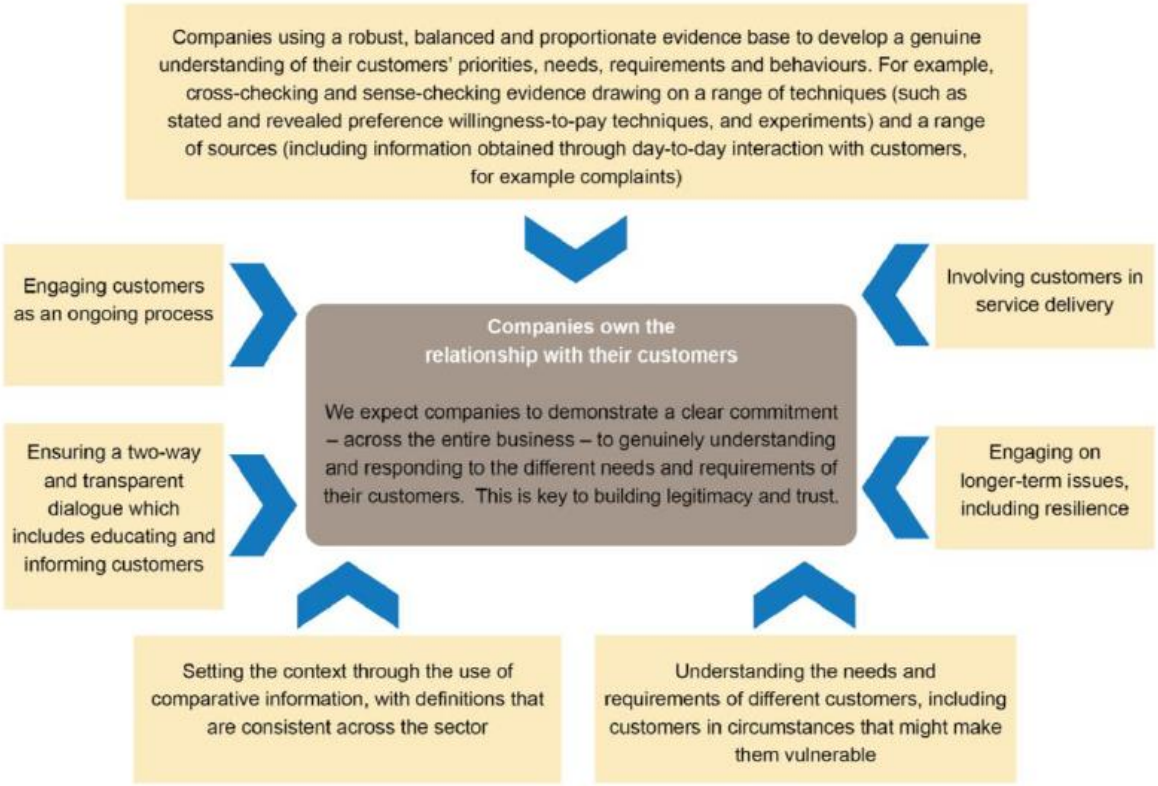
The objective of a robust valuation triangulation process is to increase the reliability and acceptability of valuations used in business planning by incorporating the range of available evidence (both quantitative and qualitative). This in turn will increase the acceptability and legitimacy of the performance commitments, ODIs and the overall plan.

Ofwat's Final PR19 Methodology sets 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). Ofwat's draft methodology made it clear that their response to concerns raised at PR14 about the robustness of valuation data was to encourage triangulation of a wider variety of customer engagement methods (page 65). This commitment is retained in the final methodology which emphasises the wide range of information on customer preferences required to set performance commitment levels (page 53).

At PR14 Ofwat guided companies to use Cost-Benefit Analysis (CBA) to set economically efficient PCs. This required estimates of WTP (marginal customer benefit from increased service) and marginal cost of increasing service. Companies mainly used Stated Preference surveys to derive WTP and in some cases companies found it difficult to obtain robust data. Doubt was cast on the robustness of some

data collected due to the variation in values across companies. Ofwat's Customer Engagement Policy Statement and Expectations for PR19 responded to this concern by encouraging companies to use a wider variety of customer engagement methods in addition to stated preference WTP, as set out in Figure 2.2.

Figure 2.2: Ofwat characterisation of Customer Engagement Expectations



Triangulated values are required for general business planning, PC setting, setting of ODIs and investment/activity planning. This includes the development of companies' WRMPs.

Appendix 2 of the Final Methodology contains a number of requirements for triangulation which have been incorporated in the Anglian Water process (page 52 and 91):

- Companies should not rely solely on stated preference WTP methods to inform their service levels.
- Companies should use a wider range of methods, where it is proportionate to do so. For example, where there are financial ODIs (both rewards and penalties), large planned improvements in performance or innovative approaches.
- Companies should test how sensitive their PCs are to changing societal valuations in CBA
- Companies should ensure customers and the CCG are engaged with the process as using multiple data sources means more scope for judgement in target setting.
- Companies should gain independent assurance of how judgements based on multiple data sources are made via peer review.
- Companies should continue to take account of impacts on the customer, community, environment, biodiversity and natural capital in their estimates of marginal costs and benefits.

2.3 CC Water findings

To support the triangulation process, CCWater commissioned a study[2] to help identify how water companies can use triangulation to:

- Draw evidence from a wider range of sources to supplement WTP estimates,
- Build a wider and more in-depth evidence base; and
- Generate new perspectives and insights to better understand customers.

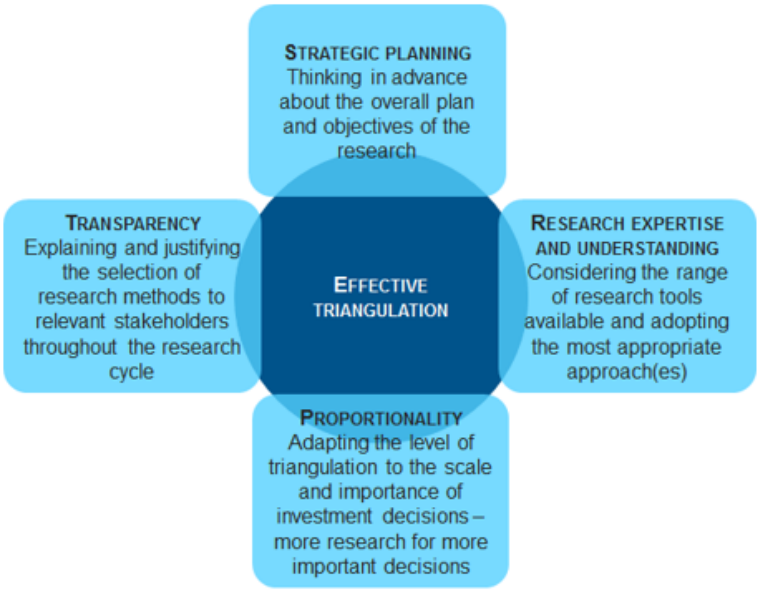
The study summarises triangulation as:

> ***"In practice, triangulation simply means using multiple and independent measures to examine a hypothesis or conclusion being investigated, with the intent of using multiple perspectives to minimise bias and maximise validity."***

The CCWater study identifies broad principles for triangulation and sets out a framework which it is recommended stakeholders use as the basis for exploring how triangulation can be applied at PR19. CCwater also recommend that companies should view triangulation as an ongoing process and that they should consider the full variety of triangulation methods.

The broad principles for effective triangulation identified in the CCWater Study are set out in Figure 2.3 and have been used in defining the Anglian Water valuation triangulation process.

Figure 2.3 CCWater characterisation of the broad principles for effective triangulation



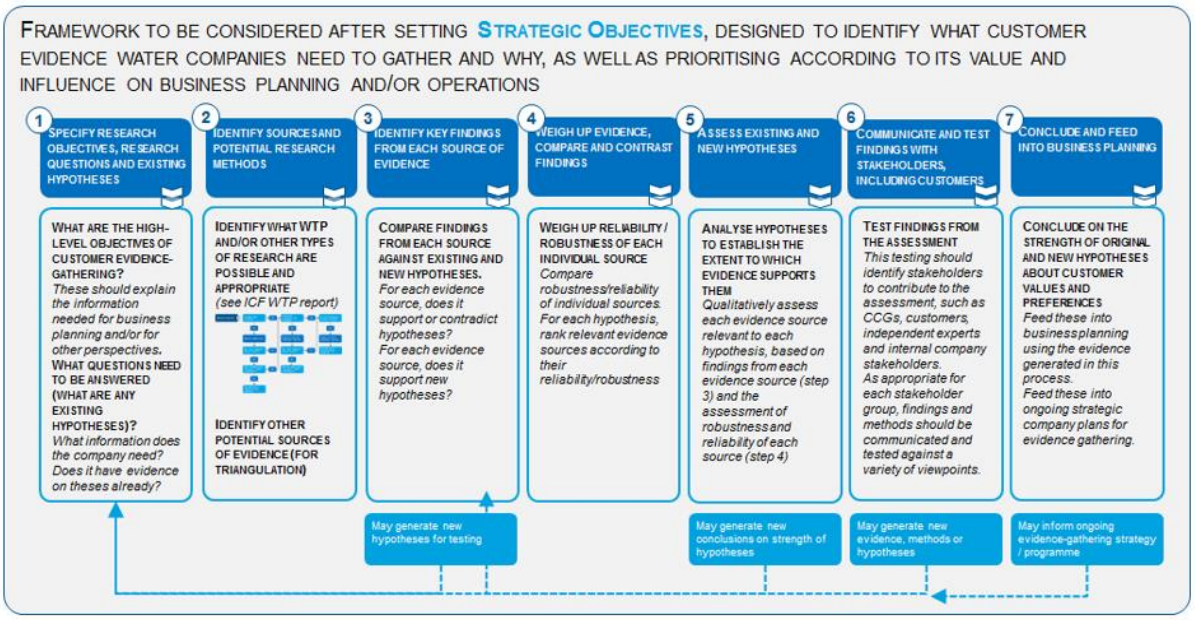
A summary of the principles laid out by CCWater are:

- The process must be transparent and flexible
- The process needs to identify contradictory evidence. These should not be ignored; the process should seek to explain or recognise differences.
- It is important to avoid any bias towards studies that give results in line with expectations – but rather favour studies that genuinely help understand what customers want and care about, that follow good practice principles and are robust.

[2] CCWater "Defining and applying triangulation in the water sector", July 2017.

Based on these key principles and observations, the CCWater study develops a framework for triangulation in the water sector as set out in Figure 2.4. This has been used to inform the Anglian Water approach.

Figure 2.4: CCWater Framework for Triangualtion in the Water Sector



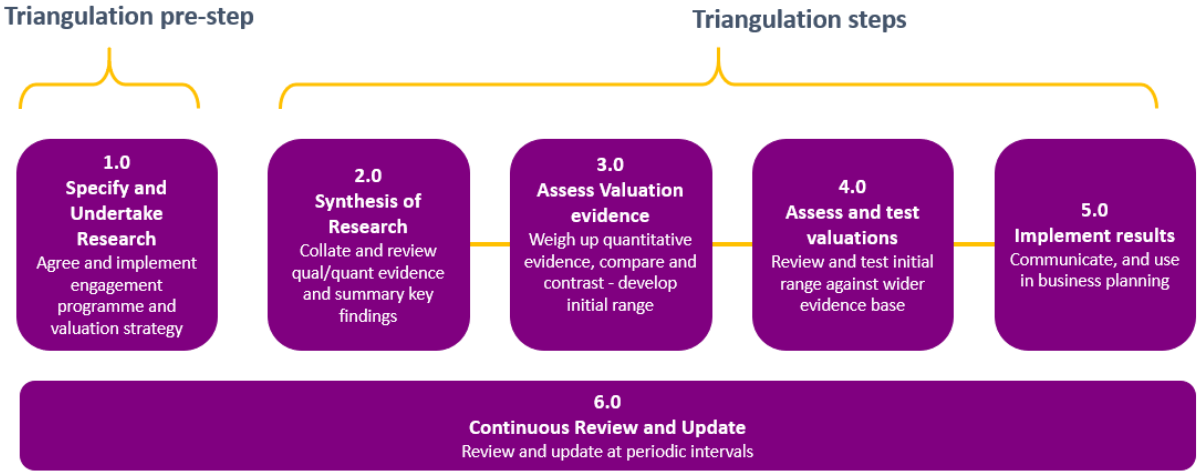
The CCWater document and Ofwat methodology have been key in developing the triangulation process as applied to societal valuations.

3 TRIANGULATION PROCESS

3.1 Overview

The Anglian Water valuation triangulation process has been developed in accordance with the various requirements and guidance set out in Section 2. It also reflects Anglian Water's requirements. The process is set out in Figure 3.1.

Figure 3.1: Anglian Water Valuation Triangulation Process



The Anglian Water process is consistent with the CCWater framework. Figure 3.2 sets out how the process maps to the CCWater framework.

Figure 3.2: Mapping to CCWater Framework

CCWater	Anglian
CCWater Step 1 – Specify research objectives, research questions and existing hypotheses	• 1.0 Triangulation pre-step (engagement programme and Societal Valuation Framework)
CCWater Step 2 – Identify Sources & Potential research Methods	• 1.0 Triangulation pre-step (engagement programme and Societal Valuation Framework)
CCWater Step 3 – Identify key findings from each sources of evidence	• 2.0 Synthesis of research
CCWater Step 4 – Weigh up evidence, compare and contrast findings	• 3.0 Assess valuation evidence
CCWater Step 5 – Assess existing and new hypotheses	• 4.0 Assess and test valuations
CCWater Step 6 – Communicate and test findings with stakeholders including customers	• 4.0 Assess and test valuations • 5.0 Communicate and implement results
CCWater Step 7 – Conclude and feed into business planning	• 5.0 Communicate and implement results • 6.0 Continuous review and update

These process steps are outlined in the rest of this section.

Note – this report 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 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 Framework

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

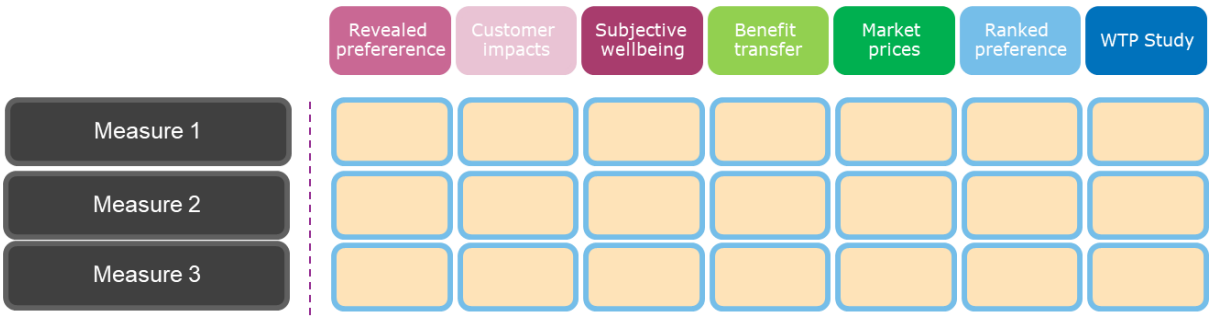
To develop the Societal Valuation Framework (SVF), Anglian Water undertook a review of its requirements for the PR19 business planning process. NERA Economic Consulting was commissioned by Anglian Water in 2016-17 to inform the development of a PR19 Societal Valuation Strategy[3]. The NERA study provided a detailed assessment of the range of customer valuation techniques that could be deployed to deliver the societal valuations required by the business and develop a strategy for selecting those methods that should be deployed to obtain the required valuations. The recommendations took account of the strategic importance of the attributes to be valued: for example, whether the attribute is a customer and/or stakeholder priority and the sensitivity of the investment decision to the societal valuation.

The SVF 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 and the Performance Commitment (PCs)
- 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 SVF identifies a range of evidence which align to each aspect of service, as shown below. As part of the wider triangulation this can be extended to cover softer engagement, customer contacts, deliberative research, etc.

Figure 3.3: Range of Evidence - illustrative



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

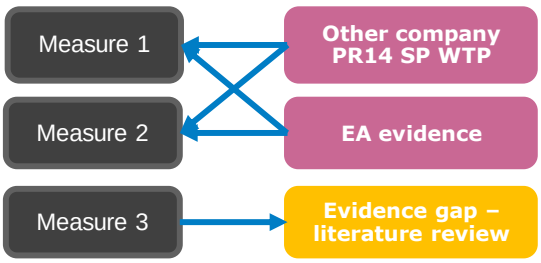
3.3 Step 2.0 - Synthesis of research

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 PR09/PR14 and PR19 quantitative and qualitative studies
- 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[4]. This is a key input into the triangulation process.

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 reviewed alongside 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, with full details provided in Annex 1.

[4] Anglian Water Customer Research & Engagement Synthesis report. The PR19 report has been developed from an earlier version produced at PR14.

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.

Overall Anglian Water PR19 research values are the most relevant and most robust valuations since these studies are designed to deliver values linked to the SVF including levels of service and therefore provide the most up-to-date evidence on customer values. These are the 'core' or 'primary' values. We have also compared older Anglian Water research to these values as part of the primary dataset. 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, where the triangulation has already been undertaken prior to the government issuing valuations for use in policy analyses, such as carbon and health and safety.

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 e.g. SP, RP for differences and similarities
- 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 Outcome and PCs. However, the detailed investment planning process involves understanding risks and the impacts on customers at a greater level of detail.

For example: consider internal flooding. The Service Measure Framework (SMF) contains a range of severity categories – property type and frequency. Whilst all flooding is unpleasant the impact on customers varies according to property type and frequency 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.

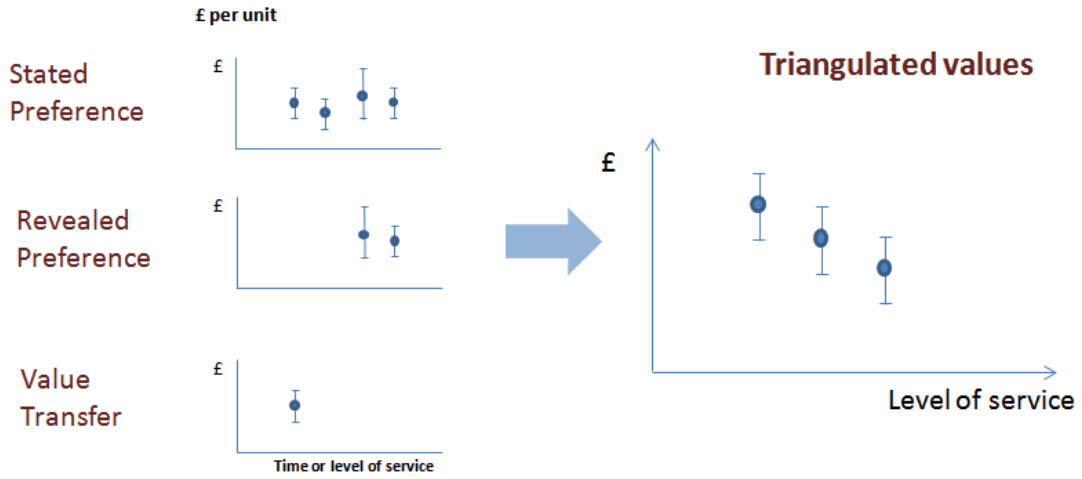
The service measures that make up the SMF are individually valued. These aggregate to give the average valuation for all properties and frequencies. This provides a starting point for values used in the ODI setting. It is important that the valuations work at both levels.

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[5]). They can then be compared to other aggregated values.

[5] The assessment in this report uses the following AW customer base (including Hartlepool) figures: Household customers – water = 1,976,225, wastewater = 2,554,933; Non-household customers – water = 109,436, wastewater = 108,299. Figures provided by Anglian Water.

Figure 3.5: Values from multiple sources aggregated to one set of values



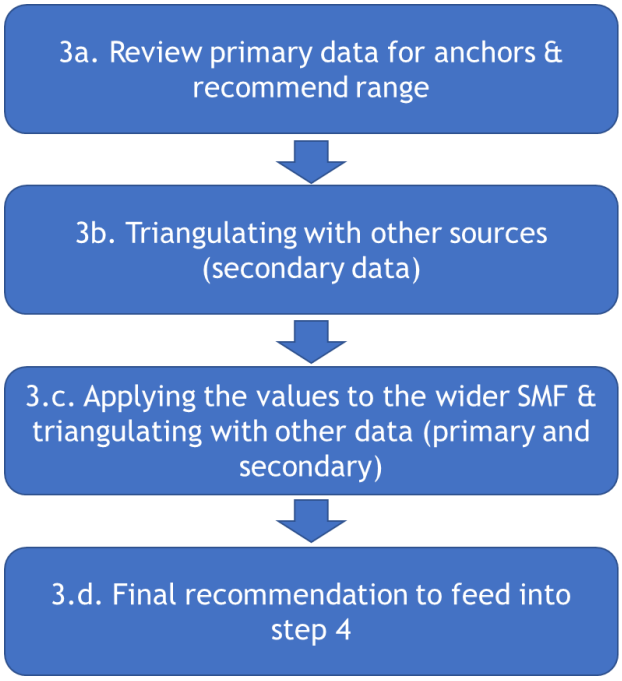
To do this requires valuations that are comparable. This means comparing values in the same units of measure, the same price base, same customer base and following good practice guidance for using value transfer.

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:

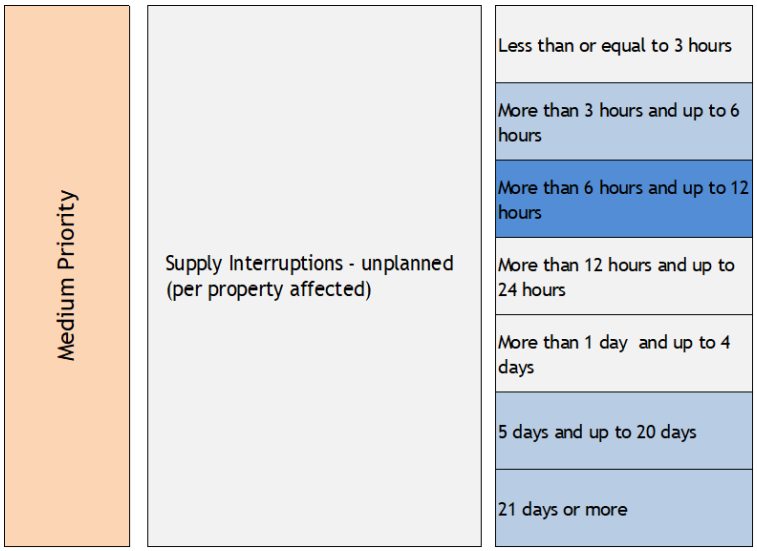
- Step 3a - Primary data & initial recommended range: This step focuses on the primary data available for the anchor measure being triangulated. These are measures where the majority of the valuation information lies e.g. 6 to 12-hour interruption. The approach recognises that valuation data is usually available for different customer types - household, non-household and combined (all) customers. The data is 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 PR19 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. This analysis is presented in Section 25.

- 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 unlikely to be available for all the measures. In the example, data is available for interruptions lasting 3 to 6 hours, 5 days to 20 days and 21 days or more. For the other durations only customer preference weights are available at this stage.

- Step 3d – Final recommendations to feed into step 4. This step summarises the findings and confirms the recommended range. It also 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 PR19 primary valuation studies are also covered in this report and the assumptions that have been made or updated outlined.

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 undertaken by Anglian Water and the findings of which can be found in Annex 7 summarising the wider research and insights from Anglian Water's Customer Research & Engagement Synthesis report and company operational data 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[6].
- 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:

[6] 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.

- 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?[7]
- 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?

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.

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.

It is important to ensure that a consistent set of valuations are used for business planning and setting ODIs.

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.

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

4 Key information on valuation data

The data and recommended ranges in this report are the final iteration of this process, updating the interim stage. The ranges are based on the:

- Full set of valuation data and study results available as of 31st March 2018.
- SMF definitions and categories, with associated assumptions for applying valuations to the SMF, up to 31st March.

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

4.1 General adjustments

For this iteration of the results the general adjusted are:

- Inflating the values to a common price base:
    - Previous studies have been updated to September 2017 using CPI as the measure of inflation. AW PR14 values assumed to be 2012 (index for year applied).
    - AW 2017 studies are not adjusted as they are based on 2017/18 bill levels
- Adjusting for the AWS customer base. Many of the values used are per household or per non-household customer value. 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 approach has been applied, where feasible, to both previous AWS studies and other company studies. This means that AWS PR14 data presented will be different to the inflated value alone as it has also been adjusted for customer numbers.

4.2 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).

  For both households and non-household results PR19 gains have been used in preference to linear values for service improvements, as in general, results indicate lower values for the mean per unit value of an improvement. This is a more conservative approach. PR19 linear and gains values are shown in primary data graphs.
- The scaled and unscaled values address the effects that are observed when large improvements to service are implemented - 'package effects'. 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 as measured in

terms of the impact on the bill[8]. 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.

- The peer review has 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 has 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.

4.3 Primary data approach

Based on the section above, this report produces two sets of ranges – one unscaled and one scaled. Based on discussions with Anglian Water and the peer reviewer the preferred approach is to test the scaled values first and then to test the unscaled values as part of the business plan testing or sensitivity testing process.

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 PR19 sources taking into account the type of value each source covers – is it likely to be a full or partial value.
- Checking against PR14 sources. In some cases PR14 and PR19 values are similar and PR14 values are used to inform the range. In other cases, the PR19 range encompasses the PR14 one so PR19 is used in preference at this stage as it provides a larger range for testing. In other cases, there appears to be a step change between the two sets of values and PR19 values are used as the more appropriate source[9].

Figure 4.1 shows the anchor measures from the service measures framework and the units in which the values are expressed in this report.

Figure 4.1: Service measure framework – anchor valuations

Performance measure / OPM	Metric/unit	Severity / level
Supply interruptions	Per property affected	6-12 hours unplanned interruption
Discolouration	Per property affected	Persistent
Severe water restrictions	Per expected day/ Per expected day per property affected	Rota cut & standpipe
Hosepipe bans	Per expected day/ Per expected day per property affected	Temporary use ban
Leakage	Per Ml/d	Leakage
Internal sewer flooding	Per property affected	Inside the living space at a property
External sewer flooding	Per property affected	Flooding the outside area/garden at a property

[8] The findings from the survey suggest the maximum package suggests a maximum of 8-13% limit on domestic bill increases for all service improvements, with a corresponding 4-7% for businesses.

[9] This may be due to changes that have occurred since the PR14 study e.g. changes to service levels.

Performance measure / OPM	Metric/unit	Severity / level
Odour nuisance	Per property affected	Odour
Pollution incidents	Per incident	Category 2
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

The final values in the tables are rounded.

4.4 Secondary data

The secondary data presented in this report is data that is available in the public domain. 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 study of PR14 values[10]. It is briefly mentioned here to explain the treatment of the data in the secondary data graphs. The Accent study provides information on a number of companies' values from PR14. In the report companies are anonymised, and values are presented as regional values (i.e. the £/unit value multiplied by the number of customers). This means the number of customers the value relates to is not known so an accurate £/household or £/non-household customer value cannot be calculated. This prevents accurate conversion for a comparison against the AWS customer base. For example, the Thames Water customer base is significantly larger than a small WOC.

To help overcome this issue the data from this report is presented in the graphs as one average value. This is an average of the values unadjusted for customer numbers divided by the average WASC customer numbers (or WOC customer numbers where this can be identified) prior to multiplying by the AWS customer base. This approach introduces uncertainty to these values when compared to the actual study results (which are not available in the public domain). To help understand the range, information is provided on the unadjusted values below the graphs.

Anglian Water are taking part in the Accent PR19 WTP comparison research study, with the main stage study results having been shared for the research. The results of the study do not feed into this report however, will form part of further secondary data for PR19 which will be available in due course.

4.5 Summary of quantitative evidence sources used in Step 3.0

A range of quantitative studies have been used in Step 3.0. These are briefly summarised in this section.

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.

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

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
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)	Potential scope of application is subject to ongoing research – the expectation however is that SWB is mainly applicable to persistent and 'readily' experienced service levels.
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 the 2012 (PR14) through to 2017. This also includes the PR19 Water Resources Study, which also contains information on a range of 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 three rounds of Stage 2 Customer Preference Studies in 2008, 2012 and 2017 that provide the basis for valuing the full set of service measures in the SMF.
- 'Other sources' primary dataset: compiling valuations from revealed preference (insurance and avertive behaviour), subjective wellbeing (flooding and traffic incidents), macroeconomic analysis (water restrictions impacts).
- '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 PR14).

The following Sections 5 to 23 (Part 2) summarise the triangulation of these evidence sources for the service measures that make up the SMF.

PART 2

5 Water service and disruption

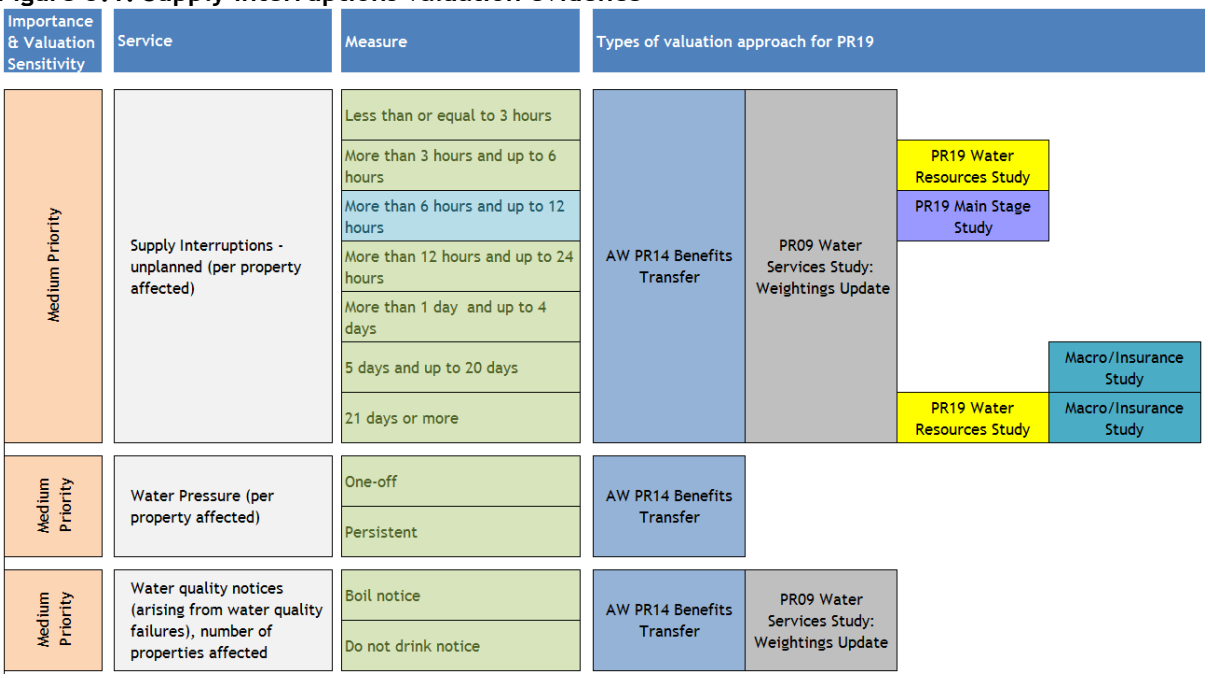
This section covers supply interruptions, and other measures that are linked to this namely low pressure and water quality notices.

Low pressure and water quality notices 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 supply interruptions 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.

Figure 5.1: Supply interruptions 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 two categories: Stated Preference, AWS compensation claims and qualitative focus group review of relative preferences. The AWS compensation claims are expected to be lower than the stated preference values as they reflect a partial valuation.

Table 5.1: Primary data sources

Study	Valuation type	Measures covered	Data	Robustness	Relevance
PR19 main stage study	Stated preference – valuation	Supply interruption 6 to 12 hours	Hhold, Non-hhold	H Large sample DCE & DCCV methodology	H Definition relevant, new study
PR19 Best-worst scaling	Stated preference – valuation	Supply interruption 6 to 12 hours	Hhold,	H Good sample size, BWS methodology	H Definition relevant, new study
PR14 main stage study	Stated preference – valuation	Supply interruption 6 to 12 hours, Pressure, Boil water notice	Hhold, Non-hhold	H Very large sample DCE & DCCV methodology	H Definition relevant, PR14 study
PR19 2nd stage water restrictions survey	Stated Preference – valuation	Supply interruption greater than 3 hours	Hhold, Non-hhold	H Good sample size, CV methodology followed by allocation exercise	H/M Definition different severity to anchor but relevant for wider SMF - compared to 3-6 hour measure, new study
PR09 Water services 2nd stage study	Stated Preference – customer preference weights	Weights for all supply interruption durations plus water quality notices in the Anglian Water SMF	Hhold	M	M Definition relevant, PR09 study
PR19 Macro economic analysis of drought impacts	AWS compensation claims (insurance data analysis)	Supply interruption 5 to 20 days	Non-hhold	L Assumptions required, partial value	M/L 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.	Hhold	M/L Qualitative, Small sample size	H Definition relevant, new research
PR19 triangulated severe water	Triangulated value – see section 7.1.	Supply interruption	Combined	H Triangulated value based on	H/M

restrictions value	Based on stated preference and macro-economic data analysis	greater than 21 days		multiple sources	Value compared relates to a 28 day restriction.

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 PR14.

Table 5.2: Secondary data sources

Study	Valuation type	Measures covered	Data	Robustness	Relevance
Southern PR14 WTP Main Stage (2013)	Stated Preference valuation	6 hours unexpected	Hhold, Non-hhold	H CV package methodology, good sample size	M/L PR14 study, study from Different company and area
South East PR14 Main Stage (2013)	Stated Preference valuation	6 – 12 hour interruption, 3 – 6 hour interruption, Persistent pressure	Hhold, Non-hhold	H CV package methodology, good sample size	M/L PR14 study, Different company and area
Affinity Water PR14 Main Stage / Accent joint study Affinity (2013)	Stated Preference valuation	Unexpected interruption 6 – 12 hours, persistent pressure, boiled water notice.	Hhold, Non-hhold	M DCE SP survey, good sample size	M PR14 study, East Anglian location, different company
Accent joint study - Unknown companies (2013)	Stated Preference valuation	Unexpected interruption 6 – 12 hours for two studies, Unexpected interruption 3 to 6 hours for 4 companies, persistent pressure for 3 companies	Hhold, Non-hhold	M Mixed surveys, limited published information	M/L Relevant definitions, PR14 study, unknown areas
South Staffs Water PR14 Main Stage	Stated Preference valuation	Unexpected interruption 6 – 12 hours, 3 to 6 hours, boiled water notice.	Combined	H DCE SP survey, good sample size	M/L PR14 study, Different company and area

5.1 Supply interruptions (6-12 hours)

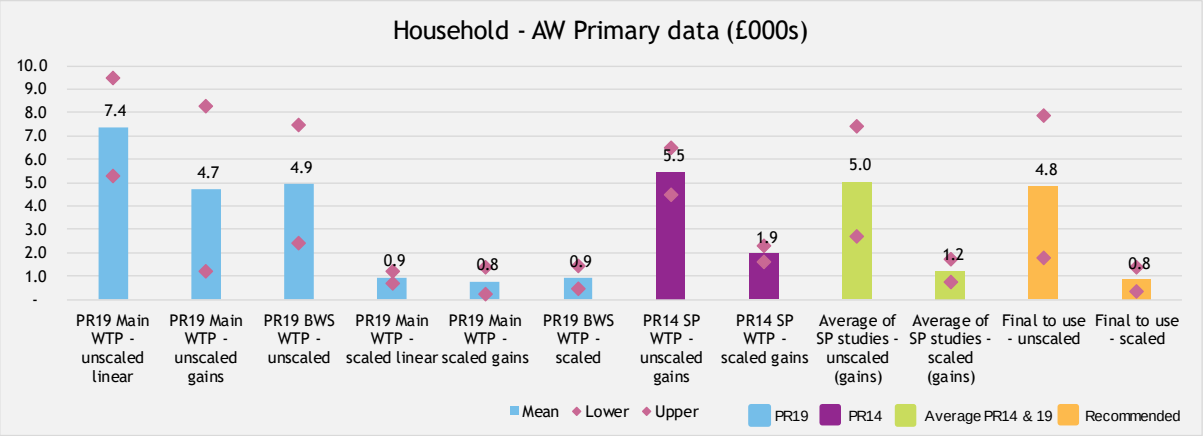
Step 3.0 Comparing valuations to produce recommendation

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

Figure 5.2: Household primary data - supply interruptions (6 - 12 hours), £ per property



Unscaled:
Both the unscaled central value and range are based on the average of the PR19 main stage unscaled gains[11] values and the PR19 BWS value. These two studies have produced similar values. The PR19 main stage gains value has been used in preference to the linear value as this is more conservative and appropriate for enhancements. The PR19 main stage mean gains value is also below the confidence range of the linear value.

The PR19 mean values are slightly lower than PR14 mean gains value with the PR19 recommended range encompassing the PR14 range. The two values can be considered consistent. The PR14 values have not been combined with the PR19 study as the PR19 range is more recent and more conservative.

Scaled:
Both the scaled central value and range are based on the average of the PR19 main study scaled gains values and the PR19 BWS values. The same reasons discussed above for unscaled apply for using the PR19 main study scaled gains value in preference to the scaled linear value. The PR19 scaled gains value is much lower than the PR14 scaled gains value suggesting that the PR14 value should not be used in the range.

Table 5.3: Scaled and unscaled household values (6- 12 hours), £k per property

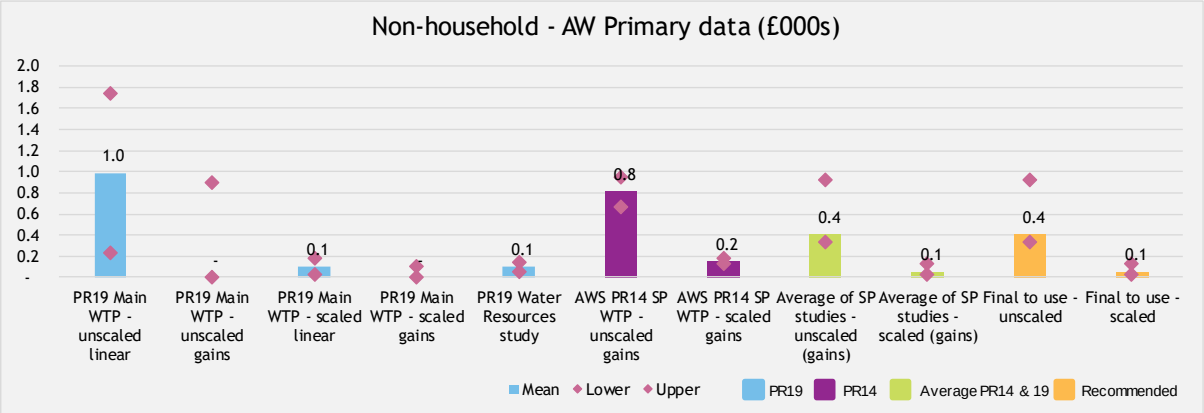
Value type	Lower	Central	Upper
Unscaled	1.8	4.8	7.9
Scaled	0.3	0.8	7.4

[11] Gains values can be used as an initial value in cost benefit analysis for testing the economic level of service.

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.

Figure 5.3: Non Household primary data - interruptions (6- 12 hours), £k per property



Unscaled:

Both the unscaled central value and range are based on the average of the PR19 main stage unscaled gains values and the PR14 value. The PR14 value is included as the PR19 value has greater uncertainty but the upper values are similar for both studies.

Similar to the household approach the PR19 unscaled main stage gains value has been used in preference to the linear value as this is more conservative.

Scaled:

Both the scaled central value and range are based on the average of the PR19 main stage scaled gains values and the PR19 Water Resources study (which is a scaled value). The PR19 Water resources study value definition is for an interruption to supply greater than 3 hours. This is a different severity to the other studies which are 6 to 12 hours. The Water Resources study value has been included for non-households as the value is higher (despite being a lower severity) than the PR19 main study which has demonstrated a reasonably large uncertainty range.

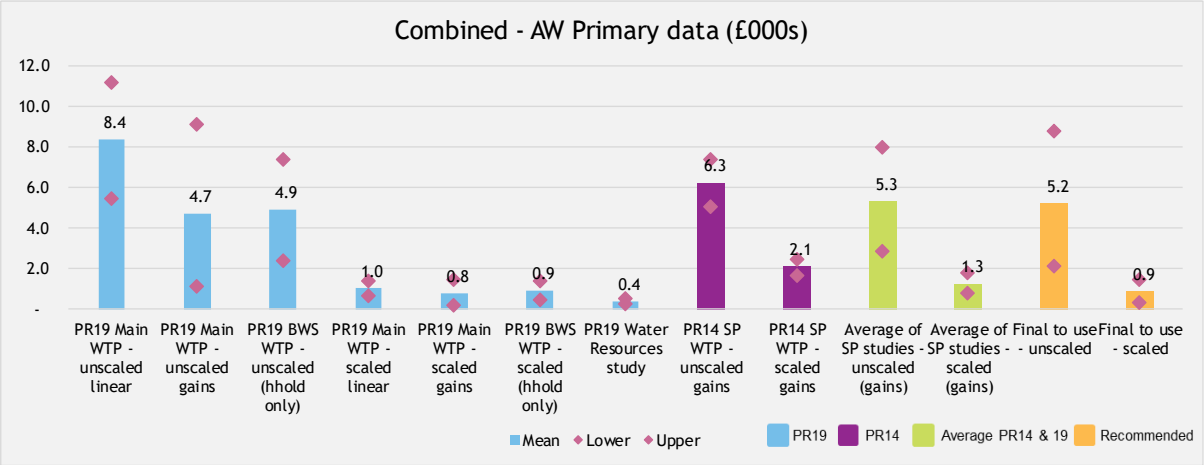
Table 5.4: Scaled and unscaled non-household values (6- 12 hours), £k per property

Value type	Lower	Central	Upper
Unscaled	0.3	0.4	0.9
Scaled	0.0	0.1	0.1

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.

Figure 5.4: Combined primary data - interruptions (6- 12 hours), £k per property



The values presented are the household range plus non-household range. The recommended unscaled values are slightly lower than PR14 but the range is wider. The recommended scaled values are lower than PR14 due to a change in the scaling factor.

Table 5.5: Initial recommended range - combined (6- 12 hours), £k per property

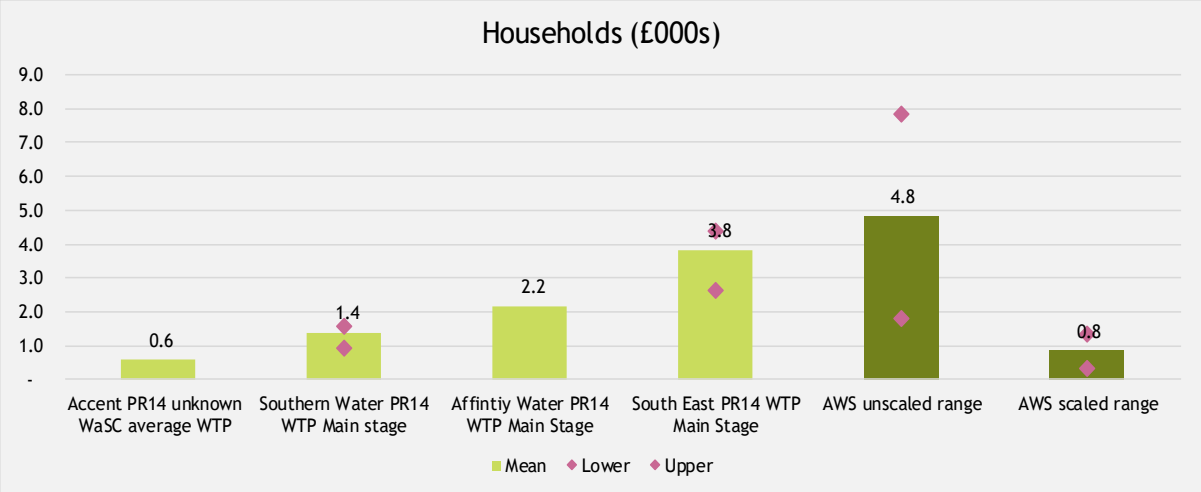
Value type	Lower	Central	Upper
Unscaled	2.1	5.2	8.8
Scaled	0.4	0.9	1.5

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. In all cases the scaled value aligns with lower values from other studies. In the household graph the unscaled value looks higher than other studies with the range overlapping whilst the non-household unscaled range is aligned with the lower values from the other studies. The combined graph shows that the impacts balance out and the combined value is aligned with the other studies. The combined graph also includes a further study at the upper end of the range.

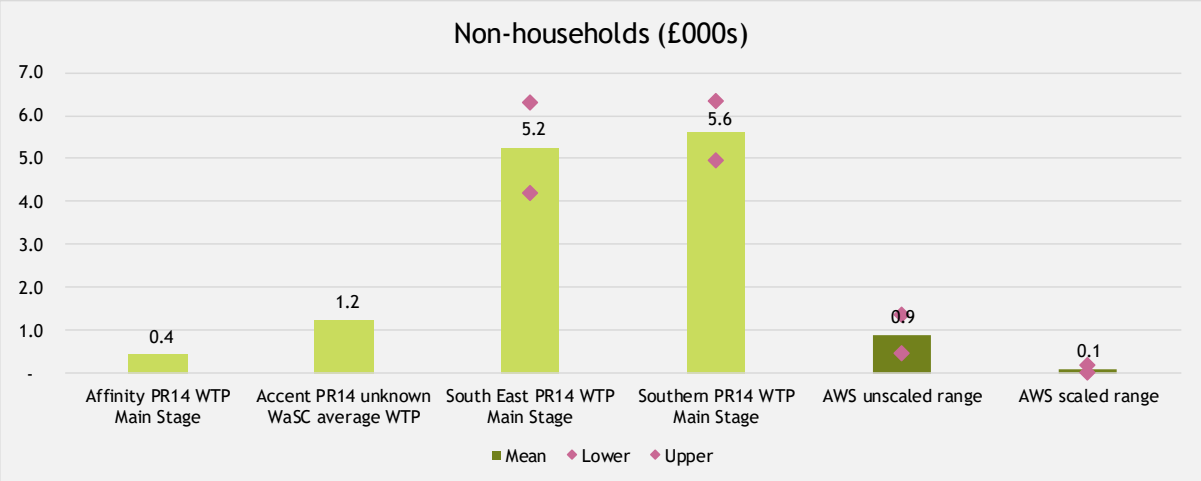
For comparison, the Southern Water and South East Water values are scaled values. The Affinity Water value is thought to be unscaled. The South Staffs Water value is unscaled.

Figure 5.5: Comparing to household secondary data - interruptions (6- 12 hours), £k per property



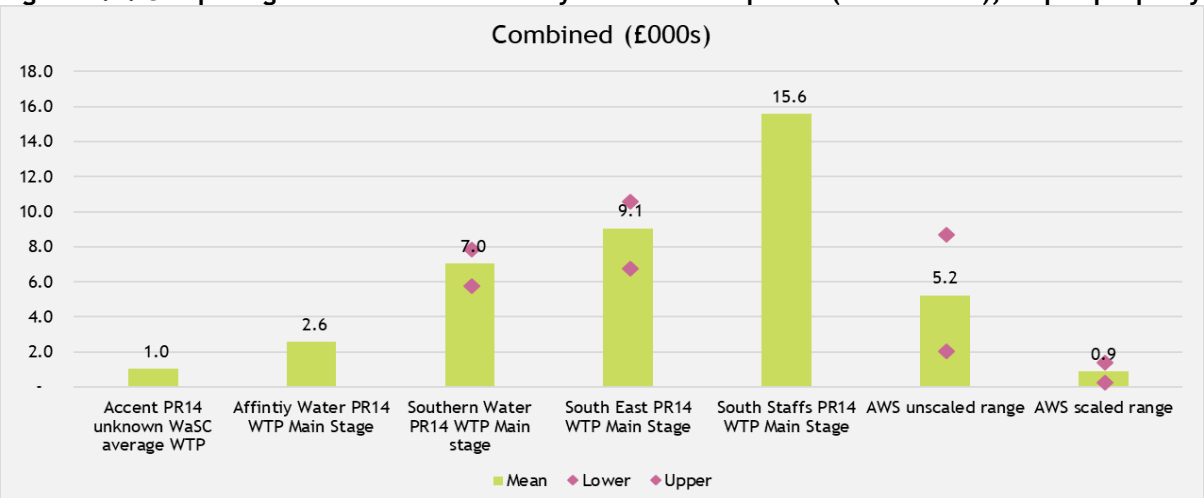
NB: Accent average unknown WaSC is based on 2 companies - average unadjusted (for customer numbers) values are 0.5k and 0.8k per property. Median = £0.6k increasing to 0.8k with the other studies included.

Figure 5.6: Comparing to non-household secondary data - interruptions (6- 12 hours), £k per property



NB: Accent average unknown WaSC is based on 2 companies - average unadjusted (for customer numbers) values are 0.4k and 2.4k per property. Median = £1.4k increasing to £2.5k with the other studies included.

Figure 5.7: Comparing to combined secondary data - interruptions (6- 12 hours), £k per property



NB: Accent average unknown WaSC is based on 2 companies - average unadjusted (for customer numbers) values are 1.2k and 2.9k per property. Median = £2.1k increasing to £5k with the other studies included.

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

The unscaled and scaled values for a 6 to 12 hours interruption have been mapped to the other durations using preference weights from the PR09 water services stated preference study. The results of the mapping are presented in the two tables below. Evidence from other primary sources is shown in the final column.

The validity of the preference weights used to map the values has been re-tested in the PR19 relative preference focus groups who generally support weightings between categories (see Annex 2). Comparing the results to wider triangulation evidence is a further validity check on both the weights and the anchor value (6 to 12 hour interruption).

For the unscaled results there are two further primary sources to compare:

- AWS compensation claims data (NERA, 2017). This is a business only value with relatively low robustness score due to the assumptions required. It is also a partial valuation as it will not cover inconvenience. The values are slightly lower than lower non-household SP value in line with expectations.
- AWS triangulated value range for a severe water restriction (see section 7). The 21 day or more value is compared to the range from this report for a severe water restriction. The interruptions unscaled value is higher.

Two secondary sources are available for the 3 to 6 hours duration band unscaled value. The unknown WaSC average value is £0.47k (this is thought to be mix of scaled and unscaled values) and the South Staffs value is £9.5k (unscaled). Both of these values have been adjusted for customer numbers.

Table 5.6: Unscaled – interruption duration bands, £

SMF duration	Unit	Lower	Central	Upper	Notes on values
Less than or equal to 3 hours	£/property	250	615	1,033	
More than 3 hours and up to 6 hours	£/property	966	2,375	3,987	Between the two PR14 secondary data sources therefore consistent.
More than 6 hours and up to 12 hours	£/property	2,128	5,232	8,783	Anchor
More than 12 hours and up to 24 hours	£/property	2,591	6,369	10,693	
More than 1 day and up to 4 days	£/property	5,122	12,591	21,139	
5 days and up to 20 days	£/property	6,920	17,013	28,563	AWS Business claims value much lower (£942 for midpoint) but limited data and partial value. Aligned with lower non-household SP value.
21 days or more	£/property	7,097	17,448	29,293	28 day severe water restriction (unscaled) lower (1,840 to 4,880)

For the scaled results there are three further primary sources to compare:

- 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 scaled 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 values are higher than the upper part of the non-household SP scaled value range.
- AWS triangulated value range for a severe water restriction (see section 7). The 21 day or more value is compared to the range from this report for a severe water restriction. The lower end of the interruptions scaled value and the upper end of the restrictions scaled value overlap. This result may be due to an underestimation of the restrictions value (see section 7 for more details).

Two secondary sources are available for the 3 to 6 hours duration band scaled value. For scaled values, the unknown WaSC average value is £0.47k (this is thought to be mix of scaled and unscaled values) and the South East Water value is £2.4k (scaled).

Table 5.7: Scaled – interruption duration bands, £

SMF duration	Unit	Lower	Central	Upper	Notes on values
Less than or equal to 3 hours	£/property	41	106	177	
More than 3 hours and up to 6 hours	£/property	160	410	684	Consistent with WR SP study – scaled value of 290 to 520. Consistent or lower than other company PR14 secondary data
More than 6 hours and up to 12 hours	£/property	353	902	1508	Anchor
More than 12 hours and up to 24 hours	£/property	429	1,099	1,835	
More than 1 day and up to 4 days	£/property	849	2,172	3,628	
5 days and up to 20 days	£/property	1,147	2,935	4,902	AWS Business claims value £942 for midpoint but limited data and partial value. Claims value is higher than the non-household recommended range.
21 days or more	£/property	1,176	3,010	5,028	28 day level 4 restriction (scaled) overlaps at lower end (1,170 to 2,480)

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final supply interruptions values to take forward are the values in Table 5.6 and Table 5.7 above.

Step 4.0 Assess and test valuations

The wider customer evidence for interruptions to supply has been reviewed for interruptions to supply (see annex 7). This review has found unplanned supply interruptions are an important service issue to customers. However, the online community research suggests the relative weights may be higher for longer duration interruptions. Testing the relative values of differing duration interruptions was also a key objective of the valuation focus groups (see annex 2). 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 the relative weights that have been used to produce the recommended values. The focus group also commented that the 5 to 20 days band is a wide range and could be more granular. Overall, given the balance of the evidence no changes have been made to the recommended value.

5.2 Low pressure and water notices

Step 3.0 Comparing valuations to produce recommendation

As outlined in Step 1, the values for low pressure and water notices are linked to the anchor value for interruptions. 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 unscaled and scaled values for a 6 to 12 hours interruption have been mapped to the wider service measures and the results are presented in Table 5.8 and Table 5.9 below. Evidence from other primary sources and notes on the calculations are shown in the final column.

The value for persistent pressure has been linked to the value for interruptions using PR14 weights derived from the PR14 main WTP study. Both of these values were included in the PR14 main WTP study and the study produces a set of customer preference weights as well as values. The PR14 relative preference weight has been applied in preference to inflating the PR14 value for two reasons:

- Preference weights are more likely to be stable over time compared to values; and
- The interruptions values have changed since PR14. The PR19 focus groups to test relative preferences have shown that customer consider pressure as a similar issue to interruptions therefore linking the two values is appropriate. Using the weight produces a lower value reflecting the change in interruptions values from PR14 to PR19.

The 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). This is explored further in the water quality section. The pressure value is a value for a persistent problem that is expected to occur throughout the year. The value for a one-off incident has been calculated by dividing by 365 to produce a value for 1 day.

Further secondary data is available for persistent water pressure. For scaled values the Accent 2014 study unknown WaSC average is £15.1k (based on 3 companies). All of the values contributing to this are thought to be scaled values. The value for South East Water is £4.1k. These values suggest that the scaled value is consistent with secondary evidence.

For unscaled there is only one secondary source. This is Affinity Water PR14 study[12] with a value of £11.9k (when adjusted for customer numbers). This is considerably lower than the unscaled value. However, this is one source and the scaled values appear to be aligned.

The drinking water quality notices are linked to the value for interruptions using PR09 water services SP study weights. Boil water notices were also included in the PR14 study. Similar to low pressure above, a relative preference weight can be calculated from this for how a boil water notice relates to a 6 to 12 hour interruption. This approach suggests a higher value than the values shown in the tables below. This suggests that the water quality notices values may be conservative. However, the PR19 relative preference focus groups likened a boil water notice to a medium length interruption (assumed to be 6 to 12 hour interruption). The recommended values have been compared to this (see table) and found to be consistent for both scaled and unscaled values (hence the lower values have been recommended).

Two further secondary data values are available for boil water notices. These are both unscaled values. South Staffs value of £7.4k is aligned and the Affinity Water value of £20.3k is higher than the recommended unscaled value.

[12] Affinity Water was identified from the Accent study.

Table 5.8: Pressure and water notices unscaled (£)

SMF duration	Unit	Lower	Central	Upper	Notes on values
Water Pressure: one-off	£/property	87	213	358	FG compared to instances of discolouration & interruptions. Calculation from persistent - based on 1 days assuming persistent is 365 days per year
Water Pressure: persistent	£/property	31,632	77,762	130,557	Linked to interruptions using the PR14 main study weight. Higher than the PR14 Affinity Water value (£11.9k)
Boil notice	£/property	2,384	5,860	9,839	FG likened boil water notice to a medium interruption. 6 to 12 hours (unscaled) is 2,130 to 8,780 so consistent. Aligned or lower than PR14 other company secondary data.
Do not drink notice	£/property	6,639	16,320	27,400	FG groups agreed with PR09 weighting relative to boil water notices and interruptions.

Table 5.9: Pressure and water notices scaled (£)

SMF duration	Unit	Lower	Central	Upper	Notes on values
Water Pressure: one-off	£/property	14	37	61	FG compared to instances of discolouration & interruptions. Calculation from persistent - based on 1 days assuming persistent is 365 days per year
Water Pressure: persistent	£/property	5,243	13,415	22,408	Linked to interruptions using the PR14 main study weight. Consistent with PR14 other company secondary evidence.
Boil notice	£/property	395	1,011	1,689	FG likened boil water notice to a medium interruption. 6 to 12 hours (scaled) is 353 to 1,508 so consistent.
Do not drink notice	£/property	1,100	2,815	4,703	FG groups agreed with PR09 weighting relative to boil water notices and interruptions.

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final low pressure and water quality notice values to take forward are the values in Table 5.8 and Table 5.9 above.

Step 4.0 Assess and test valuations

For low pressure the recommendation made in the interim stage report was to undertake further testing as the recommended values were relatively high compared to other water disruption impacts, whilst the valuation focus groups suggested that intermittent low pressure – even if this is ongoing – is not too much of a concern. This is also reflected in the wider customer evidence (see annex 7) where customers who had experienced low pressure felt able to adapt their behaviour, although recognising that it is an issue for Anglian Water to address. No further robust quantitative evidence is available to suggest an alternative value should be applied. We therefore recommend undertaking sensitivity testing using the lower end of the recommended range for this measure.

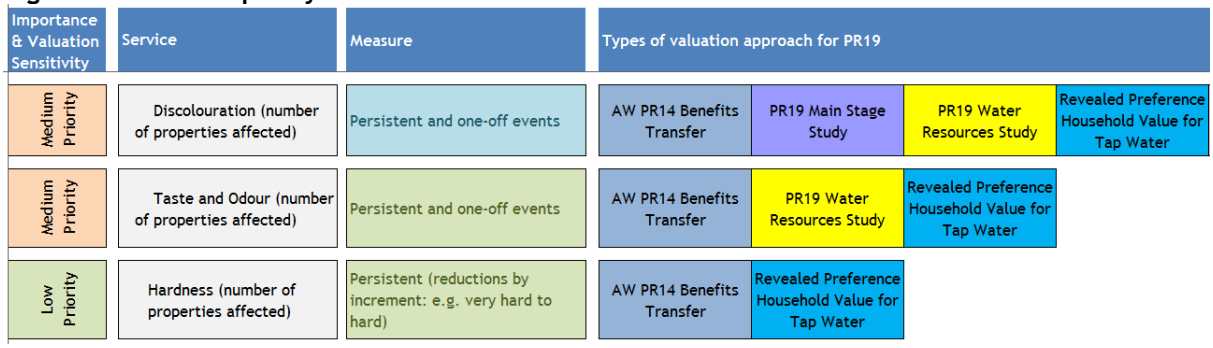
6 Drinking water quality

This section covers drinking water quality. Specifically, discoloured water, taste and odour issues, and hard water.

Step 1.0 – Specify and undertake research

The evidence base for drinking water quality is given below. The anchor measure is discolouration at one property (highlighted in blue). The wider framework covers taste and odour and hardness.

Figure 6.1: Water quality 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 Stated Preference studies, avertive expenditure and qualitative focus group review of relative preferences. The avertive behaviour values are expected to be lower than the stated preference values will not capture public good or inconvenience values.

Table 6.1 Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR19 main stage study	Stated preference valuation	Discolouration	Hhold, Non-hhold	H Large sample DCE & DCCV methodology	H Definition relevant, new study
PR19 Best-worst scaling	Stated preference valuation	Discolouration	Hhold	H Good sample size BWS methodology	H Definition relevant, new study
PR14 main stage study	Stated preference valuation	Discolouration, Taste & odour	Hhold, Non-hhold	H Very large sample DCE & DCCV methodology	H Definition relevant, new study
PR19 2nd Water Resources survey	Stated Preference valuation	Aesthetic (Discolouration + T&O)	Hhold, Non-hhold	H Good sample size, CV methodology followed by allocation exercise	H/M Definition covers total aesthetics. Adjusted to split out discolouration

PR14 Industry avertive behaviour study	Revealed preference valuation	Discolouration, Taste & odour, Hardness	Hhold	H/M Good sample size, robust estimation, partial value as excludes damage costs.	L (Discolouration & T&O) Evidence suggests covers much less severe problems H for hardness
PR09 Water services 2nd stage study	Stated Preference – customer preference weights	Weights for discolouration and T&O	Hhold	H DCE methodology, good sample size.	M Definition relevant, PR09 study
PR19 relative preference focus group	Qualitative review of customer preference weights from PR09 water services 2nd stage study plus discussion	Discolouration, Taste & odour, Hardness	Hhold	M/L Qualitative, Small sample size	H Definition relevant, new research

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. It covers a range of other company stated preference surveys from PR14 and one further study from PR09.

Table 6.2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
Cambridge PR14 WTP Main Stage (2013)	Stated Preference valuation	Taste & Odour	Hhold	H DCE methodology, good sample size	M PR14 study, East Anglian location, different company
Southern PR14 WTP Main Stage (2013)	Stated Preference valuation	Discolouration	Hhold, Non-hhold	H CV package methodology, good sample size	M/L PR14 study, study from Different company and area
South East PR14 Main Stage (2013)	Stated Preference valuation	Discolouration	Hhold, Non-hhold	H CV package methodology, good sample size	M/L PR14 study, Different company and area

Lanz and Provins (2011)	Stated Preference valuation	Discolouration	Hhold	H Unknown SP methodology, Peer reviewed academic paper, limited public domain information	M/L PR14 study for unknown area
Affinity Water PR14 Main Stage / Accent joint study Affinity (2013)	Stated Preference valuation	Discolouration, Taste & Odour	Hhold, Non-hhold	H DCE SP survey, good sample size	M PR14 study, East Anglian location, different company
Accent joint study - Unknown companies (2013)	Stated Preference valuation	Discolouration for 6 companies	Hhold, Non-hhold	M Mixed surveys, limited published information	M/L Relevant definitions, PR14 study, unknown areas
South Staffs PR14 WTP study	Stated preference valuation	Discolouration, Taste & Odour	Combined	H DCE SP survey, good sample size	M/L PR14 study, Different company and area

6.1 Discolouration

Step 3.0 Comparing valuations to produce recommendation

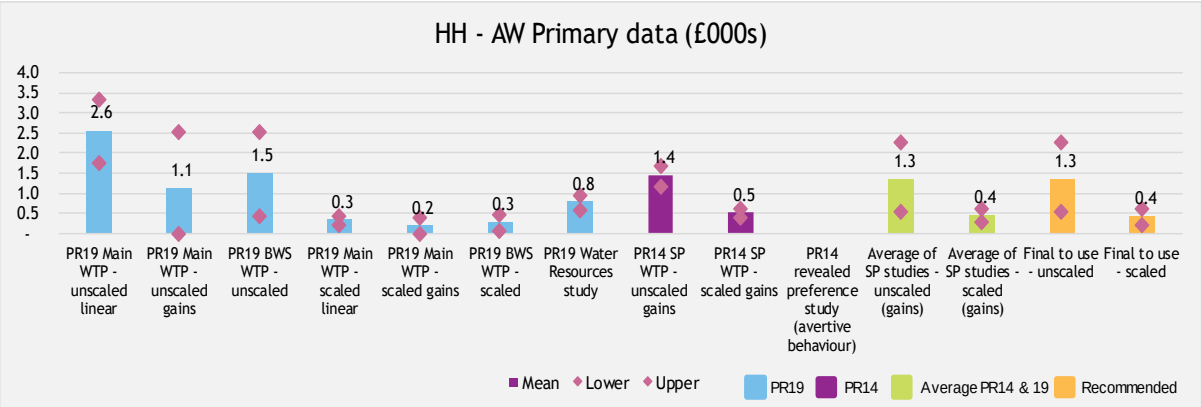
Step 3a: Primary data & initial recommended range

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 6.2. The recommended range is shown both in the graph below and in Table 6.3.

Figure 6.2: Primary data - discolouration, £k per property



NB: Water Resources study value is adjusted to present the discoloured water proportion as covered all aesthetics

Unscaled:
Both the unscaled central value and range are based on the average of the PR19 main stage unscaled gains values, the PR19 BWS value and the PR19 unscaled gains value.

The PR19 main stage 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.

The PR19 main stage mean gains value is lower than PR14 mean gains value. However, the PR19 main study range encompasses the PR14 range and the PR14 value is aligned with the PR19 BWS value. This together with the observation that the PR14 range is tighter than the ones observed for both the PR19 studies has led to the PR14 value being included in the calculation of the recommended range.

Scaled:
Both the scaled central value and range are based on the average of PR19 main stage scaled gains, PR19 BWS and PR19 Water Resource study values. The same reasons discussed above for unscaled apply for using the scaled gains value in preference to the scaled linear value applies. The PR19 main stage scaled gains value and the PR19 BWS values are lower than the PR14 scaled gains value suggesting that the PR14 value should not be used in the range.

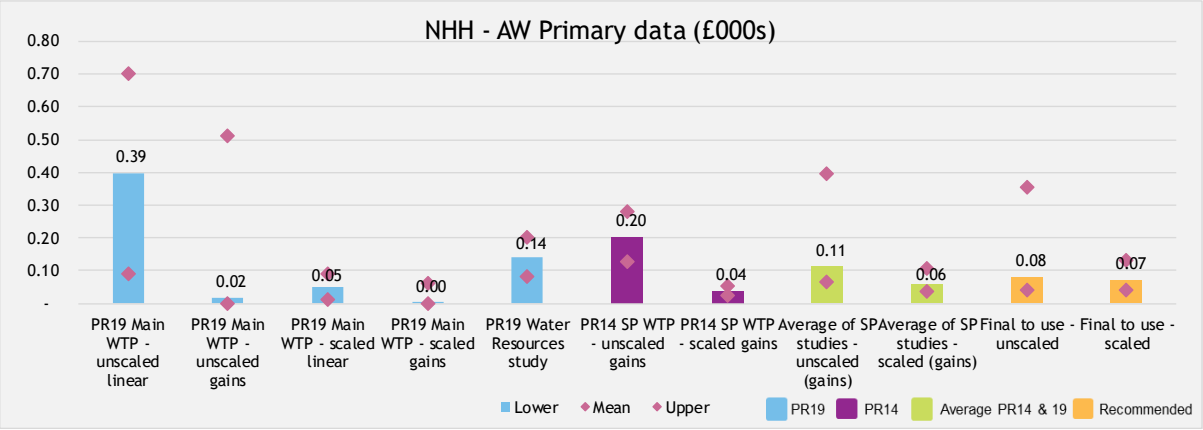
A further source is the PR14 avertive behaviour study which produced a zero value per household for qualitative changes in colour. This is due to not being able to correlate respondent categorisation of quality with expenditure on substitute products. The study was a general survey of customers that 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 failures that this value is intending to cover.

Table 6.3: Scaled and unscaled household values - discolouration, £k per property

Value type	Lower	Central	Upper
Unscaled	0.5	1.3	2.3
Scaled	0.2	0.4	0.6

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 - discolouration, £k per property



NB: Water Resources study value is adjusted to present the discoloured water proportion as covered all aesthetics

Unscaled:
Both the unscaled central value and range are based on the average of the PR19 main stage unscaled gains values and the PR19 Water Resources study. The PR19 Water Resources study is a scaled value. It has been used to inform the unscaled range as the mean value is larger than the PR19 main study unscaled mean and the PR19 main study range encompasses the PR19 Water Resources range. This means that the two values are consistent.

Similar to the household approach the PR19 main stage unscaled gains value has been used in preference to the linear value as this is more conservative. The PR14 value has not been included as the mean and lower value are larger than both of the PR19 study mean values.

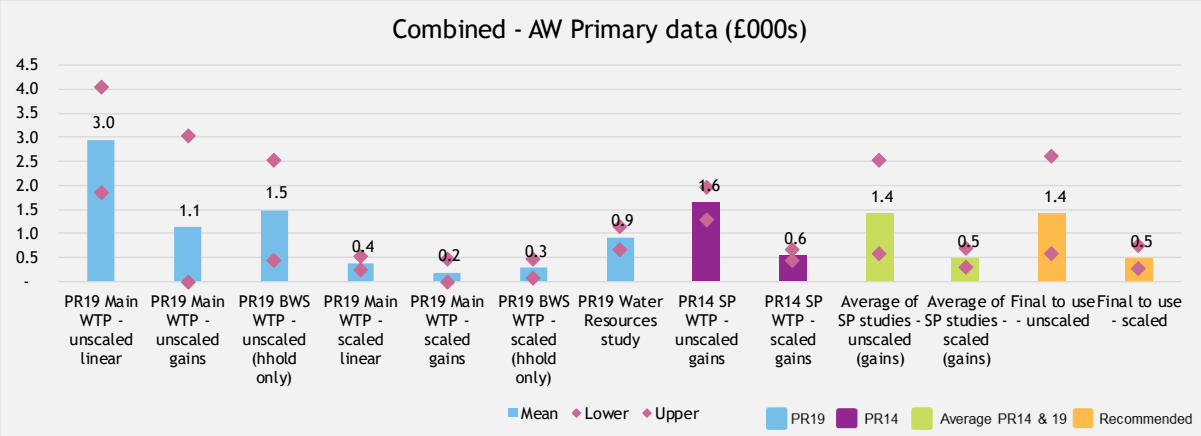
Scaled:
Both the scaled central value and range are based on the average of PR19 main study scaled gains and the PR19 Water Resource study.

Table 6.4: Scaled and unscaled non-household values, £k per property

Value type	Lower	Central	Upper
Unscaled	0.04	0.08	0.36
Scaled	0.04	0.07	0.13

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 - discolouration, £k per property



NB: Water Resources study value is adjusted to present the discoloured water proportion as covered all aesthetics

The values presented are the household range plus non-household range. The recommended unscaled values are similar to PR14 but the range is wider. The recommended scaled values are similar to PR14.

Table 6.5: Initial recommended range - combined, £k per property

Value type	Lower	Central	Upper
Unscaled	0.6	1.4	2.6
Scaled	0.3	0.5	0.7

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

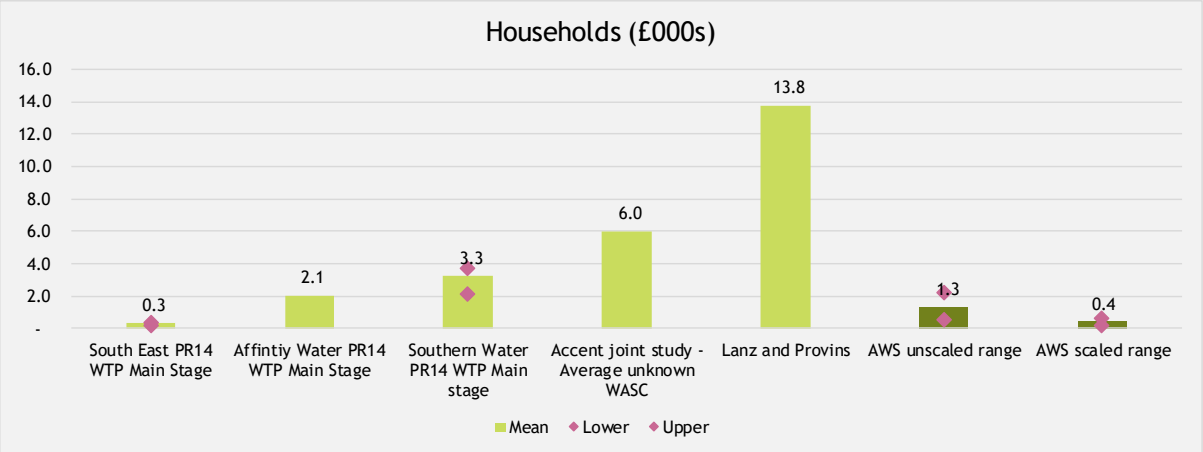
Figure 6.5 to Figure 6.7 show how the ranges compare to the secondary data sources available. The values are low compared to other studies.

A review shows that the definitions of the studies are not consistent. The studies definitions cover a mix of one-off and persistent impacts with many not clear and some descriptions reading more persistent than others. The AWS value is intended to capture a persistent but not continuous issue.

Out of the other studies shown South East and Southern Water are scaled values. The Affinity Water value is thought to be unscaled; Lanz and Provins study is a value for an unnamed WaSC that is unscaled. The studies included under the Accent joint study are thought to be a mix of scaled and unscaled values.

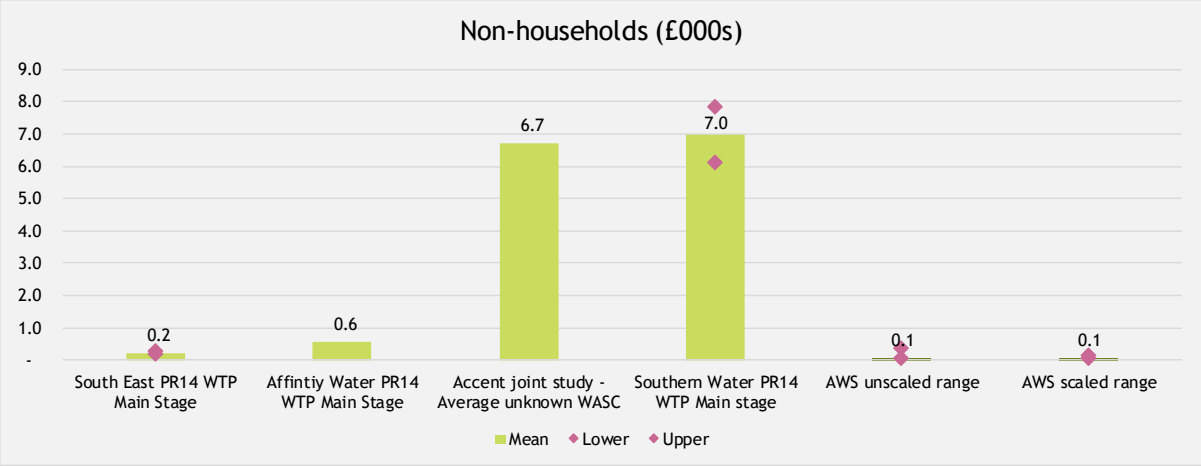
In addition to the varied descriptions the low AWS values may be linked to the low prevalence of discolouration issues in the AWS region compared to other regions.

Figure 6.5: Comparing to household secondary data, £k per property



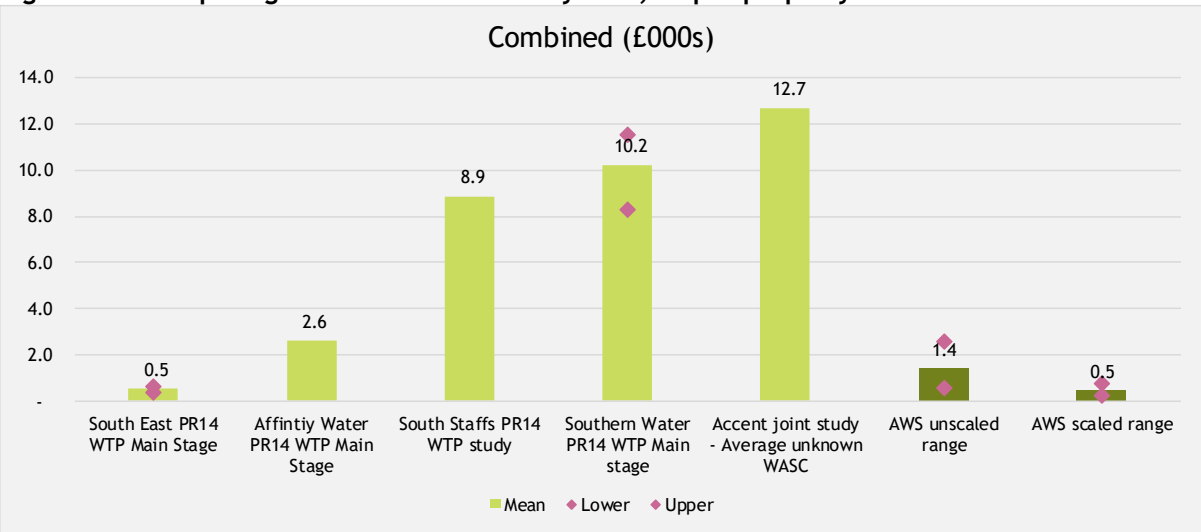
NB: Accent average unknown WaSC is based on 6 companies - masks a wide range of values. The unadjusted (for customer numbers) values range from 0.1k to 23.9k per property. Median = £3k.

Figure 6.6: Comparing to non-household secondary data, £k per property



NB: Accent average unknown WaSC is based on 6 companies - masks a wide range of values. The unadjusted (for customer numbers) values range from £0.7k to £14.2k per property. Median = £8.2k.

Figure 6.7: Comparing to combined secondary data, £k per property



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

The ranges for discolouration are shown in the tables below. The AWS value is intended to capture a persistent but not continuous issue. The value for a one-off event is a value for 1 day assuming that the persistent problem occurs for 21 day (3 weeks) per year.

Table 6.6: Unscaled - Discolouration, £ per property

SMF band	Unit	Lower	Central	Upper	Notes on values
Discolouration: one-off	£/property	28	68	124	Calculation from persistent - based on 1 days assuming persistent is 21 days/year
Discolouration: persistent	£/property	579	1,423	2,612	Anchor

Scaled - Discolouration, £ per property

SMF band	Unit	Lower	Central	Upper	Notes on values
Discolouration: one-off	£/property	13	23	36	Calculation from persistent - based on 1 days assuming persistent is 21 days/year
Discolouration: persistent	£/property	268	484	748	Anchor

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final discolouration values to take forward are in Table 6.6 and Table 6.7 above.

Step 4.0 Assess and test valuations

The wider customer evidence for discolouration has been collated and reviewed by AWS (see annex 7). Discolouration is seen as a relatively important issue to customers and there is some concern around the chemicals in the water supply and addressing common issues with tap water such as discolouration through calcium content. The review aligned with the recommendations presented in this report.

6.2 Taste & Odour and Hardness

Step 3.0 Comparing valuations to produce recommendation

As outlined in Step 1, the values for taste and odour and hardness are linked to the anchor value for discolouration. 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 unscaled and scaled values for discolouration have been mapped to the wider service measures and the results are presented in the two tables below. Evidence from other primary sources and notes on the calculations are shown in the final column.

The value for taste and odour has been linked to the value for discolouration using the PR14 weights from the main PR14 WTP study. Both of these values were included in the PR14 main WTP study. This study produces a set of customer preference weights as well as values. The weight has been applied in preference to inflating the PR14 value as preference weights are more likely to be stable over time compared to values and the discolouration value has been updated for PR19. However, the two approaches produce similar values (see tables for details).

The taste and odour value has been 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 £105 per household[13]. 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%). Even if this value is increased the result is still much lower than the stated preference value.

[13] Value quoted is the Anglian Water specific number provided in the company specific annex (inflated to 2017 prices). The value therefore differs to the main report which presents the national average 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 customer 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.

The value for a one-off taste and odour incident is calculated using the same assumptions as discolouration (see previous section).

The secondary data for taste and odour is variable but there is evidence of both lower and higher values for both the scaled and unscaled ranges.

Hardness value is calculated from the household avertive expenditure (RP) study and the Taste and Odour persistent value. The upper value is based on the percentage uplift between the Taste and Odour RP and SP mean values applied to the hardness RP value. The lower value is set equal to the RP value with the central value set at the average of the two values.

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 hardness would be lower than Taste and Odour. Taste and Odour would be an absolute maximum value. 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.

Table 6.7: Unscaled – Taste and odour and hardness, £

SMF band	Unit	Lower	Central	Upper	Notes on values
Discolouration: persistent	£/property	579	1,423	2,612	Anchor
Taste and Odour: one-off	£/property	423	1,041	1,911	Calculation from persistent - based on 1 days assuming persistent is 21 days/year
Taste and Odour: persistent	£/property	8,892	21,862	40,132	Household value (£8.3k to £34.7k) is substantially higher than RP study value (£105). T&O value is consistent with PR14 main WTP value inflated (17.1k to 27.3k). Consistent with secondary data for PR14 other company values.
Hardness	£/property	32	3,347	6,663	Lower equals RP value. Upper is uplift of the mean RP value based on relative difference between T&O SP and RP mean values. RP is partial value.

Table 6.8: Scaled – Taste and odour and hardness, £

SMF band	Unit	Lower	Central	Upper	Notes on values
Discolouration: persistent	£/property	268	484	748	Anchor
Taste and Odour: one-off	£/property	196	354	547	Calculation from persistent - based on 1 days assuming persistent is 21 days per/yr
Taste and Odour: persistent	£/property	4,115	7,443	11,492	Household value (£3.5k to £9.5k) is higher than RP study value (£105). Value is consistent with PR14 main WTP value inflated (£5.6k to £8.9k). Consistent with secondary data for PR14 other company values.
Hardness	£/property	32	1,150	2,268	Lower equals RP value. Upper is uplift of the mean from RP value based on relative difference between T&O SP and RP mean values. RP is partial value.

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final water quality (taste and odour and hardness) values to take forward are the values in Table 6.7 and Table 6.8 above.

It is noted that further analysis is available to link the hardness value to actual changes in calcium carbonate levels in the water. However, as this will exclude the damage costs of hardwater the above values are recommended in preference.

In general, further research on avertive behaviour and damage costs for different severity aesthetic impacts would be beneficial in the future.

Step 4.0 – Assess and test valuations

The wider customer evidence for aesthetic water quality has been collated and reviewed by AWS (see annex 7) This review found that customers are generally accepting of hard water and acknowledged it was a regional issue that they were used to dealing with. Customers were also keen to ensure Anglian Water address common issues with tap water such as taste and odour. This generally aligns with the recommendations presented in this report.

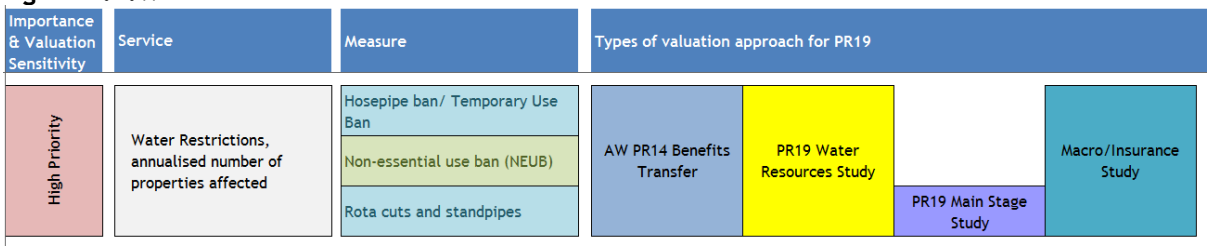
7 Water restrictions

This section covers severe water restrictions (rota cuts and standpipes), hosepipe bans and non-essential use bans. The results presented below are based on the most up-to-date triangulation of values from the main stage study, the Best Worst Scaling survey, the second stage water resources study and macroeconomic assessment. The section provides a high-level summary, focusing on the gains values (scaled and unscaled). It should be noted that a set of values were developed in October 2017 prior to the interim version of this report. These initial values underpinned the development of the draft WRMP and were based on an earlier triangulation of the valuation evidence. Annex 3 contains the final values provided for the draft WRMP and the detailed set of final values for water resource options and water restrictions.

Step 1.0 – Specify and undertake research

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

Figure 7.1:Water restrictions valuation evidence



Step 2.0 Synthesis of research

Table 7.1 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 three surveys. The valuation data from these surveys covers two measures (hosepipe bans and rota cuts). The 2nd stage WR 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.

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 7.1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR19 2nd Water resources survey	Stated Preference valuation	Rota cuts Hosepipe ban	Household Non-household	H Good sample size, CV methodology	H Definition relevant, new 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, new study
PR19 main stage study	Stated preference - valuation	Rota cuts	Household	H DCE methodology, large sample	H Definition relevant, new study
PR19 Best-worst scaling	Stated preference - valuation	Rota cuts	Household	H BWS methodology, good sample size	H Definition relevant, new 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	H Definition relevant, new study on 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	H/M 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	H/M PR14 study, Generally consistent definitions

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.

Table 7.2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
Cambridge Water PR14 WTP Main Stage (2013)	Stated Preference - valuation	Hosepipe ban	Household	H Unknown SP methodology, limited public domain information	M/L PR14 study, East Anglian location, different company Length of restriction not known to assumed 5 months in calculation for per day
Lanz and Provins (2011)	Stated Preference - valuation	Hosepipe ban	Household	H Unknown SP methodology, Peer reviewed academic paper, limited public domain information	M/L PR14 study for unknown area, Length of restriction not known to assumed 5 months in calculation for per day
Southern PR14 WTP Main Stage (2013)	Stated Preference - valuation	Hosepipe ban, Rota cuts, Long term stoppages (>2 weeks)	Household Non household	H CV package methodology, good sample size	M/L PR14 study, study from a water stressed region but different company and area
South East PR14 Main Stage (2013)	Stated Preference - valuation	Hosepipe ban	Household Non household	H CV package methodology, good sample size	M/L PR14 study, study from a water stressed region but different company and area
Thames Water PR09 WTP Main Stage (2008)	Stated Preference - valuation	Hosepipe ban	Household	H/M DCE methodology, small sample size	L Old study, Length of restriction not known to assumed 5 months in calculation for per day, study from a water stressed region but different company and area

Affinity Water PR14 Main Stage / Accent joint study Affinity (2013)	Stated Preference – valuation	Hosepipe ban	Household	H/M Unknown SP methodology, limited public domain information, back calculated from public data.	M/L PR14 study, East Anglian location, different company, Length of restriction not known to assumed 5 months in calculation for per day
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	H/M Based on PR14 studies, Meta study covering England and Wales
South Staffs Water PR14 WTP Main Stage (2013)	Stated Preference – valuation	Hosepipe ban	Combined	H DCE methodology, limited public domain information	M/L PR14 study, different company and area
Bristol Water (2014)	Stated Preference – valuation	Hosepipe ban	Combined	H Unknown SP methodology, limited public domain information	M/L PR14 study, different company and area

7.1 Severe water restrictions (rota cuts and standpipes)

Step 3.0 Comparing valuations to produce recommendation

Step 3a: Primary data & initial recommended range

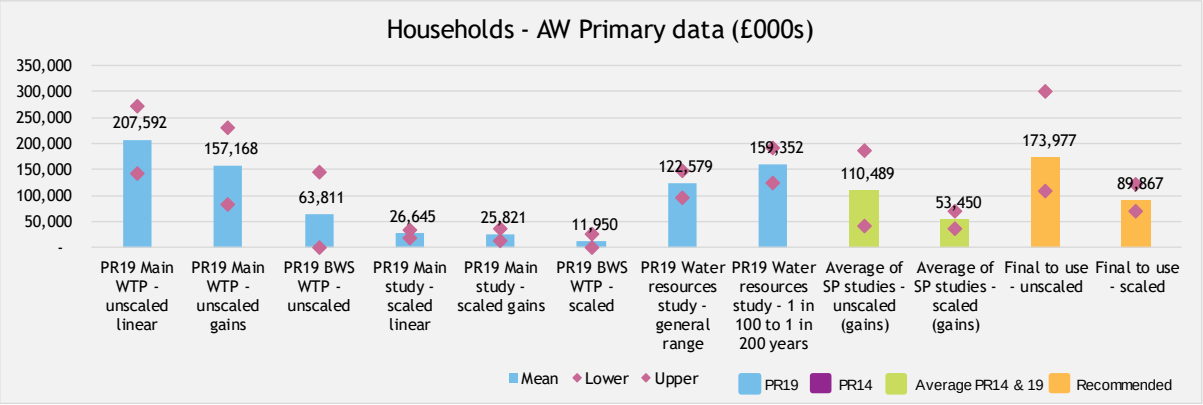
This section presents the primary data for households, non-household and the combined customer base. Severe water restriction values are the values for rota cuts & standpipes added together[14].

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.

[14] The PR19 stated preference studies (water resources and main WTP) both 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 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.

Figure 7.2: Household primary data – Severe water restrictions, £ per expected day of restriction



Note: the graph shows £/expected day of restriction. Values in tables are £/expected day of restriction/property affected.

Unscaled:
Both the unscaled central value is based on the average of the PR19 main stage unscaled gains value and an average of the PR19 main stage unscaled gains value and the PR19 BWS. This approach has been applied as the PR19 BWS value has a large confidence interval and is lower than both the PR19 main stage and the PR19 Water Resources study value, despite this last value being a scaled value. The PR19 unscaled gains value is used in preference to the linear value as this is more conservative. The ranges are set at the PR19 main stage unscaled gains values. There are no PR14 values to compare to.

The service improvement range of interest is for a change in service from 1 in 100 years to 1 in 200 years. The results from the PR19 water resources (WR) study indicated that there is a 30% uplift for this range relative to the general gains value which covers a larger range of improvement. The general ranges from the PR19 main stage study and the PR19 BWS also cover a larger improvement to service than the PR19 WR study; therefore this uplift is considered both applicable and is likely to be conservative[15].

Scaled:
Both the scaled central value and range are based on the midpoint between the average of the PR19 scaled gains and PR19 Water Resource general value and the average of the same values plus the PR19 BWS values. The same approach to the uplift is applied as for the unscaled.

Table 7.3: Scaled and unscaled household values – Severe water restrictions, £ per expected day of restriction/property affected

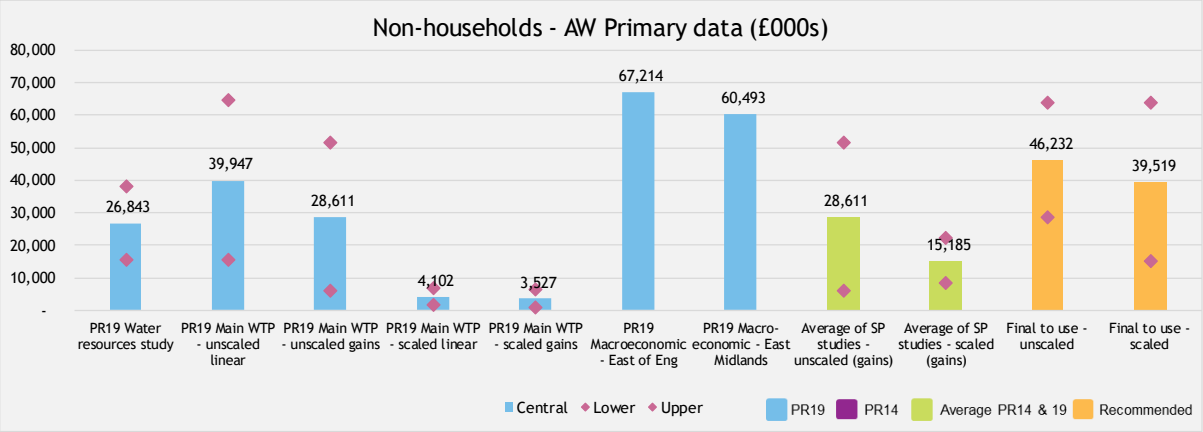
Value type	Lower	Central	Upper
Unscaled	52.16	83.42	143.77
Scaled	34.41	39.79	58.09

[15] The general value for the PR19 main study covers an improvement up to 1 in 1000 year event whereas the PR19 Water Resources study value covers an improvement up to a 1 in 500 year event. Given that the WTP per unit of improvement is expected to reduce as the service level improves the average per unit value across the improvement range for the PR19 main study value is expected to be lower than the PR19 WR study value. In other words the 30% uplift from the PR19 WR study relates to the ratio of 1.3:1.0 for a change from 1 in 100 to 1 in 200 years:1 in 100 to 1 in 500 years.

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 - Severe water restrictions, £ per expected day of restriction



Note: the graph shows £/expected day of restriction. Values in tables are £/expected day of restriction/property affected.

Unscaled:

Unscaled central value is based on the average of PR19 main WTP unscaled gains value and macroeconomic study value[16]. The lower value is set at the PR19 main WTP unscaled gains value and the upper value is set using the macro-economic study value.

Similar to the household approach the PR19 main stage unscaled gains value has been used in preference to the linear value as this is more conservative.

Scaled:

The scaled value and range uses the same approach as unscaled. The main difference is that the average of stated preference value (PR19 main stage WTP scaled gains value and PR19 Water Resource study value) is used in place of PR19 main WTP unscaled value.

The values produced for the East of England and East Midlands areas are from the Macro-economic study. These two areas cover the water resource zones where the WRMP investment is targeting service level changes. The final to use values are averaged for presentation here.

The macro-economic study values are higher than the stated preference values although the unscaled linear range does cover the East Midlands macroeconomic study values. It is recommended that the deviations in these two approaches are explored further. Possible reasons include:

- Customers do not have experience of severed restrictions, so it is difficult for them to value and they may therefore underestimate the impact
- 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). This would also provide an explanation as to why the recommended value for a 28 day severe water restriction is lower than the long run supply interruption (see section 5).

[16] The PR19 Water Resources study is not used to influence the unscaled range as this value is a scaled only value

- 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.

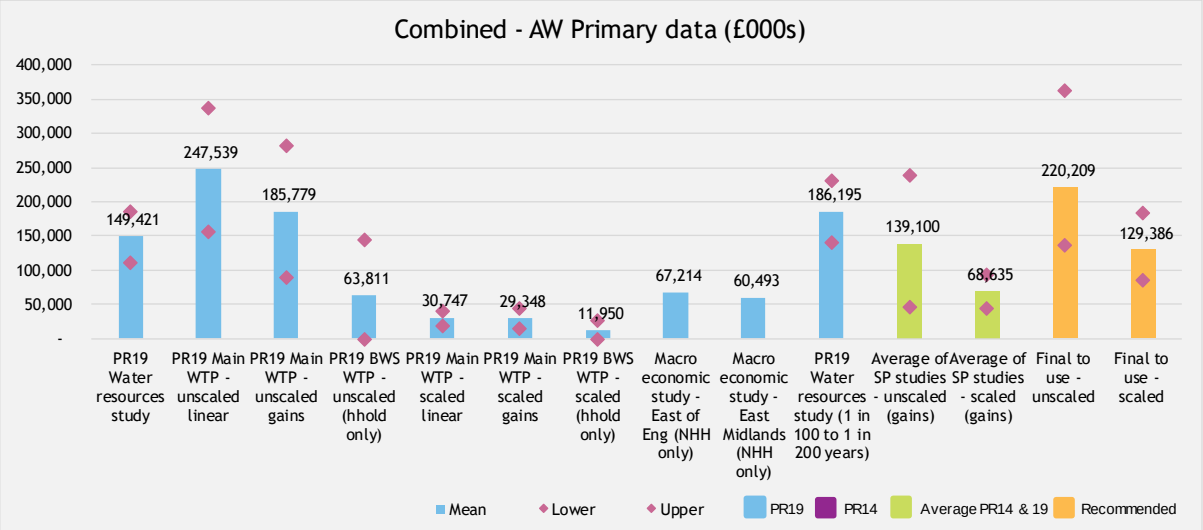
Table 7.4: Scaled and unscaled non-household values - Severe water restrictions, £ per expected day of restriction/property affected

Value type	Lower	Central	Upper
Unscaled	13.72	22.17	30.62
Scaled	7.28	18.95	30.62

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 - Severe water restrictions, £ per expected day of restriction



Note: the graph shows £/expected day of restriction. Values in table £/expected day of restriction/property affected.

The values presented are the household range plus non-household range. There are no PR14 values with which to compare.

Table 7.5: Initial recommended range - combined, £ per expected day of restriction per property affected

Value type	Lower	Central	Upper
Unscaled	65.87	105.58	174.39
Scaled	41.69	58.73	88.70

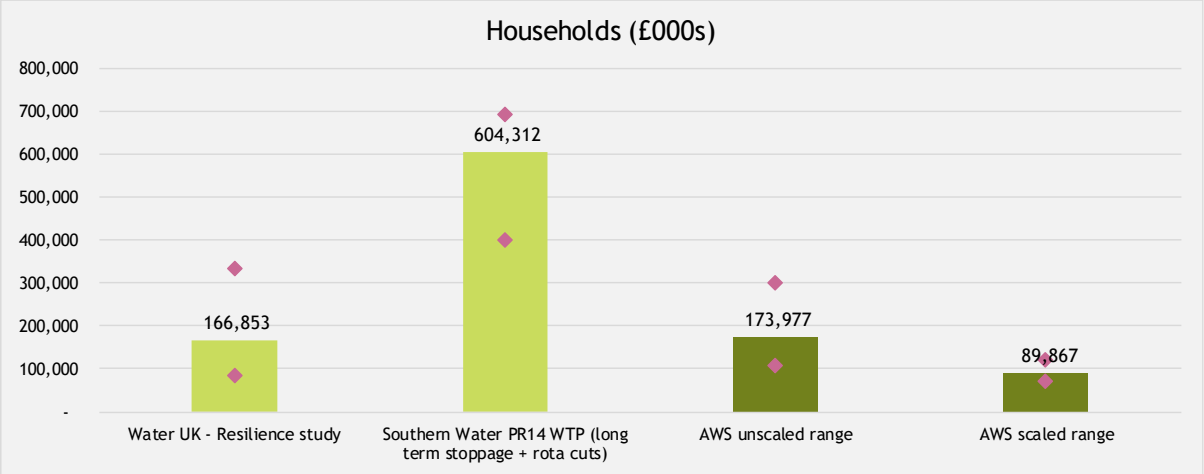
Step 3b: Triangulating against other sources (secondary data)

Figure 7.5 shows how the ranges compare to the secondary data sources available for household customers. No figures are shown for non-household and combined customers due to the lack of secondary sources available.

The figure shows that both the unscaled and scaled values are within the Water UK resilience study range. This study is a meta study that collated information from water companies that is not in the public domain separately. It presents an expected WTP per household range for severe water restrictions. It is expected that this is a mix of scaled and unscaled values.

Southern Water is a scaled value. The value for a long-term stoppage (described as an unplanned stoppage greater than 2 weeks) has been used in place of a standpipe. 14 days has been used to convert to a per day value. The stoppage is unplanned so may overestimate the value of a water restriction. This assertion is based on the fact that a standpipe will be warned and the AWS PR09 interruptions study found differences between unexpected and planned/warned values.

Figure 7.5: Comparing to household secondary data – severe water restrictions expected day of restriction/household



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

Step 3c is not applicable for this measure.

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final severe water restriction values to take forward are the values in Table 7.5.

Values provided at an earlier stage of the analysis (October 2017) for the draft WRMP are included in annex 3 to provide an audit trail along with the full details of the final valuation results.

Step 4.0 – Assess and test valuations

The wider customer evidence for water restrictions has been collated and reviewed by AWS (see annex 7). This found customers to be particularly concerned about severe water restrictions and the effect this could have on their quality of life. However, 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. The values are consistent with the key messages from the wider customer evidence.

7.2 Hosepipe bans and Non-Essential Use Bans

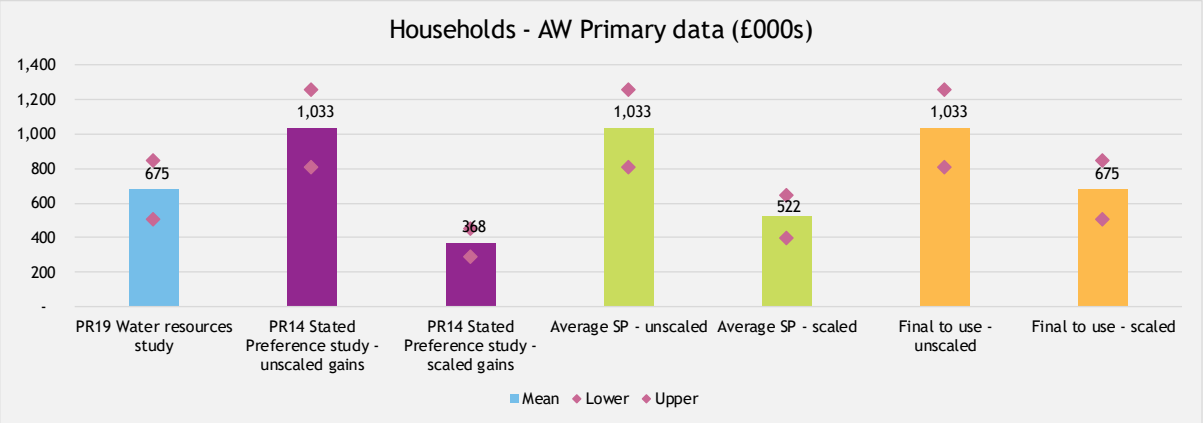
Step 3.0 Comparing valuations to produce recommendation for hosepipe bans

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 7.6. The recommended range is shown both in the graph below and in Table 7.6.

Figure 7.6: Household primary data - Hosepipe ban £ per expected day of restriction



Graph shows £/expected day of restriction. Values in tables £/expected day of restriction/property affected

Unscaled:
Both the unscaled central value and range are based the PR14 main WTP study unscaled gains. There are no PR19 main stage values to compare to.

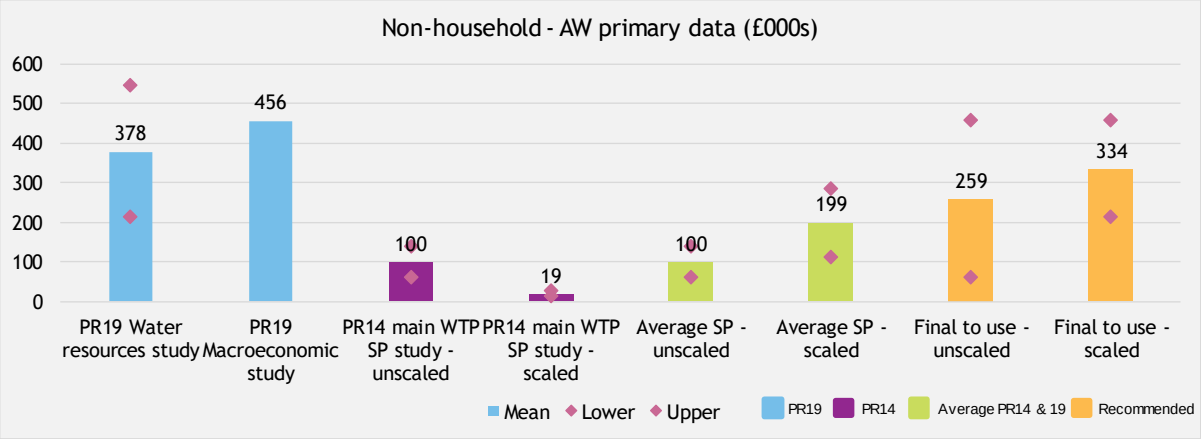
Scaled:
Both the scaled central value and range are based the PR19 water resources study value. This is a scaled gains value. There are no PR19 main stage values to compare. The PR14 scaled gains values have not been included as the ranges do not overlap with the PR19 Water Resources value.

Table 7.6: Scaled and unscaled household values - Hosepipe ban £ per expected day of restriction/property affected

Value type	Lower	Central	Upper
Unscaled	0.41	0.52	0.64
Scaled	0.26	0.34	0.43

Non-households
The primary data for AWS non-household customers is shown in Figure 7.7. The recommended range is shown both in the graph below and in Table 7.7.

Figure 7.7: Non household primary data - Hosepipe ban £ per expected day of restriction



Graph shows £/expected day of restriction. Values in table £/expected day of restriction/property affected

Unscaled:
The unscaled central value is based on the average of the PR14 main WTP unscaled value & the PR19 macroeconomic study value. The lower value is set at the PR14 main WTP unscaled value and the upper value using the macro-economic study value.

Scaled:
The scaled value and range uses the same approach as unscaled. The main difference is that the PR19 Water resources study value (which is a scaled-gains value) is used in place of the PR14 value. The macroeconomic study and water resources study values are broadly aligned. This suggests step change in value from PR14.

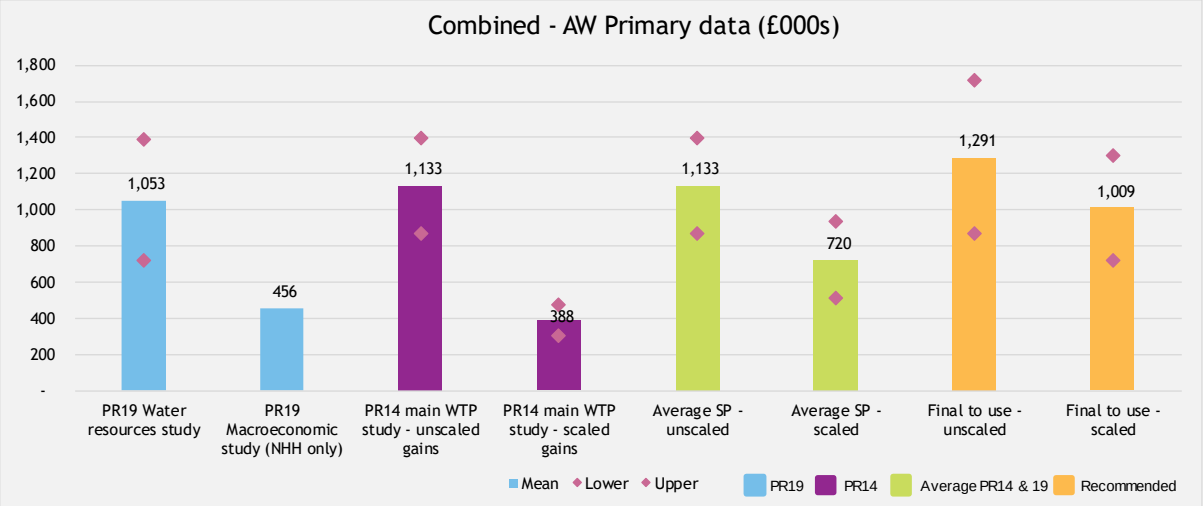
The results produce a scaled value that is higher than the unscaled value. The confidence intervals overlap suggesting that these values are similar. The difference is due to the change in value from PR14 to PR19 and that a PR19 unscaled value is not available. Given that the scaled value uses this more recent study it is recommended that the scaled range is used as a proxy for the unscaled one.

Table 7.7: Scaled and unscaled non household values - Hosepipe ban £ per expected day of restriction/property affected

Value type	Lower	Central	Upper
Unscaled	0.05	0.14	0.23
Scaled	0.19	0.21	0.23

Combined (households and non-households)
The primary data for AWS combined customers is shown in Figure 7.8. The recommended range is shown both in the graph below and in Table 7.8.

Figure 7.8: Combined primary data – Hosepipe ban £ per expected day of restriction



Graph shows £/expected day of restriction. Values in table £/expected day of restriction/property affected

The values presented are the household range plus non-household range. The PR19 values are larger (particularly for the scaled value) due to the changes between the PR19 water resources study being greater value than the PR14 study and the inclusion of the macroeconomic analysis.

Table 7.8: Scaled and unscaled combined values – Hosepipe ban £ per expected day of restriction per property affected

Value type	Lower	Central	Upper
Unscaled	0.46	0.66	0.87
Scaled	0.45	0.55	0.66

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

Figure 7.9 to Figure 7.11 show how the ranges compare to the secondary data sources available.

The household and combined graphs show that the AWS ranges are aligned with other company values. In the household and combined graph a key comparator is the Water UK resilience study. This study is a meta study that collated information from water companies that is not in the public domain. It presents an expected WTP per household range for hosepipe bans. It is expected that this is a mix of scaled and unscaled values.

The non-household graph includes fewer comparators that are scaled values only. This graph without the context of the other two graphs suggests that the AWS value is high. However, it is important to note that, as well as the comparators being scaled only values, the AWS value range is influenced by the macroeconomic study value which was found to be larger than the SP values.

The Southern Water and South East Water values are scaled values. The South Staffs, Cambridge, Thames Water and Lanz and Provins values are unscaled values. It is not clear if the Bristol Water value is scaled or not.

Figure 7.9: Comparing to household secondary data - hosepipe £ per expected day of restriction/property affected

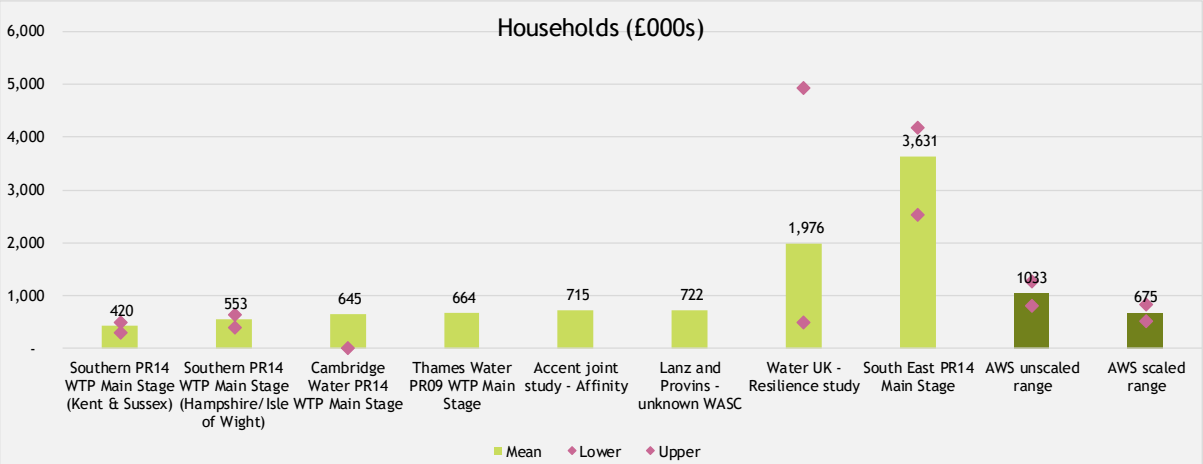


Figure 7.10: Comparing to non-household secondary data - hosepipe £ per expected day of restriction/property affected

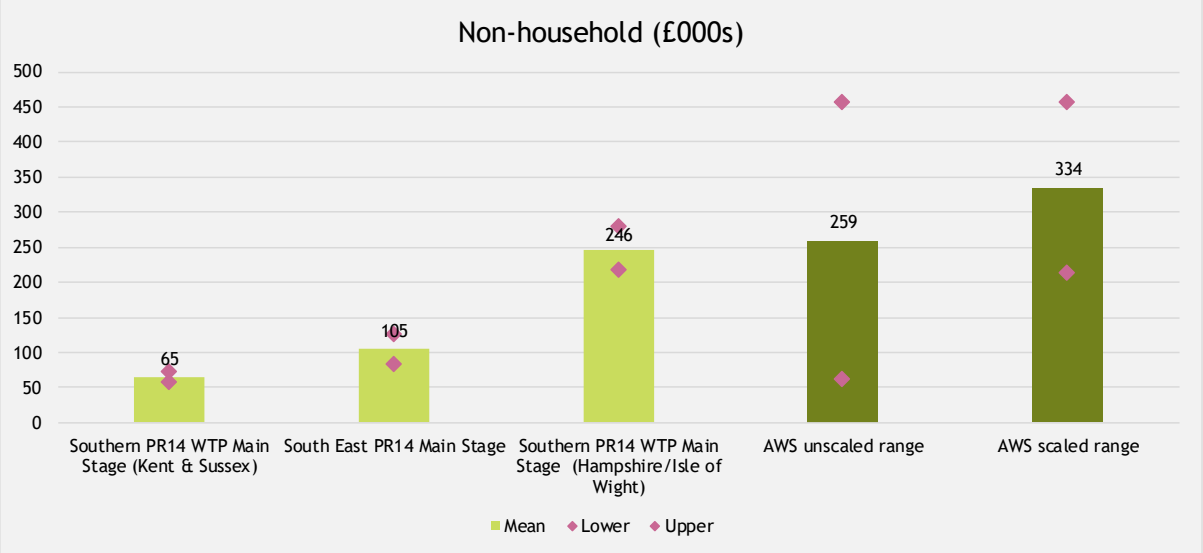
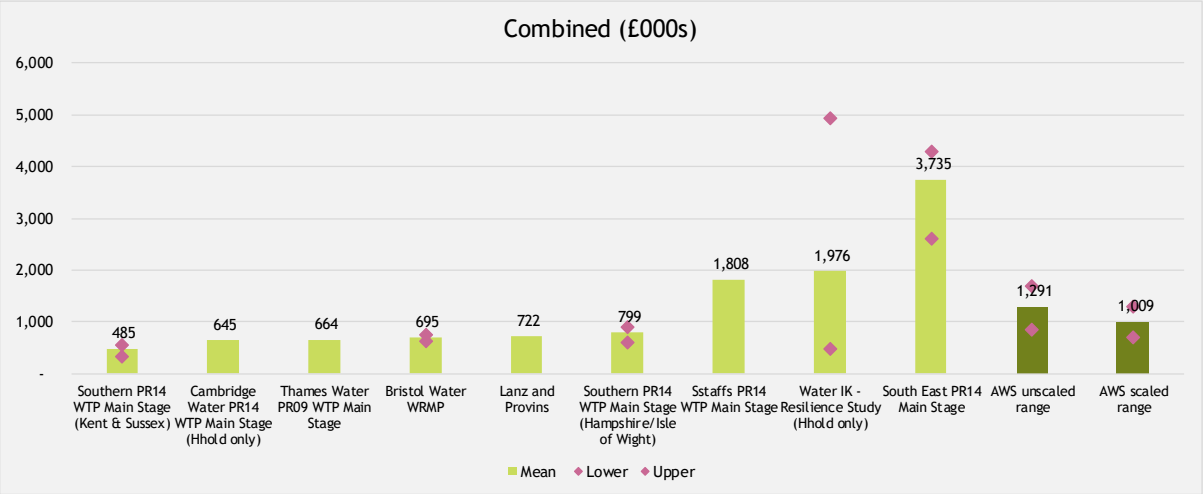


Figure 7.11: Comparing to combined secondary data - hosepipe £ per expected day of restriction/property affected



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

The unscaled and scaled values for a hosepipe ban have been mapped to the wider service measures for a non-essential use ban and the results are presented in the two tables below.

The value for a non-essential use ban has been calculated using the relative weights from the PR19 Water Resources study.

Table 7.9: Unscaled – hosepipe ban and non-essential use ban, £

SMF band	Unit	Lower	Central	Upper	Notes on values
Hosepipe ban	£/expected day of restriction/ property	0.46	0.66	0.87	Anchor
Non-essential use ban	£/expected day of restriction/ property	2.38	3.39	4.39	Value is linked to the anchor using the Water Resources study relative weights

Table 7.10: Scaled – hosepipe ban and non-essential use ban, £

SMF band	Unit	Lower	Central	Upper	Notes on values
Hosepipe ban	£/expected day of restriction/ property	0.45	0.55	0.66	Anchor
Non-essential use ban	£/expected day of restriction/ property	0.65	1.27	1.89	Value is linked to the anchor using the Water Resources study relative weights

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final restriction values for hosepipe bans and non-essential use bans to take forward are the values in Table 7.9 and Table 7.10.

Values provided at an interim stage of the analysis (October 2017) for the draft WRMP are included in Annex 3.

Step 4.0 – Assess and test valuations

The wider customer evidence for water restrictions has been collated and reviewed by AWS (see annex 7). This found that customers felt hosepipe bans and non-essential use bans not to be overly detrimental and would be more accepting of higher frequency restrictions i.e. every 5-10 years than severe water restrictions which they felt should occur less frequently or never. This review was found to align with the recommendations presented in this report.

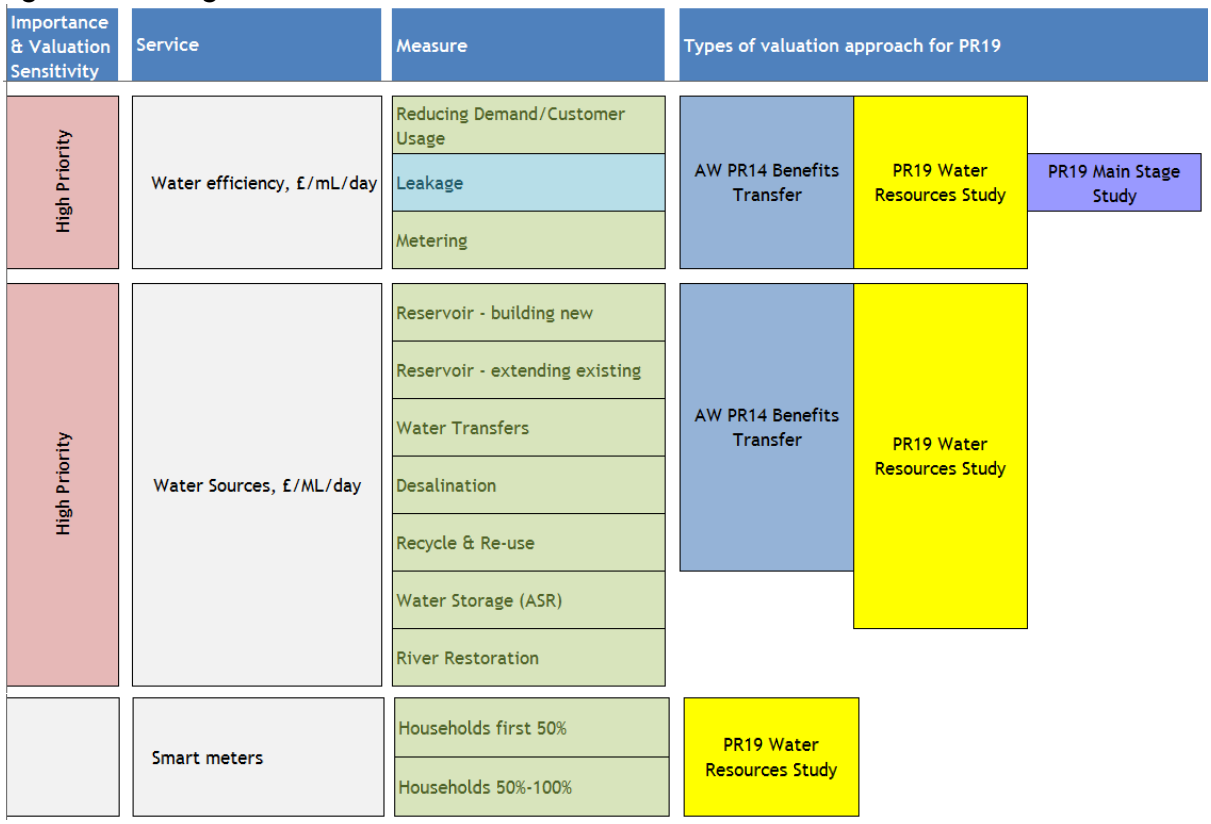
8 Water resource options

This section covers leakage and other water resource options. The results presented below are based on the most up-to-date triangulation of values from the main stage survey, the Best Worst Scaling survey and the second stage water resources study. The section provides a high-level summary, focusing on the gains values (scaled and unscaled). 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. Annex 3 contains the values provided for the draft WRMP and the detailed set of final values for water resource options and water restrictions. It should also be noted that the values presented here are based on the assumption of medium reliability.

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 in the third column). The wider framework also covers the remaining water efficiency (demand) options and water sources (supply options).

Figure 8.1:leakage and water resource valuation evidence



Step 2.0 Synthesis of research

Table 8.1 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 2nd stage WR study also provides additional customer preference weights that show how customers view the relative value of the different water resource option types.

Table 8.1: PR19 data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR19 2nd stage Water resource survey	Stated Preference valuation	Leakage	Hhold Non-hhold	H Good sample size, CV methodology	H Definition relevant, new 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 and network management, qualitative focus group assessments for options excluded above.	Hhold Non-hhold	H Good sample size, DCE/pairwise comparison methodology	H Definition relevant, new study
PR19 main stage study	Stated preference valuation	Leakage	Hhold	H Large sample DCE & DCCV methodology	H Definition relevant, new study
PR19 Best-worst scaling	Stated preference valuation	Leakage	Hhold	H Good sample size, BWS methodology	H Definition relevant, new study

Table 8.2 overleaf 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 8.2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
Affinity Water PR14 Main Stage / Accent joint study Affinity (2013)	Stated Preference valuation	Leakage	Hhold, Non-hhold	H/M Unknown SP methodology, back calculated from public domain data	M PR14 study, different company and area. Area adjacent to Anglian Water
Accent joint study (2013) - WOC N	Stated Preference valuation	Leakage	Hhold, Non-hhold	M/L Unknown SP methodology, unknown WOC, back calculated from public domain data assuming average WOC properties	M/L PR14 study, different company and area, unknown WOC
Accent joint study (2013) - WASC M	Stated Preference valuation	Leakage	Hhold	M/L Unknown SP methodology, unknown WASC, back calculated from public domain data assuming average WASC properties	M/L PR14 study, different company and area, unknown WASC
Thames PR09 Leakage WTP (2008)	Stated Preference valuation	Leakage	Hhold	H/M DCE methodology, small sample size	L Old study, different company and area
Cambridge Water PR14 WTP Main Stage (2013)	Stated Preference valuation	Leakage	Hhold	H DCE methodology, limited public domain data	M PR14 study, East Anglian location, different company
South Staffs Water PR14 WTP Main Stage (2013)	Stated Preference valuation	Leakage	Combined	H DCE methodology, limited public domain information	M/L PR14 study, different company and area
Bristol Water (2014)	Stated Preference valuation	Leakage, Water efficiency, metering	Combined	H Unknown SP methodology, limited public domain information	M/L PR14 study, different company and area L for water efficiency & metering due to conversion.

8.1 Leakage

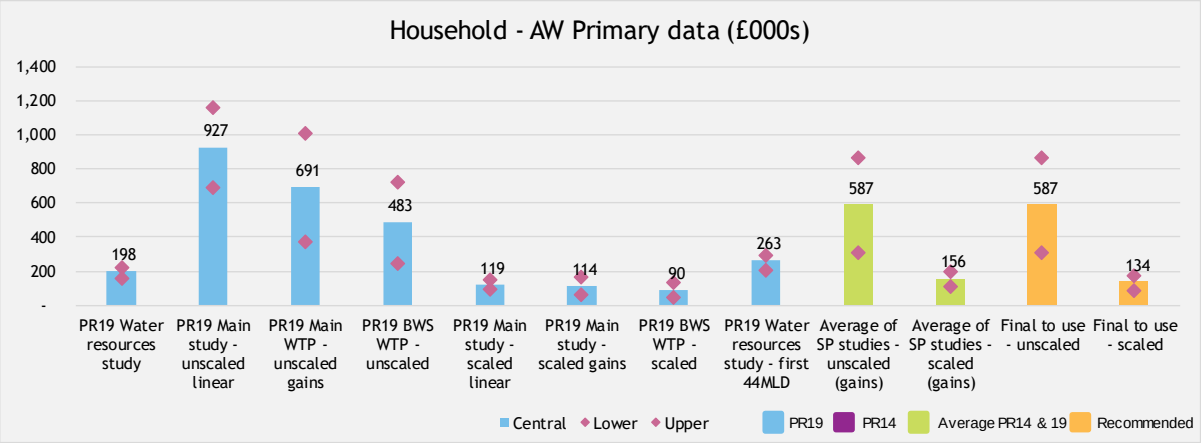
Step 3.0 Comparing valuations to produce recommendation

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 8.2. The recommended range is shown both in the graph below and in Table 8.3.

Figure 8.2: Household primary data - leakage £ per MLD (£000s)



Unscaled:
Both the unscaled central value and range are based on an average of the PR19 unscaled gains values and the PR19 BWS values.

The unscaled gains value has been used in preference to the linear value as this is more conservative. There are no PR14 values to compare to[17].

Scaled:
Both the scaled central value and range are based on the average of PR19 scaled gains, the PR19 BWS and PR19 WR study general value.

Table 8.3: Scaled and unscaled household values - leakage £ per MLD (£000s)

Value type	Lower	Central	Upper
Unscaled	309	587	865
Scaled	88	134	173

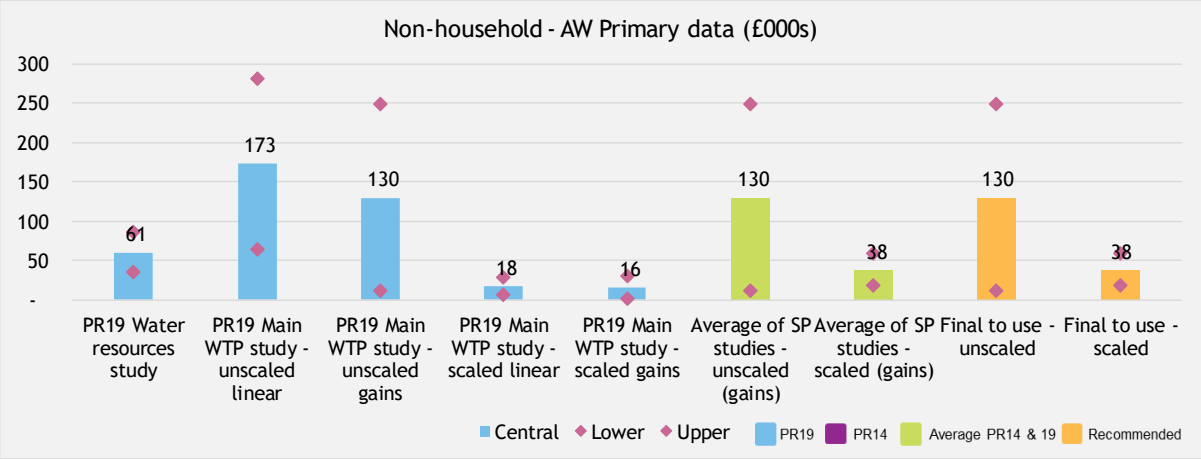
Similar to the severe water restrictions value, the PR19 Water Resources study suggests an uplift for initial improvements (first 44 MLD). This uplift highlights that respondents place higher incremental values on first improvements, up to 44 MLD, but lower values on subsequent improvements. Full details of the values for these service levels are provided in Annex 3. For reference the scaled mean is £178k for the first 44 MLD.

[17] The PR14 leakage value was calculated from the PR14 hosepipe ban value. This value is not considered here as it was significantly higher, considered less accurate and covered a service level improvement that is now below the current level of service.

Non-households

The primary data for AWS non-household customers is shown in Figure 8.3. The recommended range is shown both in the graph below and in Table 8.4.

Figure 8.3: Non Household primary data - leakage £ per MLD (£000s)



Unscaled:

Both the unscaled central value and range are based on the PR19 main stage unscaled gains values. Similar to the household approach the PR19 main stage unscaled gains value has been used in preference to the linear value as this is more conservative. There are no PR14 values to compare.

Scaled:

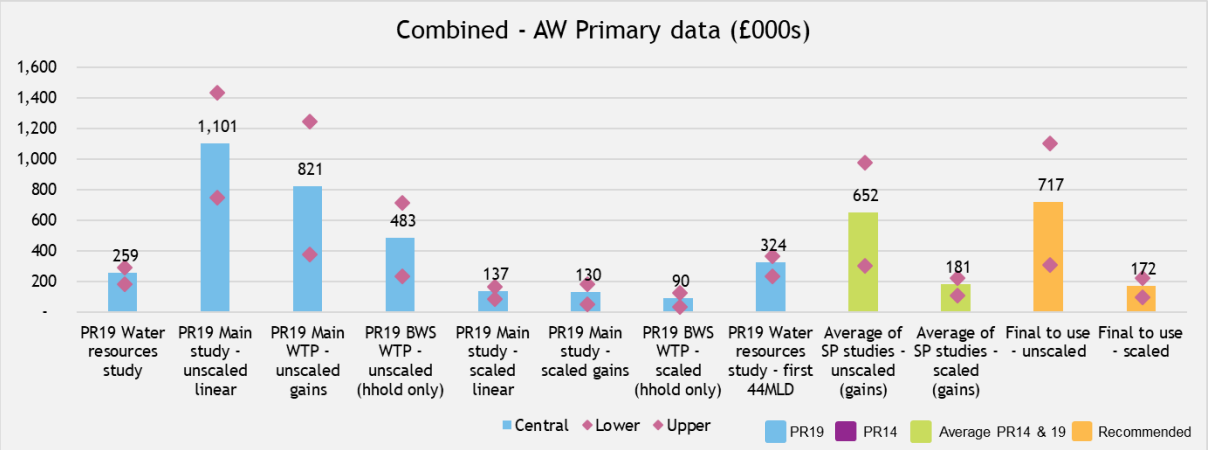
Both the scaled central value and range are based on the average of PR19 main stage scaled linear value and PR19 Water Resource study value. The same reasons apply as for unscaled. There are no PR14 values to compare.

Table 8.4: Scaled and unscaled non-household values - leakage £ per MLD (£000s)

Value type	Lower	Central	Upper
Unscaled	11	130	249
Scaled	18	38	59

Combined (households and non-households)
The primary data for AWS combined customers is shown in Figure 8.4. The recommended range is shown both in the graph below and in Table 8.5.

Figure 8.4: Combined primary data - leakage £ per MLD (£000s)



The values presented are the household range plus non-household range. There are no PR14 values to compare to.

Table 8.5: Initial recommended range - combined, £ per MLD (£000s) (average for all improvements)

Value type	Lower	Central	Upper
Unscaled	320	717	1,114
Scaled	106	172	232

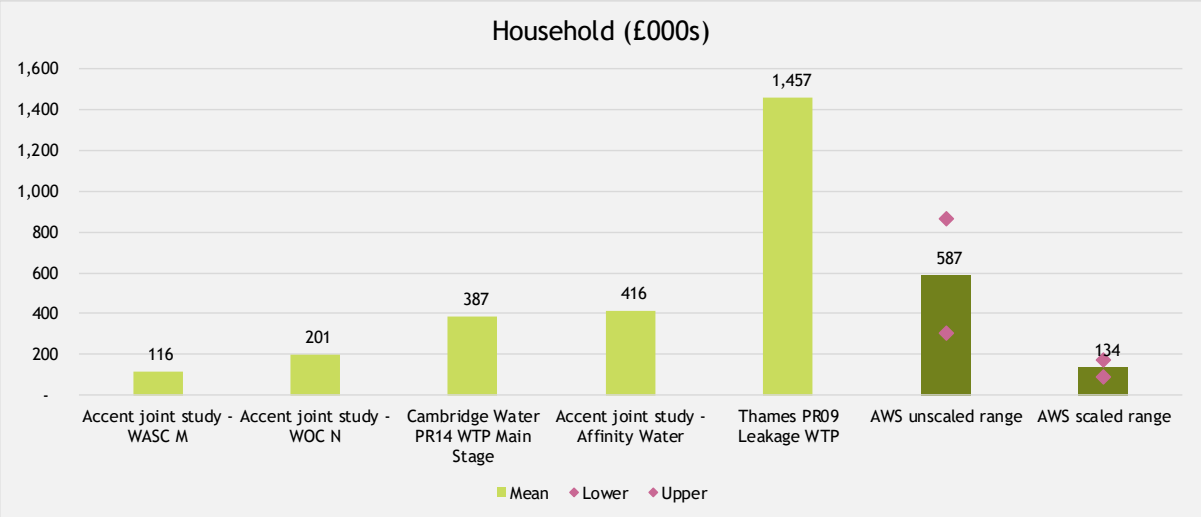
Similar to severe water restrictions, the Water Resources study suggests an uplift for initial improvements in leakage reduction (first 44 MLD) and a lower value for subsequent improvements. Scaled mean for combined customers for the first 44 MLD is £216k scaled and £909k unscaled. This is the same as the losses value provided.

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

Figure 8.5 to Figure 8.7 show how the ranges compare to the secondary data sources available. The findings are that values are aligned with other studies.

Affinity Water, Cambridge Water & WASC 'M' values are thought to be unscaled values. Thames is unscaled. For WOC 'N' and Bristol Water it is not clear if the values are scaled or unscaled. WASC 'M' & WOC 'N' values are taken from the Accent study and are based on average number of WASC/WOC customers and are therefore less certain.

Figure 8.5: Comparing to household secondary data - leakage £ per MLD (£000s)



NB: Thames Water PR09 upper value of £4,299k removed from graph due to effect on scale.

Figure 8.6: Comparing to non-household secondary data - leakage £ per MLD (£000s)

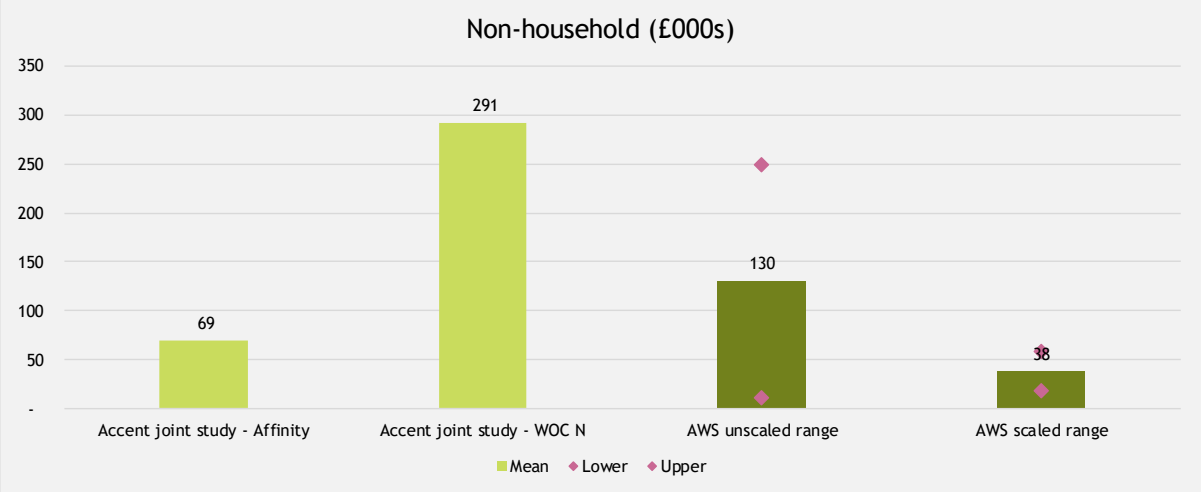
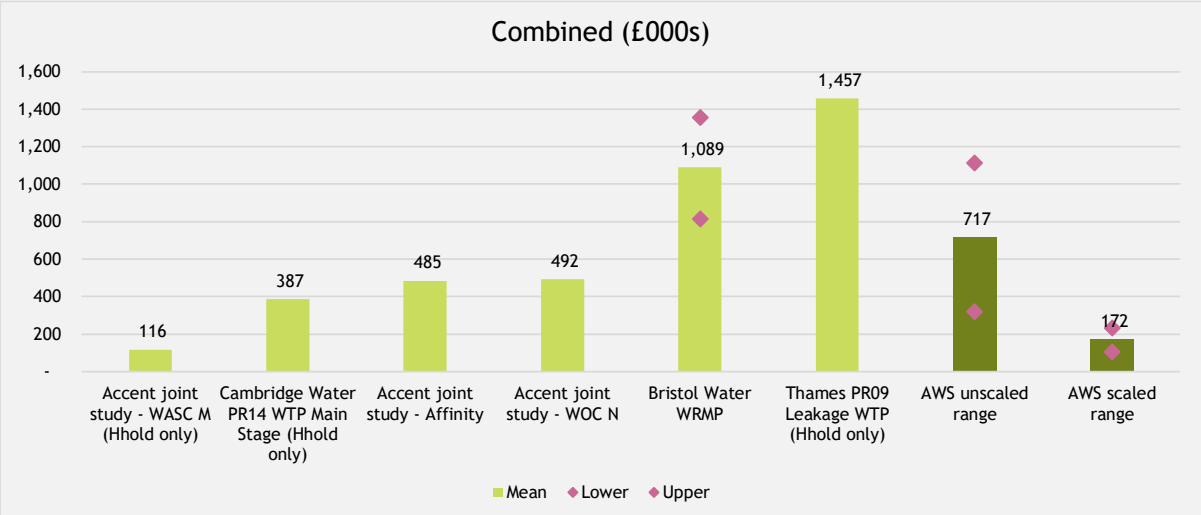


Figure 8.7: Comparing to combined secondary data - leakage £ per MLD (£000s)



NB: Thames Water PR09 upper value of £4,299k removed from graph due to affect on scale.

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 3d Comparing valuations to produce recommendation – Final recommendation

The final values for leakage to take forward to are the values in Table 8.5. These values are a general gains value. A higher value is available for the first 44MLD improvement. This is the same as the losses value provided. A lower value is available for subsequent improvements. Full details are provided in Annex 3.

Values provided at an earlier stage of the analysis (October 2017) for the draft WRMP results are also included in Annex 3.

Step 4.0 – Assess and test valuations

The wider customer evidence for leakage has been collated and reviewed by AWS (see annex 7). This review showed that leakage continues to be a high customer priority with support to continue to reduce leakage. This evidence aligns with the recommendations presented in this report.

8.2 Water resource options

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

The unscaled and scaled values for leakage have been mapped to the wider service measures for water resource options and the results are presented in the two tables below. The leakage value is mapped to other options using weights from the PR19 water resources stated preference study. River restoration was not included in the survey. The option was instead assessed in a post survey focus group undertaken as part of the 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 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 presented in this section are medium reliability values.

The results shown relate to the general range of service level improvements. Further detail on these values is included in Annex 3, which includes:

- A higher value for the first 44ML/d (which is the same as the losses value) and a lower value for subsequent improvements.
- Values for variations in reliability.

No other primary value evidence is available to compare to.

The PR19 Water Resources study weights have been compared to the PR14 Water Resource study weights where the same options have been included in both studies. This shows that, for households, relative to leakage, the weights for encouraging metering, water transfer and desalination have decreased and the weight for new reservoir and recycle and reuse water has increased. For non-household customers, relative to leakage, the water transfer and desalination weights are stable, the weights for metering and new reservoir show moderate increases whereas the recycling and reuse weight has increased significantly. The PR19 preference weights have been used in preference to the PR14 weights as this is the newer dataset.

For secondary evidence data is available for Bristol Water for water efficiency and metering. These values are aligned with the unscaled values.

Table 8.6: Unscaled – Water resources option, £ per MLD, medium reliability

SMF band	Unit	Lower	Central	Upper
Reducing Demand/Customer Usage	£/MLD	171,317	374,104	576,888
Leakage	£/MLD	320,120	717,232	1,114,339
Metering	£/MLD	134,181	304,297	474,410
Reservoir - building new	£/MLD	147,556	318,855	490,150
Reservoir - extending existing	£/MLD	303,167	637,350	971,527
Water Transfers	£/MLD	100,596	217,109	333,620
Desalination	£/MLD	73,401	176,050	278,698
Recycle & Re-use	£/MLD	201,169	434,401	667,631
Water Storage (ASR)	£/MLD	328,111	711,451	1,094,785
River Restoration	£/MLD	315,639	674,400	1,033,156

Table 8.7: Scaled – Water resources option, £ per MLD, medium reliability

SMF band	Unit	Lower	Central	Upper
Reducing Demand/Customer Usage	£/MLD	56,609	91,613	122,928
Leakage	£/MLD	106,193	172,405	231,765
Metering	£/MLD	45,008	73,390	98,909
Reservoir - building new	£/MLD	47,358	75,860	101,176
Reservoir - extending existing	£/MLD	94,895	150,402	199,324
Water Transfers	£/MLD	32,250	51,634	68,847
Desalination	£/MLD	25,920	43,093	58,722
Recycle & Re-use	£/MLD	64,523	103,328	137,790
Water Storage (ASR)	£/MLD	105,636	169,432	226,150
River Restoration	£/MLD	100,265	159,917	212,737

Table 8.8 shows the recommended values for Smart metering from the PR19 Water Resources stated preference study. The values shown are broken down for households and non-households.

No other primary evidence is available to compare to.

Table 8.8: Smart metering - £ per smart meter

SMF band	Unit	Lower	Central	Upper
Households - first 50%	£/smart meter	£4.47	£5.83	£7.19
Non-Households - first 50%	£/smart meter	£0.98	£1.71	£2.44
Total - first 50% customers	£/smart meter	£5.45	£7.54	£9.63
Households - 50%-100%	£/smart meter	£0.00	£0.23	£1.04
Non-Households - 50%-100%	£/smart meter	£0.98	£1.71	£2.44
Total - 50%-100%	£/smart meter	£0.98	£1.94	£3.48

NB: 50% based on figure of 2m customers

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final water resource option values to take forward are the values in Table 8.6, Table 8.7 and Table 8.8.

Further detail is provided in Annex 3. This annex includes the WRMP interim values provided at an earlier stage of the project for the draft WRMP (October 2017), as well as a more detailed breakdown of the values including: a higher value for the first 44ML/d (which is the same as the losses value) and a lower value for subsequent improvements; and tables setting out how the values vary as reliability changes.

Step 4.0 – Assess and test valuations

The wider customer evidence for water resource options has been collated and reviewed by AWS (see annex 7). This found leakage was the most popular customer choice when asked their views on deficit reduction measures along with water storage, whilst water transfers were viewed as the least popular customer choice. 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.

9 Habitats and recreation

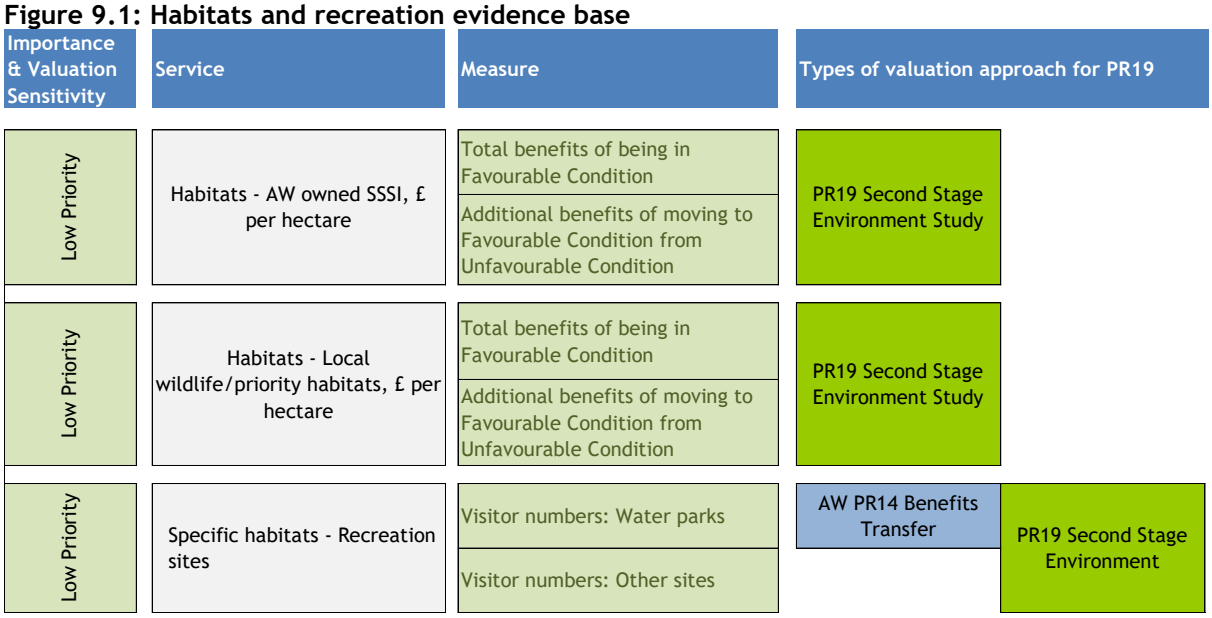
This section provides an overview of the societal values associated with habitats and recreation.

- Habitats
  - AW owned SSSIs
  - Priority habitats
- Recreation values associated with AW Water Parks
- Recreation values for habitats affected by AW operations

Step 1.0 – Specify and undertake research

The evidence base for habitats and recreation is given below.

Figure 9.1: Habitats and recreation evidence base



Step 2.0 Synthesis of research

Table 9.1 presents a summary of the data sources for habitats and recreation. The sources include values sourced from the value transfer literature and visitor expenditure and revealed preference travel cost analysis from PR14.

Table 9.1: Data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
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	H Relevant definition, same sites, PR14 study
PR19 2nd Stage Environment Study – ORVal analysis (University of Exeter 2016)	Revealed preference Travel cost	Recreation – Water Parks, Grafham Water	General value	H Partial value but only compared to the relevant data from PR14	H/M Analysis of Grafham water, accounts for location and substitutes but not for unique characteristics.
Christie and Rayment (2012)	Value transfer – stated preference	Habitats	General value	H/M Sample size moderate, DCE methodology.	H Relevant habitats, 2012 study.
Sen et al (2014)	Value transfer – recreational use value	Recreation – other sites		H Meta study reviewing several hundred studies. Function from study used in the 2nd stage environment study to provide values for the relevant sites by land use.	M Relevant land uses, Does not account for site-specific variation in facilities

9.1 Habitats

Step 3.0 Comparing valuations to produce recommendation

Habitats values are based on the analysis from the PR19 Environment Study. The habitat values are taken from Christie and Rayment (2012)[18] which provides estimates for the total benefits of achieving favourable condition and the additional benefits from moving from unfavourable to favourable condition. This study provides values for a range of habitat types. The value is a weighted value (by area) for the habitats based on relative proportion of (a) Anglian Water owned designated sites and (b) Priority habitat sites weighted by AW region's breakdown of SSSI habitats.

The ranges are based on the minimum and maximum values from the set of habitat types included in each calculation.

[18] Christie and Rayment (2012) An Economic Assessment of the Ecosystem Service Benefits Derived from the SSSI Biodiversity Conservation Policy in England and Wales, Ecosystem Services

Table 9.2: AWS owned SSSIs, £ per hectare

AWS owned SSSIs	Unit	Lower	Central	Upper
Total benefits of being in Favourable Condition	£/ha	886	1,107	1,328
Additional benefits of moving to Favourable Condition from Unfavourable Condition	£/ha	386	482	578

Table 9.3: Priority habitats, £ per hectare

Local wildlife / Priority habitats	Unit	Lower	Central	Upper
Total benefits of being in Favourable Condition	£/ha	1,186	1,460	1,752
Additional benefits of moving to Favourable Condition from Unfavourable Condition	£/ha	442	553	664

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final habitat values to take forward to are the values in Table 9.2 and Table 9.3.

Step 4.0 – Assess and test valuations

No specific wider customer evidence is available for these measures. However there is a general increase in customers' interest and importance of environmental issues, which has been reflected in this report.

9.2 Recreation

Step 3.0 Comparing valuations to produce recommendation

The AWS water parks value has been updated from PR14. PR14 analysis used survey data from the water parks to understand distance travelled and expenditure on site. The values have been inflated to 2017, and car operational costs updated. The cost to travel to Grafham Water (one of the AWS water parks) was cross checked against ORVal values – as provided in the PR19 Environment Study – and was found to be consistent.

Other habitat sites affected by AW operations: recreational values are based on study sources identified in the PR19 Environment Study. Using Sen et al (2014), the value is an average of the values for the habitats considered. Excludes mountains, moors and heathlands as these are not suitable for Anglian Water region.

Table 9.4: Habitats recreation, £

Local wildlife / Priority habitats	Unit	Lower	Central	Upper
Visitor numbers: Water parks	£/visitor	38	47	57
Visitor numbers: other sites	£/visitor	2.98	3.73	4.48

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final recreation values to take forward 4 are the values in Table 9.4 above.

Step 4.0 – Assess and test valuations

No further wider customer evidence is available for these measures as the values already incorporate direct customer data from AWS sites.

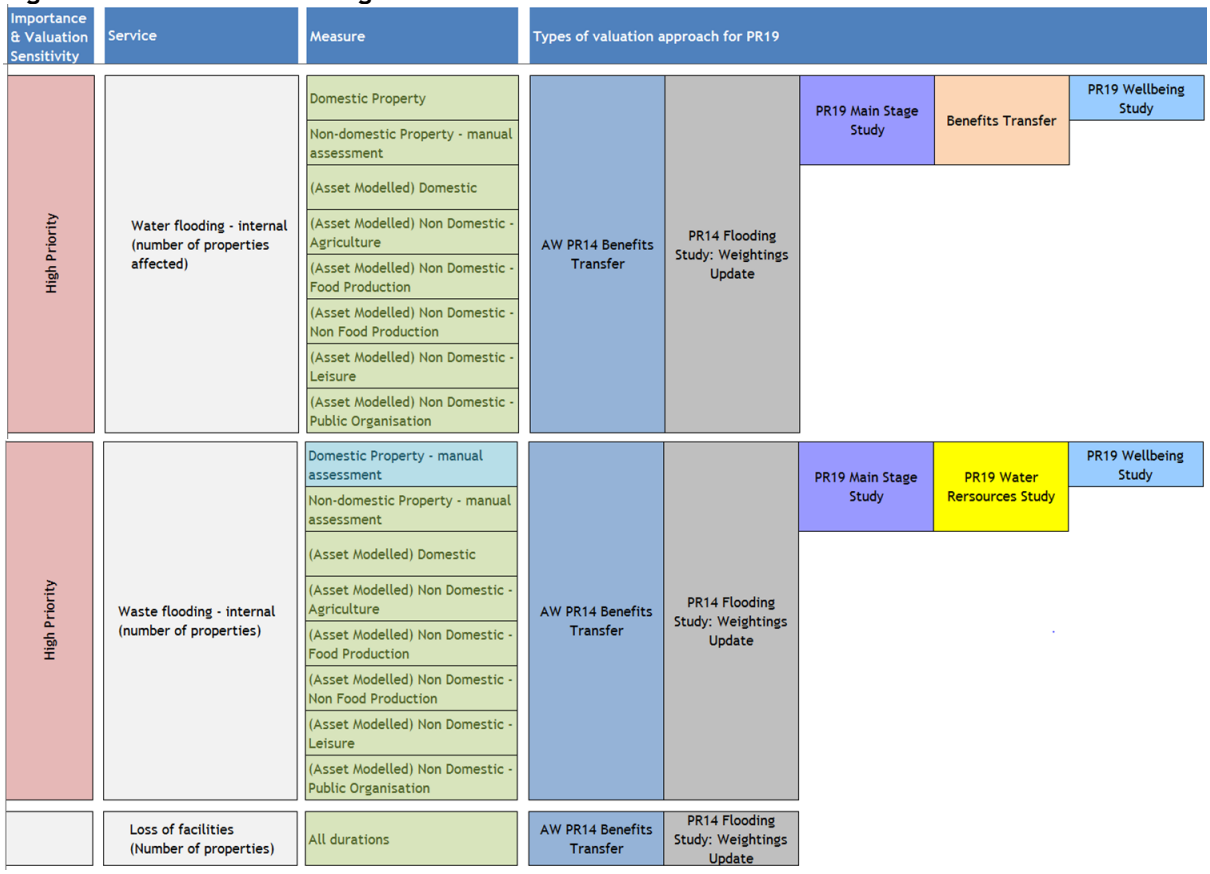
10 Internal flooding

This section covers water and wastewater internal flooding, as well as loss of facilities.

Step 1.0 – Specify and undertake research

The evidence base for internal flooding is given below. The anchor measure is waste flooding at a domestic property (highlighted in blue in the second column). The wider framework also covers waste flooding at other locations, water flooding and loss of facilities (waste only).

Figure 10.1: Internal flooding valuation evidence



Step 2.0 Synthesis of research

Table 10.1 presents a summary of primary data. The table includes a range of valuation types covering Stated Preference studies, subjective wellbeing expenditure 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 section 4.2). 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. Therefore the subjective wellbeing value is compared to both the unscaled and scaled stated preference values in the subsequent analysis.

Table 10.1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR19 main stage study	Stated preference – valuation	Internal wastewater flooding	Hhold, Non-hhold	H Large sample DCE & DCCV methodology	H Definition relevant, new study
PR19 Best-worst scaling	Stated preference – valuation	Internal wastewater flooding	Hhold	H Good sample size, BWS methodology	H Definition relevant, new study
PR14 main stage study	Stated preference – valuation	Internal wastewater flooding	Hhold, Non-hhold	H Very large sample DCE & DCCV methodology	H Definition relevant, new study
PR19 2nd stage water resources survey	Stated Preference – valuation	Internal wastewater flooding	Hhold, Non-hhold	H Good sample size, CV methodology followed by allocation exercise	H Definition relevant, new study
PR19 subjective wellbeing study	Subjective wellbeing	Internal wastewater flooding, internal water flooding	Hhold	H/M New method.	H Definition relevant, new study.
PR14 2nd Stage flooding study	Stated Preference – customer preference weights	Weights for wider internal flooding SMF. Covers water and waste flooding.	Hhold	H DCE methodology, good sample size	H Definition relevant, PR14 study
PR19 relative preference focus group	Qualitative review of customer preference weights from PR09 water services 2nd stage study plus discussion	All measures in the internal flooding SMF. Covers water and waste flooding.	Hhold	M/L Qualitative, Small sample size	H Definition relevant, new research

Table **10.2** overleaf 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 PR14, some damage cost data and insurance data. The damage cost and insurance data will not capture the public good or altruism value, inconvenience or sentimental loss values that are captured in the stated preference values.

Table 10.2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
FHRC and Environment Agency (2013) - Flood and Coastal Erosion Risk Management - A Manual for Economic Appraisal	Damage costs	Internal water flooding	Hhold, Non-hhold	M Partial value	H/M (Hhold) average cost over a range of depths, new study L (Non-hhold) value not used as requires conversion from £/m2
Environment Agency (2010) The costs of the summer 2007 floods in England	Damage cost	Internal water flooding	Hhold, Non-hhold	M Partial value	H/M Average cost depths not clear, new study
Southern PR14 WTP Main Stage (2013)	Stated Preference valuation	Internal wastewater flooding	Hhold, Non-hhold	H CV package methodology, good sample size	M/L PR14 study, study from Different company and area
Accent joint study - Unknown companies (2013)	Stated Preference valuation	Internal wastewater flooding for six companies	Hhold, Non-hhold	M Mixed surveys, limited published information	M/L Relevant definitions, PR14 study, unknown areas
Ofwat survey of customers affected by sewer flooding (2004)	Insurance data	Internal wastewater flooding	Hhold	L Insurance costs, Small sample	M/L Relevant definitions, may cover a a mix of severities, Old study.

10.1 Internal Sewer flooding

Step 3.0 Comparing valuations to produce recommendation

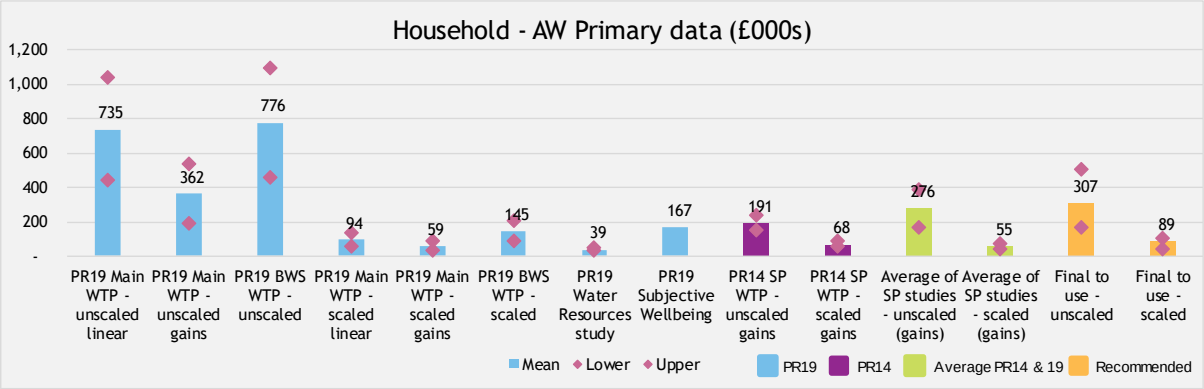
Step 3a: Primary data & initial recommended range

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 10.2. The recommended range is shown both in the graph below and in Table 10.3.

Figure 10.2: Household primary data - Internal Sewer Flooding: £ per property (£000s)



Unscaled:
The unscaled central value is based on the midpoint between the average of the PR19 main stage unscaled gains value, the PR19 subjective well-being value and the PR14 unscaled gains value and an average of the same studies plus the PR19 BWS value. This approach places less weight on the PR19 BWS value which is higher than the other studies. PR14 values are included as the range is within the PR19 value validating the range and the PR14 mean & subjective wellbeing value are similar.

The PR19 unscaled upper value is set using the same approach as the central value with the exclusion of the SWB value. This is because the SWB does not have a confidence interval and the value is lower than the central recommended value. The unscaled lower value is set at the average of the SWB value, the PR19 main stage and PR14 values.

Scaled:
The scaled central and upper value is based on the midpoint between the average of the PR19 main stage scaled gains value, the PR19 subjective well-being value, the PR19 Water Resources study and the PR14 scaled gains value and an average of the same studies plus the PR19 BWS value. The scaled upper value uses the central SWB value (due to no confidence intervals for SWB)[19].

The scaled lower value is set at the average of the PR19 main stage scaled gains, PR19 WR study and PR14 scaled gains lower values to reflect that this is the lowest value for PR19. The SWB central value is excluded due to it being higher than the recommended central value.

Overall, the PR19 main stage 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 implying that this is more appropriate to use for an improvement value.

Table 10.3: Scaled and unscaled household values - Internal Sewer Flooding: £ per property (£000s)

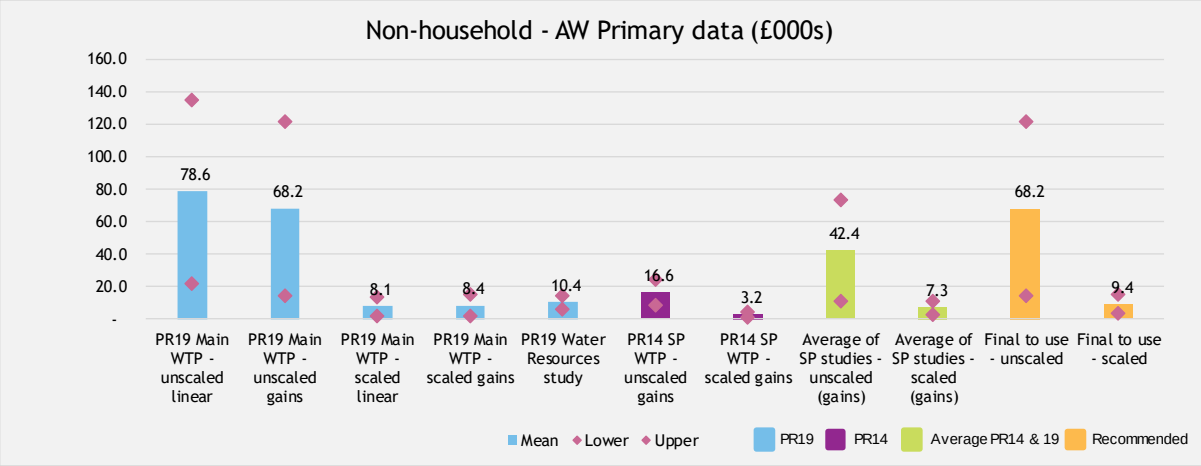
Value type	Lower	Central	Upper
Unscaled	166	307	505
Scaled	37	89	101

[19] Difference for upper range on inclusion of SWB: On unscaled the SWB is lower than others. Including the SWB value would make the upper value lower than the PR19 central value.

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.

Figure 10.3: Non Household primary data - Internal Sewer Flooding: £ per property (£000s)



Unscaled:

Both the unscaled central value and range are based on the PR19 unscaled gains values. Similar to the household approach the PR19 main stage unscaled gains value has been used in preference to the linear value as this is more conservative.

The PR14 value is excluded as the mean value is much lower and confidence intervals do not overlap.

The information informing the scaled range (see above relating to the value of the Water Resource study relative to the PR19 scaled linear value) indicates the recommended value could be higher, however, the range allows for this uncertainty.

Scaled:

The scaled central value and range is based on the average of the PR19 scaled gains value and PR19 Water Resources study value.

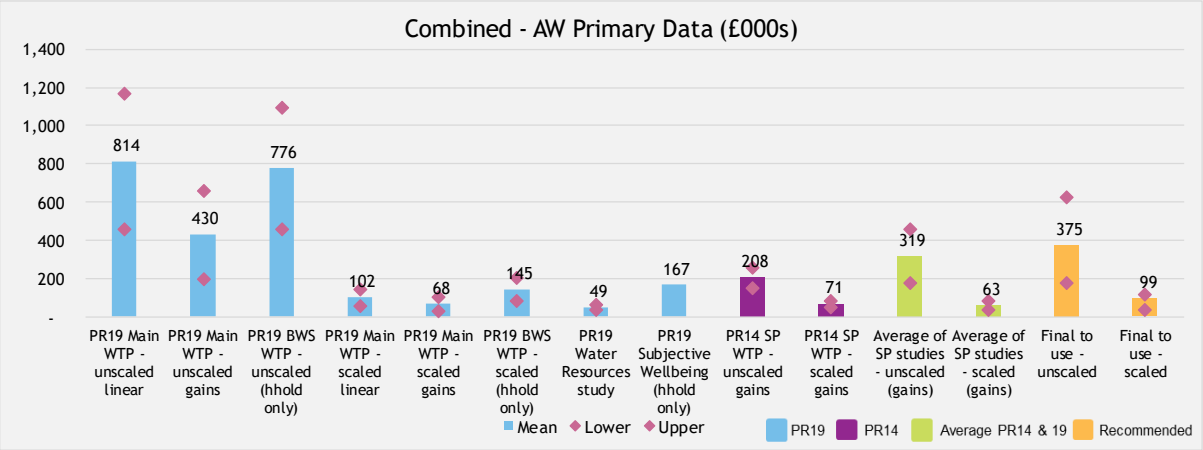
The PR19 main WTP study and PR14 values only overlap with the lower end of the PR19 range. The PR19 Water Resources study value and PR14 gains value do not overlap suggesting a step change in the value.

Table 10.4: Scaled and unscaled non-household values - Internal Sewer Flooding: £ per property (£000s)

Value type	Lower	Central	Upper
Unscaled	14.5	68.2	121.9
Scaled	3.9	9.4	14.9

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 - 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 but is a household only value. The recommended unscaled value is higher than PR14 due to a step change in the stated preference value. The recommended scaled value is higher than PR14 due to the inclusion of the SWB value.

Table 10.5: Initial recommended range - combined - Internal Sewer Flooding: £ per property (£000s)

Value type	Lower	Central	Upper
Unscaled	181	375	626
Scaled	41	99	116

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

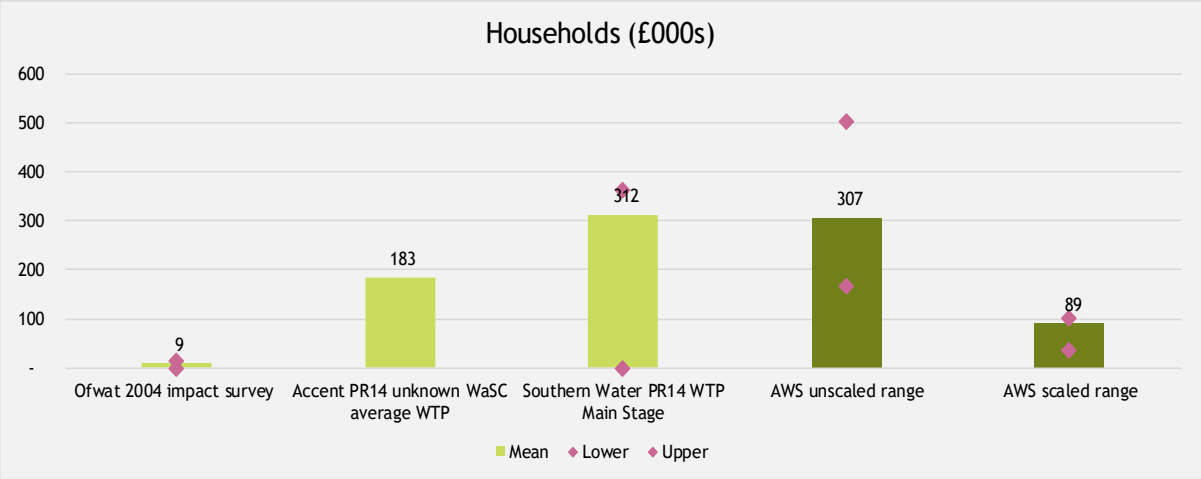
Figure 10.5 to Figure 10.7 show how the ranges compare to the secondary data sources available.

For both household and non household comparisons, the scaled values are low compared to other studies. Although the household scaled value does not look out of line with some of the unadjusted figures from the Accent study and the unscaled range looks reasonable.

The Ofwat impact survey is a 2004 study that collated information on the impacts of sewer flooding. The value shown is based on insurance costs; the sample for this is small and is therefore considered to have a low robustness score. Insurance costs will only capture direct cost and will exclude inconvenience and the value that unaffected customers place on these service failures. These values (inconvenience and altruism) are known to be significant for internal sewer flooding.

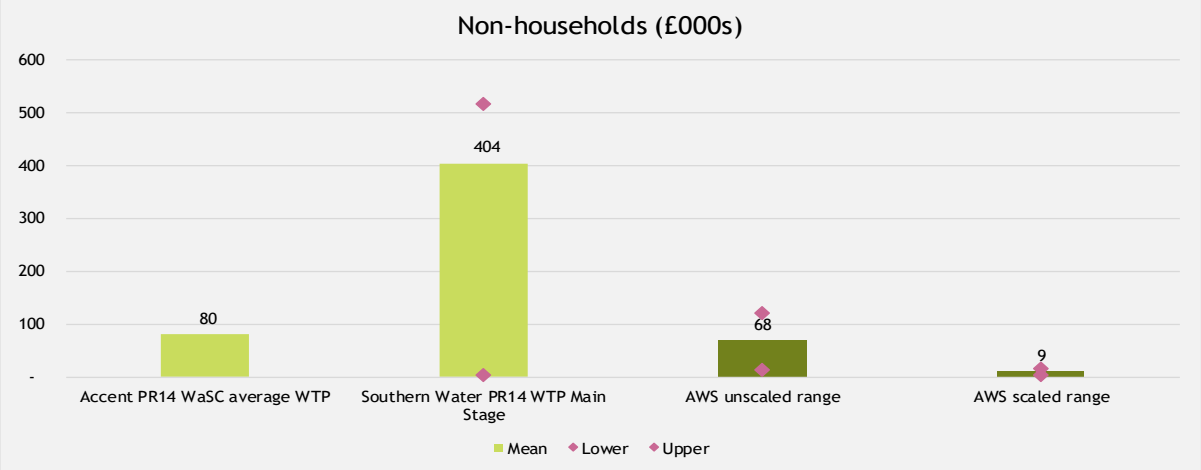
The Southern water study provides a scaled value. The Accent study is thought to be a mix of scaled and unscaled values.

Figure 10.5: Comparing to household secondary data - Internal Sewer Flooding: £k per property



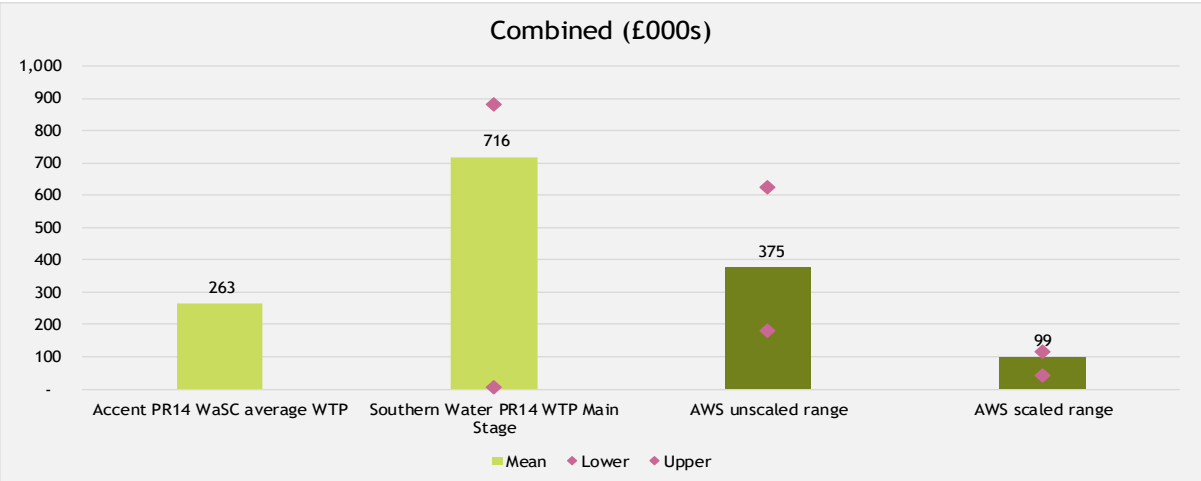
NB: Accent average unknown WaSC is based on 6 companies - masks a wide range of values but reasonable number of companies for this measure. The unadjusted (for customer numbers) values range from 23k to 367k per property. Median = £115k.

Figure 10.6: Comparing to non-household secondary data - Internal Sewer Flooding: £ per property (£000s)



NB: Accent average unknown WaSC is based on 6 companies - masks a wide range of values but reasonable number of companies for this measure. The unadjusted (for customer numbers) values range from 3k to 350k per property. Median = £46k.

Figure 10.7: Comparing to combined secondary data - Internal Sewer Flooding: £ per property (£000s)



NB: Accent average unknown WaSC is based on 6 companies - masks a wide range of values but reasonable number of companies for this measure. The unadjusted (for customer numbers) values range from 26k to 434k per property. Median is £225k.

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

The unscaled and scaled values for internal sewer flooding have been mapped to the wider service measures for waste water and the results are presented in Table 10.6 and Table 10.7 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 support the weightings between categories (See Annex 2).

There is limited primary and secondary evidence for the categories (except for the anchor – domestic property). More evidence is available for internal and external water flooding as opposed to waste flooding.

Table 10.6: Unscaled – internal sewer flooding, £

SMF band	Unit	Lower	Central	Upper
Domestic Property - manual assessment	£/property	180,709	375,047	626,443
Non-domestic Property - manual assessment	£/property	76,564	170,923	288,015
(Asset Modelled) Domestic	£/property	180,709	375,047	626,443
(Asset Modelled) Non Domestic - Agriculture	£/property	39,782	85,697	143,796
(Asset Modelled) Non Domestic - Food Production	£/property	76,564	170,923	288,015
(Asset Modelled) Non Domestic - Non Food Production	£/property	76,564	170,923	288,015
(Asset Modelled) Non Domestic – Leisure	£/property	76,564	170,923	288,015
(Asset Modelled) Non Domestic - Public Organisation	£/property	76,927	162,357	271,752
Loss of facilities (Number of properties)	£/property	74,959	156,755	262,076

Table 10.7: Scaled - internal sewer flooding, £

SMF band	Unit	Lower	Central	Upper
Domestic Property - manual assessment	£/property	41,353	98,805	116,331
Non-domestic Property - manual assessment	£/property	17,693	42,329	51,059
(Asset Modelled) Domestic	£/property	41,353	98,805	116,331
(Asset Modelled) Non Domestic - Agriculture	£/property	9,149	21,873	26,071
(Asset Modelled) Non Domestic - Food Production	£/property	17,693	42,329	51,059
(Asset Modelled) Non Domestic - Non Food Production	£/property	17,693	42,329	51,059
(Asset Modelled) Non Domestic - Leisure	£/property	17,693	42,329	51,059
(Asset Modelled) Non Domestic - Public Organisation	£/property	17,643	42,166	49,919
Loss of facilities (Number of properties)	£/property	17,171	41,031	48,429

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values for internal sewer flooding to take forward are the values in Table 10.6 and Table 10.7.

Step 4.0 - Assess and test valuations

The wider customer evidence for internal sewer flooding has been collated and reviewed by AWS (see annex 7). Internal sewer flooding was found to be a very important service issue and priority to customers with customers wanting to see Anglian Water maintain current performance levels. The wider evidence aligns with the recommendations presented in this report and the increase in values from PR14.

10.2 Internal Water Flooding

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

The unscaled and scaled values for internal sewer flooding have been mapped to the wider service measures for water flooding and the results are presented in the Table 10.8 and Table 10.9 below. The internal domestic sewer flooding value is mapped to other measures using weights from the PR14 flooding stated preference study. This study is used as it covered the weights between sewer and water flooding. The PR19 relative preference focus groups support the weightings between categories (Annex 2).

The subjective wellbeing analysis is an additional primary source of data that can be compared for a domestic property. This value is slightly lower than the lower end of the unscaled range and higher than the upper end of the scaled range. This suggests that the scaled value could be higher. However, the SWB value for waste water flooding has been taken into account when setting the anchor value that has been used for water flooding. Due to this no further adjustments have been made.

A number of additional secondary sources have also been compared. These are damage costs (see step 2 for details). Damage costs are an estimate of the impact caused to the property by flooding. They do not capture non-use values and the full level of inconvenience. Sewer and water flooding is known to be an area with significant altruism and inconvenience therefore the costs should be thought of as a partial value or a lower estimate. In the case of the data for the 2007 floods the calculated economic losses have been reported. This is the value of the damage costs adjusted for taxes (VAT) and based on the value of the actual goods damaged opposed to replacing the goods with new items.

For the unscaled results the damage cost values are lower than the range for a domestic property (see the domestic measure in Table 10.8). For non-domestic properties the damage costs are aligned with the range.

For the scaled results the damage costs are aligned with the low to central value for domestic properties. The damage costs for non-domestic are much higher indicating that the stated preference values may be underestimating the value. The source of the 2007 flood non-domestic values is drawn from 3 sources within the EA report. The sample sizes are significant and range from 7,300 to 35,000 with the largest sample associated with the lower end of the range. However, information is not available on the size of the businesses affected. It is therefore recommended that the non-domestic values in the final column of Table 10.9 are used in sensitivity testing when applying the scaled values.

Table 10.8: Unscaled - internal water flooding, £

SMF band	Unit	Lower	Central	Upper	Notes on values
Domestic Property - manual assessment	£/prop	60,554	125,850	210,245	FHRC & EA value is £16.3k to £32.5k. EA cost of summer 2007 floods value £10.5k to £24.5k.* Subjective wellbeing is £54.3k.
Non-domestic Property - manual assessment	£/prop	25,675	57,436	96,806	EA cost of summer 2007 floods in England is between £19k and £72k per property
(Asset Modelled) Domestic	£/prop	60,554	125,850	210,245	As domestic above
(Asset Modelled) Non Domestic - Agriculture	£/prop	13,336	28,777	48,298	
(Asset Modelled) Non Domestic - Food Production	£/prop	25,675	57,436	96,806	
(Asset Modelled) Non Domestic - Non Food Production	£/prop	25,675	57,436	96,806	
(Asset Modelled) Non Domestic – Leisure	£/prop	25,675	57,436	96,806	
(Asset Modelled) Non Domestic - Public Organisation	£/prop	25,782	54,498	91,237	

Table 10.9: Scaled - internal water flooding, £

SMF band	Unit	Lower	Central	Upper	Notes on values
Domestic Property - manual assessment	£/prop	13,860	33,115	39,007	FHRC & EA value is £16.3k to £32.5k. EA cost of summer 2007 floods value £10.5k to £24.5k. Subjective wellbeing is £54.3k.
Non-domestic Property - manual assessment	£/prop	5,935	14,199	17,140	EA cost of summer 2007 floods in England is between £19k and £72k per property
(Asset Modelled) Domestic	£/prop	13,860	33,115	39,007	As domestic above
(Asset Modelled) Non Domestic - Agriculture	£/prop	3,068	7,334	8,747	
(Asset Modelled) Non Domestic - Food Production	£/prop	5,935	14,199	17,140	
(Asset Modelled) Non Domestic - Non Food Production	£/prop	5,935	14,199	17,140	
(Asset Modelled) Non Domestic – Leisure	£/prop	5,935	14,199	17,140	
(Asset Modelled) Non Domestic - Public Organisation	£/prop	5,914	14,135	16,743	

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values for water flooding to take forward are the values in Table 10.8 and Table 10.9. The secondary evidence from damage costs suggests the scaled values may be underestimating the value for non-domestic properties. It is recommended that the damage cost values are used in sensitivity testing.

Step 4.0 – Assess and test valuations

No further customer evidence is available specifically for water flooding. However, wider customer evidence on flooding in general (see annex 7) did find that customers consider mitigating flooding, to be high priority for Anglian Water.

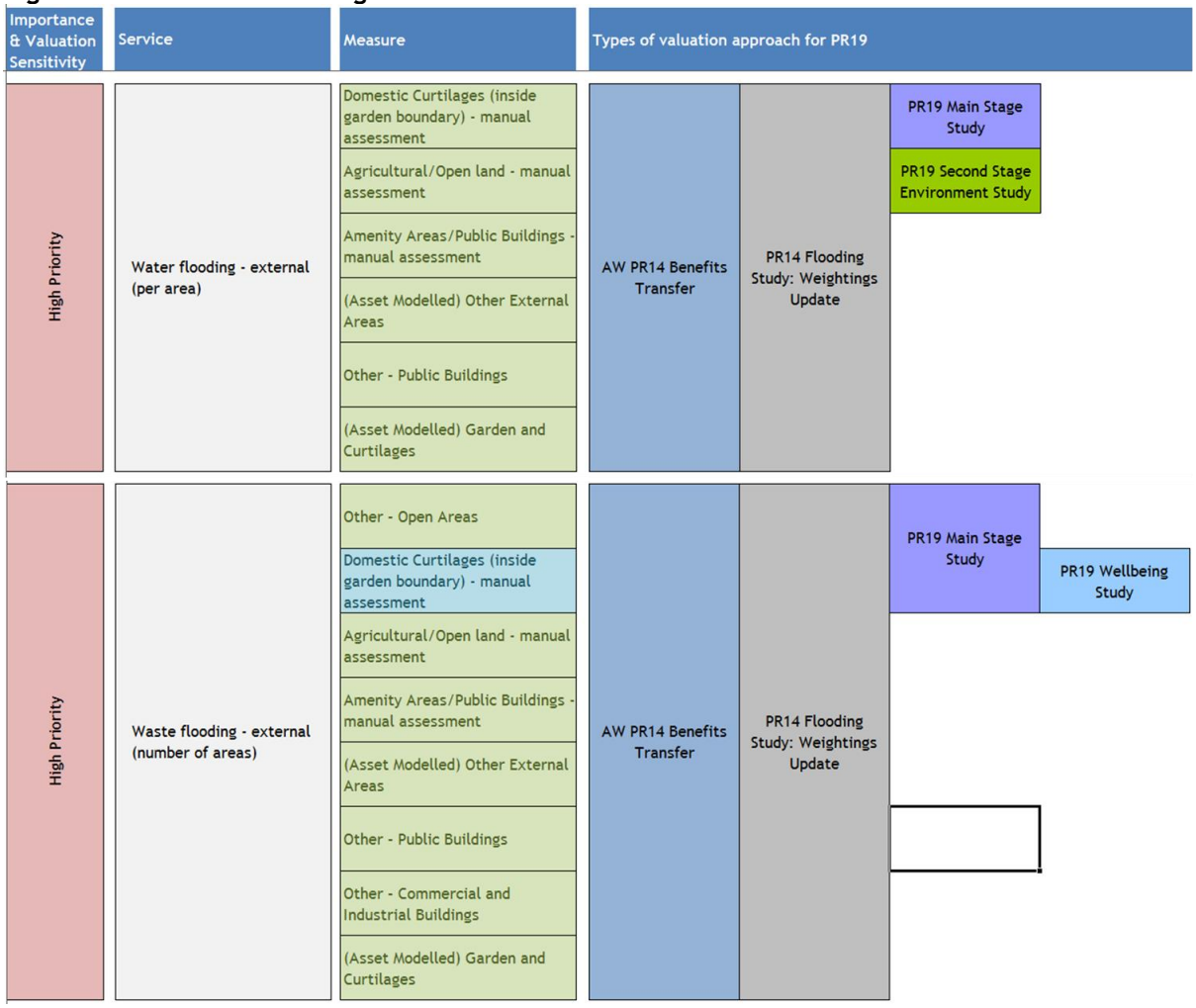
11 External flooding

This section covers water and wastewater external flooding.

Step 1.0 – Specify and undertake research

The evidence base for external flooding is given below. The anchor measure is waste flooding at a domestic curtilage i.e. inside a garden or boundary (highlighted in blue in the second column). The wider framework also covers waste flooding at other locations and water flooding.

Figure 11.1:External flooding valuation evidence



Step 2.0 Synthesis of research

Table 11.1 presents a summary of primary data. The table includes a range of valuation types covering Stated Preference studies, subjective wellbeing expenditure 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 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 section 4.2). 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. Therefore, the subjective wellbeing value is compared to both the unscaled and scaled stated preference values in the subsequent analysis.

Table 11.1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR19 main stage study	Stated preference - valuation	External wastewater flooding	Hhold, Non-hhold	H Large sample, DCE & DCCV methodology.	H Definition relevant, new study.
PR19 Best-worst scaling	Stated preference - valuation	External wastewater flooding	Hhold	H Good sample size, BWS methodology.	H Definition relevant, new study.
PR14 main stage study	Stated preference - valuation	External wastewater flooding	Hhold, Non-hhold	H Very large sample, DCE & DCCV methodology.	H Definition relevant, new study.
PR19 subjective wellbeing study	Subjective wellbeing	External wastewater flooding	Hhold	H/M New method.	H Definition relevant, new study.
PR14 2nd Stage flooding study	Stated Preference - customer preference weights	Weights for wider external flooding SMF. Covers water and waste flooding.	Hhold	H DCE methodology, good sample size.	H Definition relevant, PR14 study.
PR19 relative preference focus group	Qualitative review of customer preference weights from PR09 water services 2nd stage study plus discussion	All measures in the external flooding SMF. Covers water and waste flooding.	Hhold	M/L Qualitative, Small sample size.	H Definition relevant, new research.

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 PR14, insurance data and market value of impact costs. The market cost and insurance data will not capture the public good or altruism value, inconvenience or sentimental loss values that are captured in the stated preference values.

Table 11.2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
Southern PR14 WTP Main Stage (2013)	Stated Preference valuation	External wastewater flooding	Hhold, Non-hhold	H CV package methodology, good sample size.	M/L PR14 study, study from Different company and area.
Accent joint study - Unknown companies (2013)	Stated Preference valuation	External wastewater flooding for five companies	Hhold, Non-hhold	M Mixed surveys, limited published information.	M/L Relevant definitions, PR14 study, unknown areas.
Ofwat survey of customers affected by sewer flooding (2004)	Insurance data	External wastewater flooding	Hhold	L Insurance costs, Small sample.	M/L Relevant definitions, may cover a mix of severities, Old study.
eftec (2016) Targeting investments to protect and improve natural capital in England	Market impact assessment (yield costs)	External water flooding	Non-hhold	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.

11.1 External sewer flooding

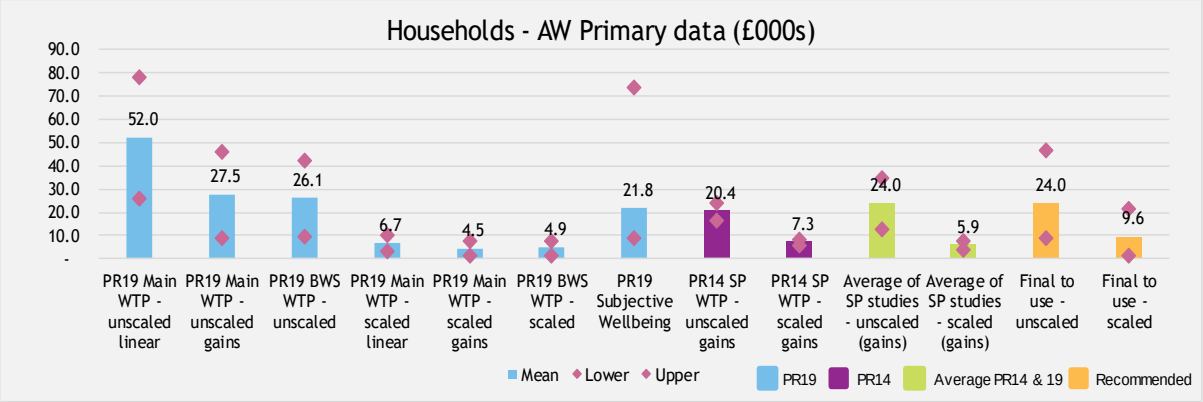
Step 3.0 Comparing valuations to produce recommendation

Step 3a: Primary data & initial recommended range

Households

The primary data for household customers is shown in Figure 11.2. The recommended range is shown both in the graph below and in Table 11.3.

Figure 11.2: Household primary data - External Sewer Flooding: £ per area, inside garden boundary (£000s)



NB: SWB range based on report assumptions on incident:area ratio not on a confidence interval.

Unscaled:

The unscaled central and upper value is based on the average of the PR19 unscaled gains values, PR19 BWS values, PR19 Subjective Well-Being (SWB) values and the PR14 unscaled gains values. PR14 values are included as the range is within the PR19 value validating the range. The PR19 value is higher than the PR14 value so this is a conservative estimate. It also acts to reduce the influence of the SWB which is based on a new approach where there is increased uncertainty when converting the value from a per incident value to a per area value.

The PR19 unscaled lower value is the average of the PR19 unscaled gains lower value, the PR19 BWS and the SWB lower value. The PR14 value is excluded as value higher than PR19 values. This is a more conservative approach that is aligned with the most recent data.

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.

Scaled:

The scaled central value is based on the same approach as the unscaled value. The scaled lower value is set at the average of the PR19 main study scaled gains and PR19 BWS lower value. The resulting value is lower than the central approach (which gives a value similar to PR19 scaled gains mean due to the SWB lower value being relatively high). The scaled upper value is set at the SWB mean value as this is much higher than the stated preference values.

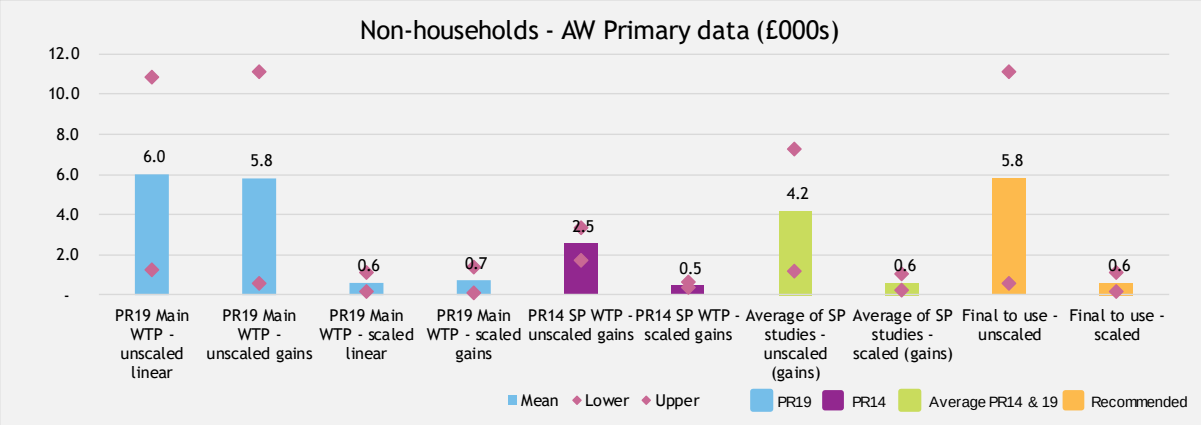
Table 11.3: Scaled and unscaled household values - External sewer flooding: £ per area, inside garden boundary (£000s)

Value type	Lower	Central	Upper
Unscaled	9.3	24.0	46.7
Scaled	1.7	9.6	21.8

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.

Figure 11.3: Non Household primary data - External sewer flooding: £ per area, inside garden boundary (£000s)



Unscaled:

Both the unscaled central value and range are based on the PR19 unscaled gains values. Similar to the household approach the PR19 main stage unscaled gains value has been used in preference to the linear value as this is more conservative. The PR14 value has been excluded as the PR19 mean values are much higher. A similar step change in values is also observed for the primary evidence for internal flooding.

Scaled:

The scaled central value and range is based on the PR19 scaled linear values. The linear values have been used in place of the gains values as the two values are similar but the linear value has a tighter confidence range[20]. The reasoning for excluding the PR14 value is the same as above.

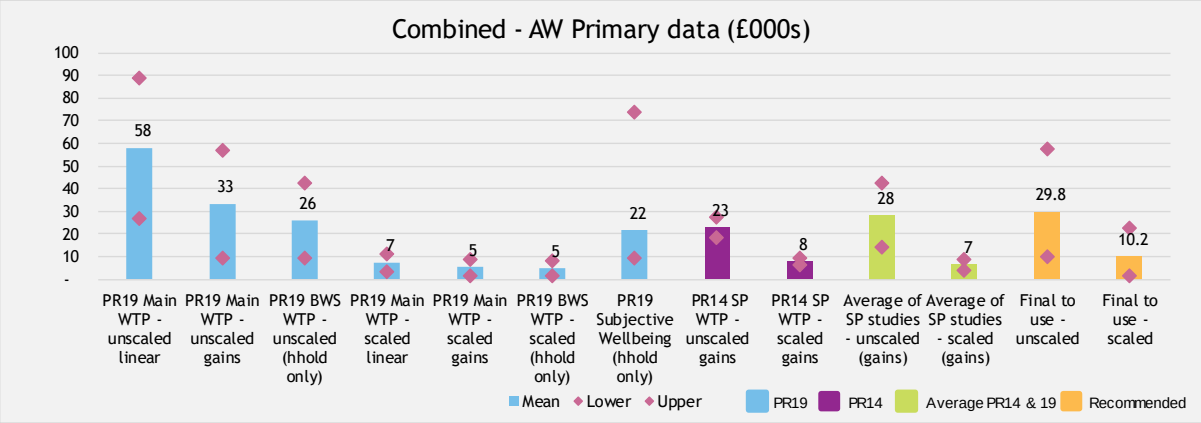
Table 11.4: Scaled and unscaled non-household values - External sewer flooding: £ per area, inside garden boundary (£000s)

Value type	Lower	Central	Upper
Unscaled	0.5	5.8	11.1
Scaled	0.1	0.6	1.1

[20] This is expected to be due to the linear model using a greater number of observation compared to the gains-loss model.

Combined (households and non-households)
The primary data for 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 - External sewer flooding: £ per area, inside garden boundary (£000s)



The values presented are the household range plus non-household range. The SWB value is included for completeness however, this is a household only value. The recommended unscaled value is higher than PR14 equivalent due to increases in stated preference value for households. The recommended scaled values are slightly higher than the PR14 values.

Table 11.5: Initial recommended range - combined - External sewer flooding: £ per area, inside garden boundary (£000s)

Value type	Lower	Central	Upper
Unscaled	9.9	29.8	57.8
Scaled	1.8	10.2	22.9

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

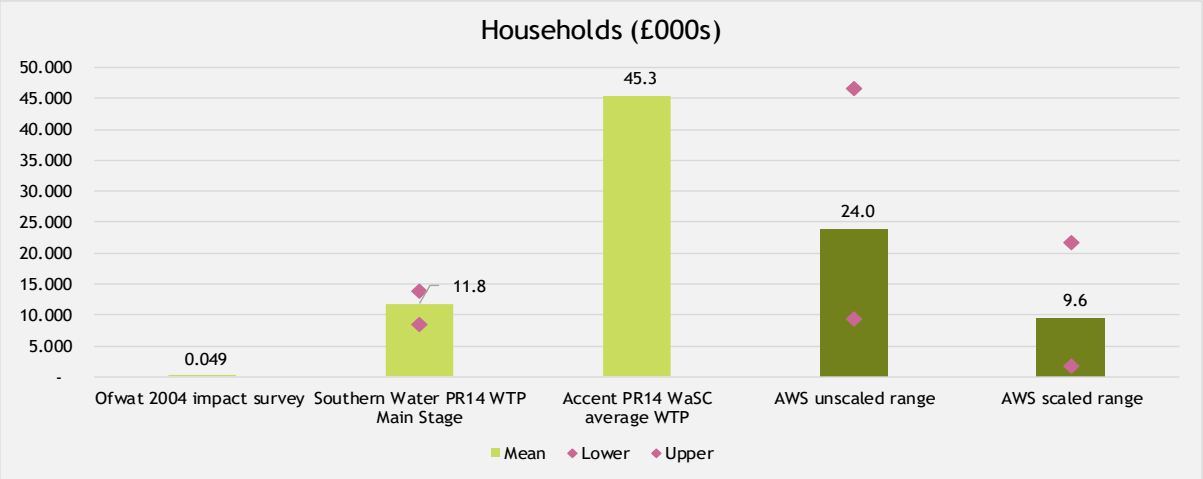
Figure 11.5 to Figure 11.7 show how the ranges compare to the secondary data sources available.

Unscaled and scaled values look aligned for households and low for non-household customers. When combined, the scaled value initially looks low when compared with other studies but is in line with the unadjusted median from the PR14 Accent study. The unscaled value looks reasonable.

The Ofwat impact survey is a 2004 study that collated information on the impacts of sewer flooding. The value shown is based on insurance costs; however, the sample for this is small and is therefore considered to have a low robustness score. Insurance costs will only capture direct cost and will exclude inconvenience and the value that unaffected customers place on these service failures. However, these values are likely to be less significant for external flooding compared to internal flooding where they are known to be significant (see internal flooding section).

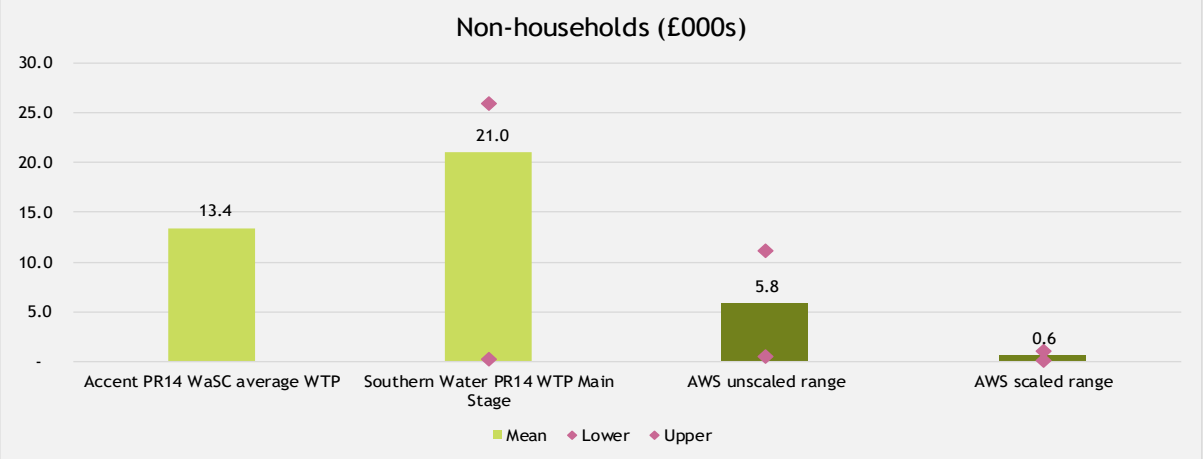
The Southern Water study is a scaled value. The Accent study is thought to be a mix of scaled and unscaled values.

Figure 11.5: Comparing to household secondary data - External sewer flooding: £ per area, inside garden boundary (£000s)



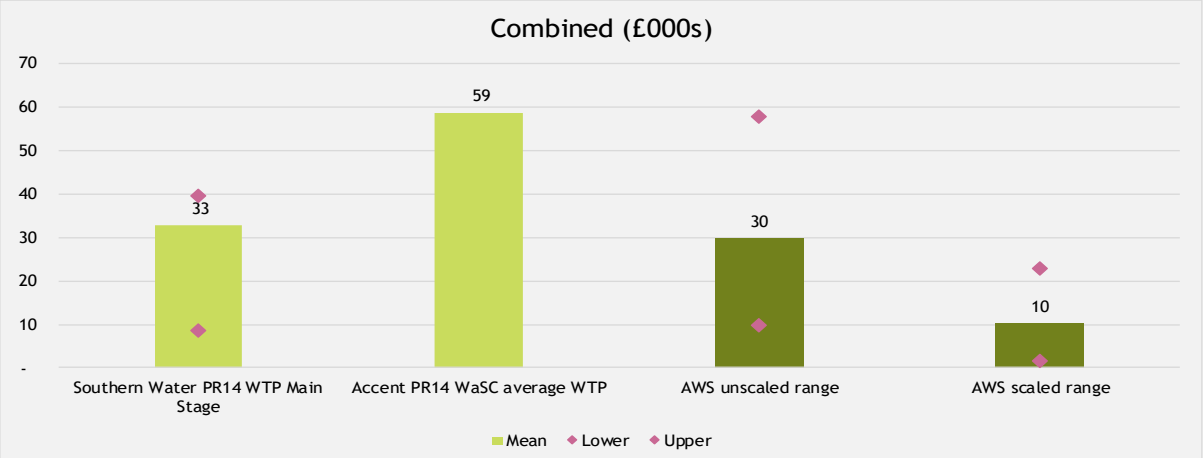
NB: Accent average unknown WaSC is based on 5 companies - masks a wide range of values but reasonable number of companies for this measure. The unadjusted (for customer numbers) values range from 3k to 162k per property. Median is £3.4k.

Figure 11.6: Comparing to non-household secondary data - external sewer flooding: £ per area, inside garden boundary (£000s)



NB: Accent average unknown WaSC is based on 5 companies - masks a wide range of values but reasonable number of companies for this measure. The unadjusted (for customer numbers) values range from 0.5k to 61k per area (median is £4k).

Figure 11.7: Comparing to combined secondary data - External sewer flooding: £ per area, inside garden boundary (£000s)



NB: Accent average unknown WaSC is based on 5 companies - masks a wide range of values but reasonable number of companies for this measure. The unadjusted (for customer numbers) values range from 3.4k to 223k per area (median is £15k).

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

The unscaled and scaled values for external sewer flooding have been mapped to the wider service measures for waste water and the results are presented in the two tables below. The external flooding value is mapped to other measures using weights from PR14 flooding stated preference study. The PR19 relative preference focus groups support weightings between categories (Annex 2).

There is limited primary and secondary evidence for all the categories (except for the anchor – domestic property). More evidence is available for internal and external water as opposed to wastewater flooding.

Table 11.6: Unscaled – External sewer flooding, £

SMF band	Unit	Lower	Central	Upper
Other – Open Areas	£/area	4,111	13,704	26,531
Domestic Curtilages (inside garden boundary) - manual assessment	£/area	9,885	29,785	57,800
Agricultural/Open land - manual assessment	£/area	3,133	10,272	19,893
Amenity Areas/Public Buildings - manual assessment	£/area	4,151	13,314	25,797
(Asset Modelled) Other External Areas	£/area	4,111	13,704	26,531
Other – Public Buildings	£/area	4,191	12,923	25,064
Other – Commercial and Industrial Buildings	£/area	4,111	13,704	26,531
(Asset Modelled) Garden and Curtilages	£/area	9,885	29,785	57,800

Table 11.7: Scaled – External sewer flooding, £

SMF band	Unit	Lower	Central	Upper
Other – Open Areas	£/area	751	4,272	9,459
Domestic Curtilages (inside garden boundary) - manual assessment	£/area	1,782	10,234	22,863
Agricultural/Open land - manual assessment	£/area	571	3,254	7,216
Amenity Areas/Public Buildings - manual assessment	£/area	754	4,307	9,570
(Asset Modelled) Other External Areas	£/area	751	4,272	9,459
Other – Public Buildings	£/area	757	4,342	9,682
Other – Commercial and Industrial Buildings	£/area	751	4,272	9,459
(Asset Modelled) Garden and Curtilages	£/area	1,782	10,234	22,863

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values for waste external flooding to take forward are the values in Table 11.6 and Table 11.7.

Step 4.0 – Assess and test valuations

The wider customer evidence for external sewer flooding has been collated and reviewed by AWS (see annex 7). The review found external sewer flooding to be an important service issue for customers and a high priority but not as important as internal sewer flooding. This evidence aligns with the recommendations presented in this report and in seeing an increase from PR14 values.

11.2 External Water Flooding

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

The unscaled and scaled values for external sewer flooding have been mapped to the wider service measures for water flooding and the results are presented in the Table 11.8 and Table 11.9 below. The external sewer flooding value is mapped to the other measures using weights from the PR14 flooding stated preference study. This study is used as it covered the weights between sewer and water flooding. The PR19 relative preference focus groups support weightings between categories (Annex 2).

Two further secondary sources are available. The first is taken from a study by eftec[21] 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 unscaled and 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.

[21] Eftec (2016) Targeting investments to protect and improve natural capital in England.

Table 11.8: Unscaled - external water flooding, £

SMF band	Unit	Lower	Central	Upper	Notes on values
Domestic Curtilages (inside garden boundary) - manual assessment	£/area	3,311	9,997	19,398	
Agricultural/Open land - manual assessment	£/area	1,050	3,452	6,685	eftec natural capital study (£4.2k to £10.0k) based on an area of 5.9ha (5% of average farm), EA cost of summer floods between £5k to £11k based on an area of 5.9ha
Amenity Areas/Public Buildings - manual assessment	£/area	1,391	4,473	8,666	
(Asset Modelled) Other External Areas	£/area	1,378	4,606	8,917	
Other – Public Buildings	£/area	1,404	4,339	8,414	
(Asset Modelled) Garden and Curtilages	£/area	3,311	9,997	19,398	

Table 11.9: Scaled - external water flooding, £

SMF band	Unit	Lower	Central	Upper	Notes on values
Domestic Curtilages (inside garden boundary) - manual assessment	£/area	597	3,428	7,658	
Agricultural/Open land - manual assessment	£/area	191	1,091	2,418	eftec natural capital study (£4.2k to £10.0k) based on an area of 5.9ha (5% of average farm), EA cost of summer floods between £5k to £11k based on an area of 5.9ha
Amenity Areas/Public Buildings - manual assessment	£/area	253	1,443	3,206	
(Asset Modelled) Other External Areas	£/area	252	1,432	3,170	
Other – Public Buildings	£/area	254	1,455	3,243	
(Asset Modelled) Garden and Curtilages	£/area	597	3,428	7,658	

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values for external water flooding to take forward are the values in Table 11.8 and Table 11.9. As part of future data collection, it is recommended further information is sought on the average size of an area to improve the comparison to the secondary data source for agricultural land.

Step 4.0 - Assess and test valuations

No further customer evidence is available specifically for water flooding. However, wider customer evidence (see annex 7) on flooding in general, did find that customers consider mitigating flooding, to be a high priority for Anglian Water.

11.3 Flooding Solutions

A bespoke PR19 SUDs Benefit Tool is being developed by Atkins for Anglian Water to feed into investment planning for the appraisal of the benefits of SUDs. The aim of this spreadsheet tool is to assess the multiple benefits of SUDs schemes on a quantitative and monetised basis. Wider societal benefits in addition to avoided flooding include; carbon, air quality and amenity value.

In addition to this source, the table below shows the weights from PR14 Second Stage Flooding Study which indicate that customers place a premium on non-traditional solutions to manage flood risk. Testing at PR19 customer preferences focus groups suggests the PR14 weights may be on the high side, with evidence that whilst there is a premium for these solutions, a factor of 2.17 for SuDS may be too high.

Overall the weights provide evidence that whilst the value of the premium is uncertain non-traditional solutions do drive further benefit for customers and it is appropriate to seek to identify additional benefits through the SUDs benefit tool.

Table 11.10: SUDS valuation evidence

	Flooding solution type (Multiplier)	Traditional	1.00
		SuDS	2.17
		Customer	1.63

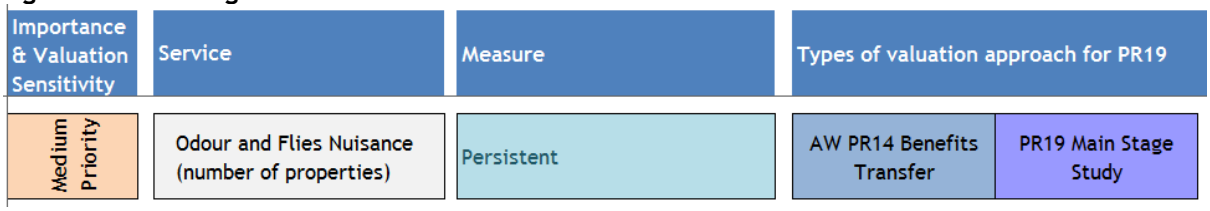
12 Sewage Odour

This section covers sewage odour.

Step 1.0 – Specify and undertake research

The evidence base for sewage odour is given below. The anchor measure is sewage odour. No other measures are linked to this.

Figure 12.1: Sewage Odour valuation evidence



Step 2.0 Synthesis of research

Table 12.1 presents a summary of primary data. The table includes three Stated Preference surveys.

Table 12.1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR19 main stage study	Stated preference valuation	Odour	Hhold, Non-hhold	H Large sample DCE & DCCV methodology	H Definition relevant, new study
PR19 Best-worst scaling	Stated preference valuation	Odour	Hhold	H Good sample size, BWS methodology	H Definition relevant, new study
PR14 main stage study	Stated preference valuation	Odour	Hhold, Non-hhold	H Very large sample DCE & DCCV methodology	H Definition relevant, PR14 study

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 PR14.

Table 12.2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
Southern PR14 WTP Main Stage (2013)	Stated Preference valuation	Odour	Hhold, Non-hhold	H CV package methodology, good sample size	M/L PR14 study, study from Different company and area

Thames PR09 Leakage WTP (2008)	Stated Preference valuation	Odour	Hhold	H/M DCE methodology, small sample size	L Old study, different company and area
Lanz and Provins (2011)	Stated Preference valuation	Odour	Hhold	H Unknown SP methodology, Peer reviewed academic paper, limited public domain information	M/L PR14 study for unknown area
Accent joint study - Unknown companies (2013)	Stated Preference valuation	Odour for three companies	Hhold, Non-hold	M Mixed surveys, limited published information	M/L Relevant definitions, PR14 study, unknown areas

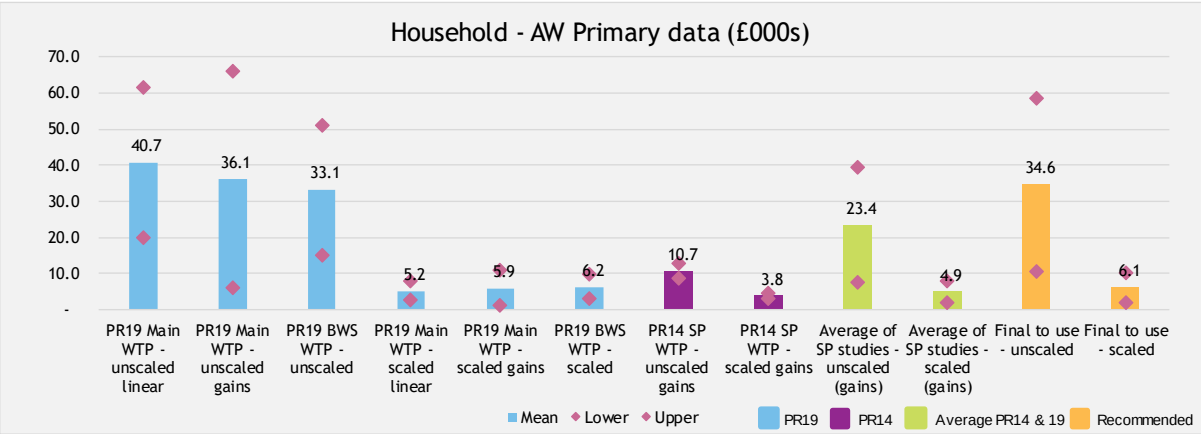
Step 3.0 Comparing valuations to produce recommendation

Step 3a: Primary data & initial recommended range

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.

Figure 12.2: Household primary data - £ per property, odour (£000s)



Unscaled:

The unscaled central and range values are based on an average of the PR19 unscaled gains values and the PR19 BWS value. The PR14 values have been excluded as the PR19 values are higher than the PR14 ones indicating a step change in value. It is not clear what is driving this change as there has been an improvement to service levels since PR14.

Scaled:

The scaled central and range values are based on the same approach as the unscaled value. As with the unscaled recommended range the PR14 values have been excluded. The PR19 mean value is higher than the PR14 upper range, however, the lower recommended value does overlap with the PR14 range.

Overall, the gains value has been used in preference to the linear value as this is more appropriate for an improvement value due to the mean gains value being below the confidence range of the linear value.

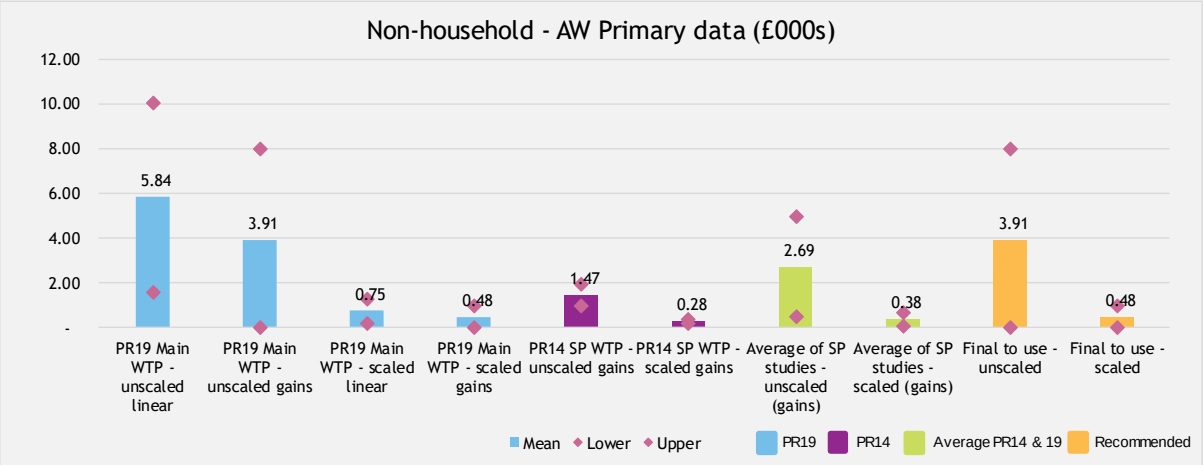
Table 12.3: Scaled and unscaled household values - £ per property, odour (£000s)

Value type	Lower	Central	Upper
Unscaled	10.6	34.6	58.6
Scaled	1.9	6.1	10.2

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.

Figure 12.3: Non Household primary data - £ per property, odour (£000s)



Unscaled:

Both the unscaled central value and range are based on the PR19 unscaled gains values. The mean PR19 value is much higher than PR14, however, the PR19 range overlaps the PR14 range at lower end. This may reflect a step change similar to that observed with household customers or it may imply that a value towards the lower end of the PR19 range is more valid. In the absence of more data points the more recent data is recommended.

Similar to the household approach the PR19 main stage unscaled gains value has been used in preference to the linear value as this is more conservative.

Scaled:

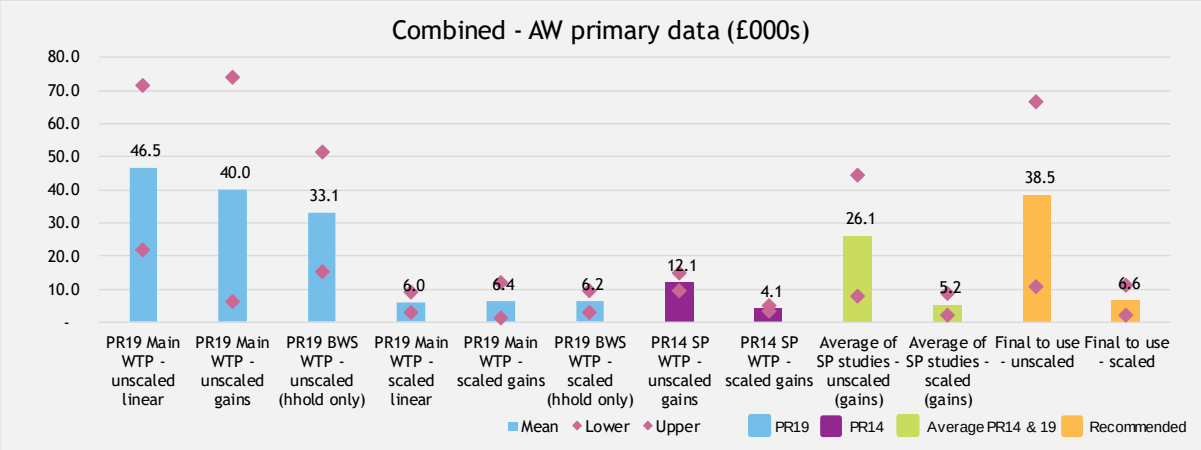
The scaled central value and range are based on the PR19 scaled gains value. As with the unscaled value the PR19 mean is higher than the PR14 range however, the PR19 range overlaps with the PR14 range. The same implications apply.

Table 12.4: Scaled and unscaled non-household values - £ per property, odour (£000s)

Value type	Lower	Central	Upper
Unscaled	0.00	3.91	8.03
Scaled	0.00	0.48	0.99

Combined (households and non-households)
The primary data for AWS household 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 property, odour (£000s)



The values presented are the household range plus non-household range. The recommended unscaled and scaled values are higher than PR14 equivalent due to increases in the stated preference values.

Table 12.5: Initial recommended range - combined - £ per property, odour (£000s)

Value type	Lower	Central	Upper
Unscaled	10.6	38.5	66.6
Scaled	1.9	6.6	11.2

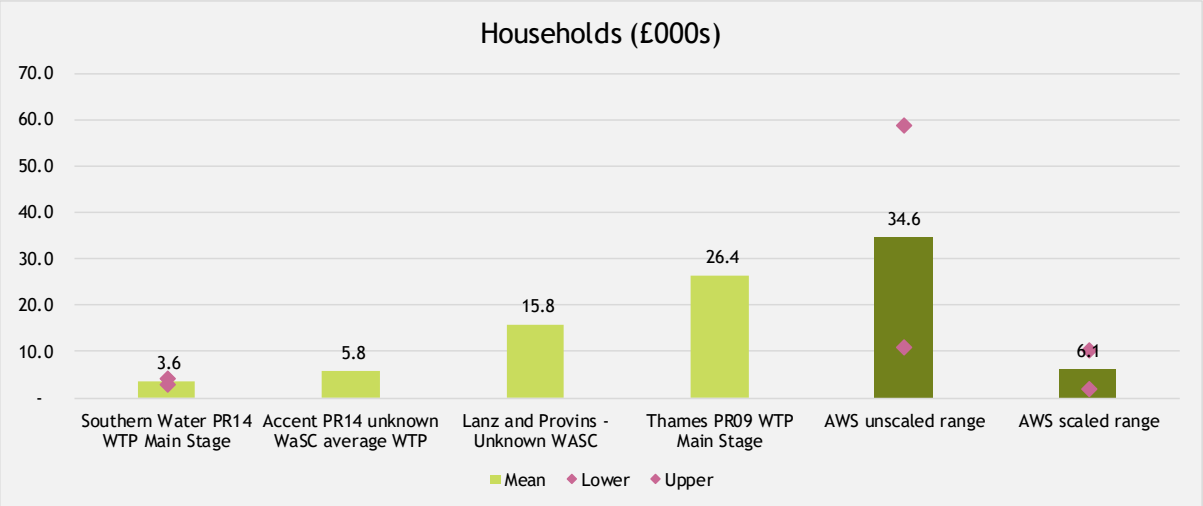
Step 3b: Triangulating against other sources (secondary data)

Figure 12.5 to Figure 12.7 show how the ranges compare to the secondary data sources available.

For households and combined customers the scaled values are aligned with the lower end of the other studies range. Unscaled mean value is higher than the other studies but the range overlaps with the other study values suggesting that there is some consistency. For non household customers the scaled values look low but the unscaled value is more aligned.

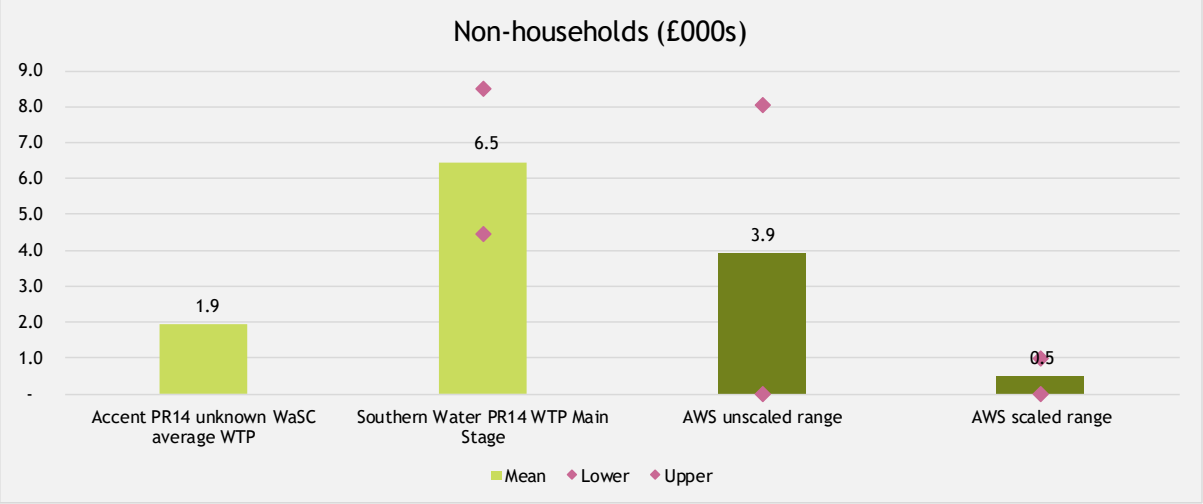
The Southern water study is a scaled value. Lanz and Provins and Thames Water are unscaled values. The Accent study is thought to be a mix of scaled and unscaled values.

Figure 12.5: Comparing to household secondary data



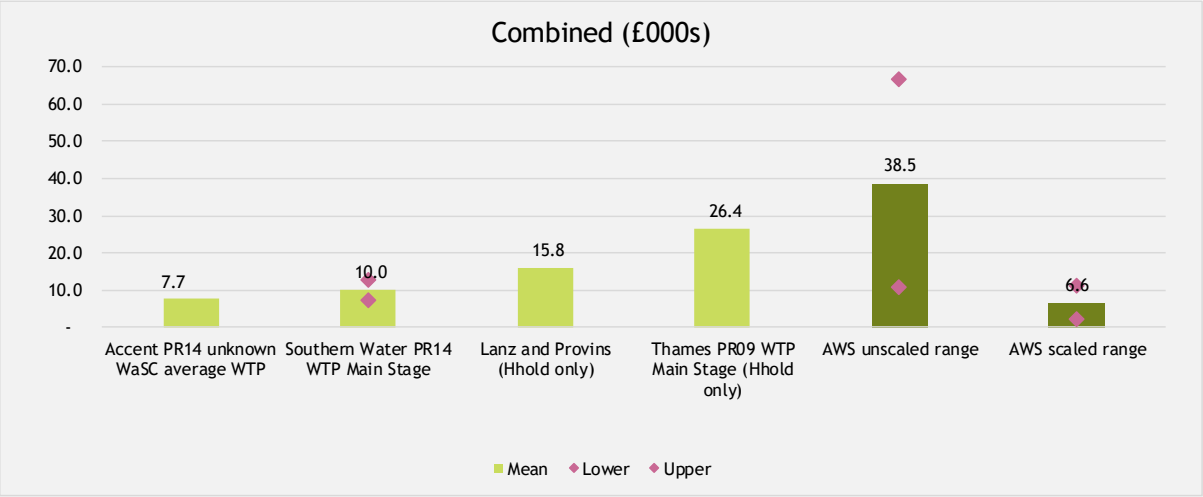
NB: Accent average unknown WaSC is based on 3 companies. The unadjusted (for customer numbers) values range from £0.8k to £12k per property (median is £1.5k).

Figure 12.6: Comparing to non-household secondary data



NB: Accent average unknown WaSC is based on 3 companies. The unadjusted (for customer numbers) values range from £0.4k to £4.9k per property (median is £1.5k)

Figure 12.7: Comparing to combined secondary data



NB: Accent average unknown WaSC is based on 3 companies. The unadjusted (for customer numbers) values range from £1.9k to £16.7k per property (median is £2.3k). Note some values in the graph are household only.

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 3d Comparing valuations to produce recommendation – Final recommendation

The final values for sewage odour to take forward are the values in Table 12.5 above.

Step 4.0 – Assess and test valuations

The wider customer evidence has been collated and reviewed by AWS (see annex 7). There is little on odour from sewerage treatment works in the wider customer evidence. However additional information from the valuation studies found that customers have little experience of problems with odour and do not view it as a high customer priority such as sewer flooding. This suggests the values are consistent with these key messages from the wider customer evidence.

13 Pollution

This section covers different severities of pollution and water discharge compliance.

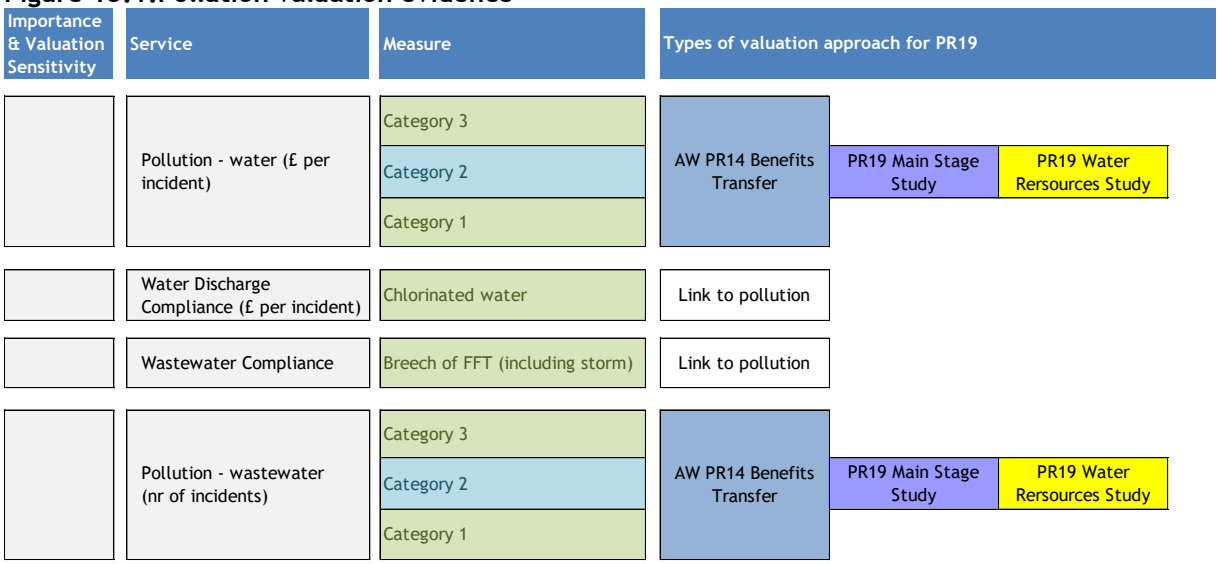
Step 1.0 – Specify and undertake research

The evidence base for pollution is given below. The anchor measure has been updated from the interim values and report to be a category 2 pollution incident.

The interim stage reported the anchor values for pollution incidents linked to a category 3 incident. However, the interim report also highlighted a step change in values between PR19 and PR14 and a corresponding change in the definition provided to customers[22].

Given the high values observed for PR19 we hypothesised that people may have interpreted this more as a category 2 incident. The interim report recommended that the interpretation was tested with customers to rule out this being the driver of the increase in value. In response to this recommendation Anglian Water has tested the PR19 pollution category definitions with customers in an exercise in their online community during March 2018. The results show that on balance customer believed the definition used in the PR19 valuation studies better aligned with a category 2 incident and not a category 3 incident. As a result, the anchor measure has been updated to a category 2 pollution incident. This has reduced the values for pollution incidents for categories 1 to 3; however, the values are still showing an increased compared to PR14 values.

Figure 13.1:Pollution valuation evidence



Step 2.0 Synthesis of research

Table 13.1 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.

Following the interim stage and the subsequent research with customers the PR19 studies measure description has been updated to refer to a category 2 incident.

[22] PR19 definition from the stated preference studies: 'Occasionally the sewerage system is affected by pump failures, blockages and heavy rain, which results in untreated sewage entering and polluting rivers or the sea. This can cause some damage to fish and other wildlife. All water companies are required to reduce the number of pollution incidents over time.'

Table 13.1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR19 main stage study	Stated preference - valuation	Pollution incident - category 2	Hhold, Non-hhold	H Large sample DCE & DCCV methodology	H New study, Definition relevant & tested with customers in March 18.
PR19 Best-worst scaling	Stated preference - valuation	Pollution incident - category 2	Hhold	H Good sample size, BWS methodology	H New study, Definition relevant & tested with customers in March 18.
PR14 main stage study	Stated preference - valuation	Pollution incident - category 3	Hhold, Non-hhold	H Very large sample, DCE & DCCV methodology	H Definition relevant, new study
PR19 2nd stage water resources survey	Stated Preference - valuation	Pollution incident - category 3	Hhold, Non-hhold	H Good sample size, CV methodology followed by allocation exercise	H New study, Definition relevant & tested with customers in March 18.
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
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	Hhold	M/L Qualitative, Small sample size	H Definition relevant, new research
PR19 online community research - pollution exercise	Review of the PR19 pollution definition	PR19 definition	Hhold	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, new research

Table **13.2** 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 PR14.

Table 13.2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
Southern PR14 WTP Main Stage (2013)	Stated Preference valuation, CV package method plus allocation from DCE	Category 2/3 pollution incident	Hhold, Non-hold	H CV package methodology, good sample size	M/L PR14 study, study from Different company and area
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	Hhold, Non-hold	M Mixed surveys, limited published information	M/L Relevant definitions, PR14 study, unknown areas

13.1 Pollution incidents (Category 2)

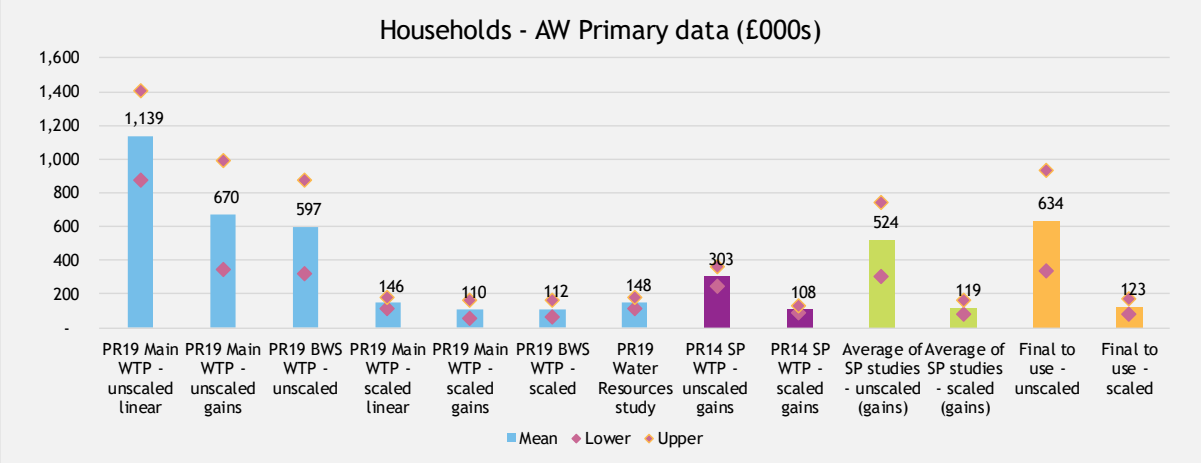
Step 3.0 Comparing valuations to produce recommendation

Step 3a: Primary data & initial recommended range

Households

The primary data for AWS household customers is shown in Figure 13.2. The recommended range is shown both in the graph below and in Table 13.3. The PR14 values have been adjusted to represent a category 2 value (from a category 3) using the PR14 Environment Study customer preference weights.

Figure 13.2: Household primary data - £ per category 2 incident (£000s)



Unscaled:

The unscaled central value and ranges is based on an average of the PR19 unscaled gains values and the PR19 BWS values as these are distinctly higher than PR14. The PR19 values are higher than the

PR14 value and the PR14 value is not used to adjust the recommended range, however, the lower end of the recommend range overlaps with the PR14 range.

Scaled:
The scaled central value and range is based on an average of the PR19 main stage scaled gains mean value, the PR19 BWS value and the PR19 WR study mean value. The Water Resources Study is a higher value but the range shows reasonable overlap. The PR19 range encompasses the PR14 range.

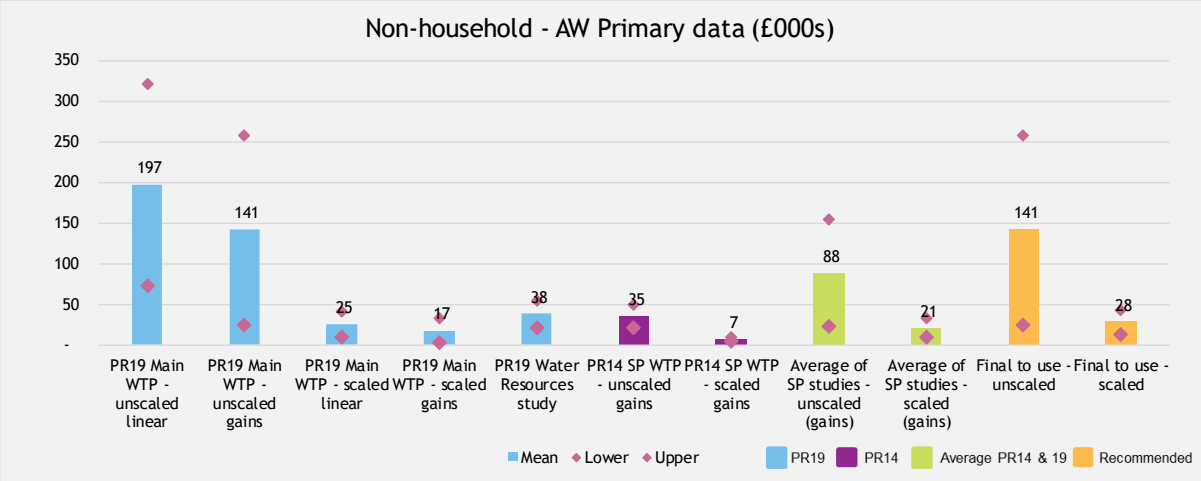
Overall, the gains value has been used in preference to the linear value as this is more conservative. The mean gains value is also below the confidence range of the linear value.

Table 13.3: Scaled and unscaled household values - £ per category 2 incident (£000s)

Value type	Lower	Central	Upper
Unscaled	335	634	932
Scaled	77	123	169

Non-households
The primary data for AWS non-household customers is shown in Figure 13.3. The recommended range is shown both in the graph below and in Table 13.4. As with households, the PR14 values have been adjusted to represent a category 2 value (from a category 3) using the PR14 Environment Study customer preference weights.

Figure 13.3: Non Household primary data - £ per category 2 incident (£000s)



Unscaled:
The unscaled central value and range is based on the PR19 unscaled gains values. Similar to the household approach the PR19 main stage unscaled gains value has been used in preference to the linear value as this is more conservative.

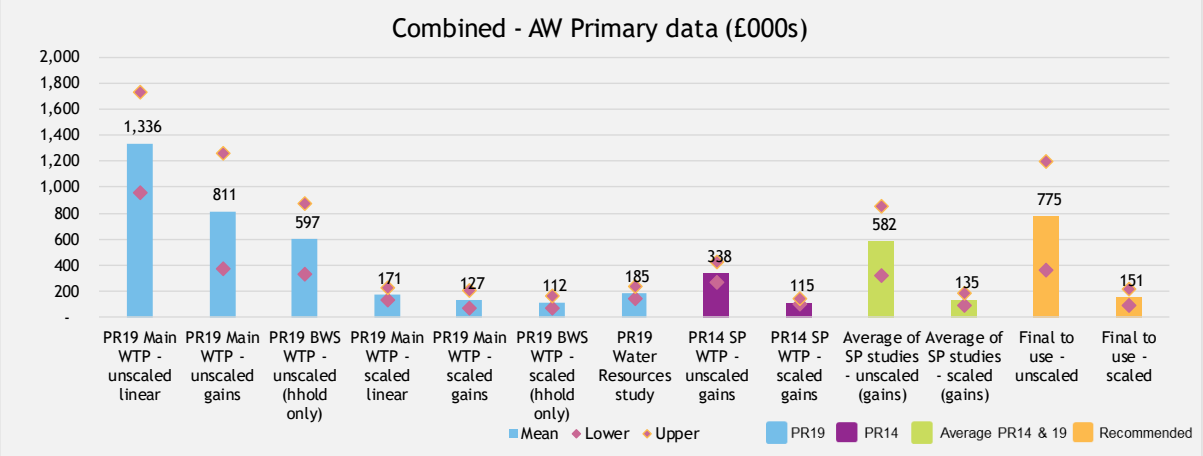
Scaled:
The scaled central value and ranges are based on the average of the PR19 main stage scaled gains value and the PR19 water resources study values.

Table 13.4: Scaled and unscaled non-household values - £ per category 2 incident (£000s)

Value type	Lower	Central	Upper
Unscaled	25	141	258
Scaled	12	28	43

Combined (households and non-households)
The primary data for AWS combined customers is shown in Figure 13.4. The recommended range is shown both in the graph below and in Table 13.5. The PR14 values have been adjusted to represent a category 2 value (from a category 3) using the PR14 Environment Study customer preference weights.

Figure 13.4: Combined primary data - £ per category 2 incident (£000s)



The values presented are the household range plus non-household range. The recommended unscaled value is higher than the PR14 equivalent value due to increases in stated preference value.

Table 13.5: Initial recommended range - combined - £ per category 2 incident (£000s)

Value type	Lower	Central	Upper
Unscaled	360	775	1,190
Scaled	89	151	212

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

Figure 13.5 to Figure 13.7 show how the ranges compare to the secondary data sources available.

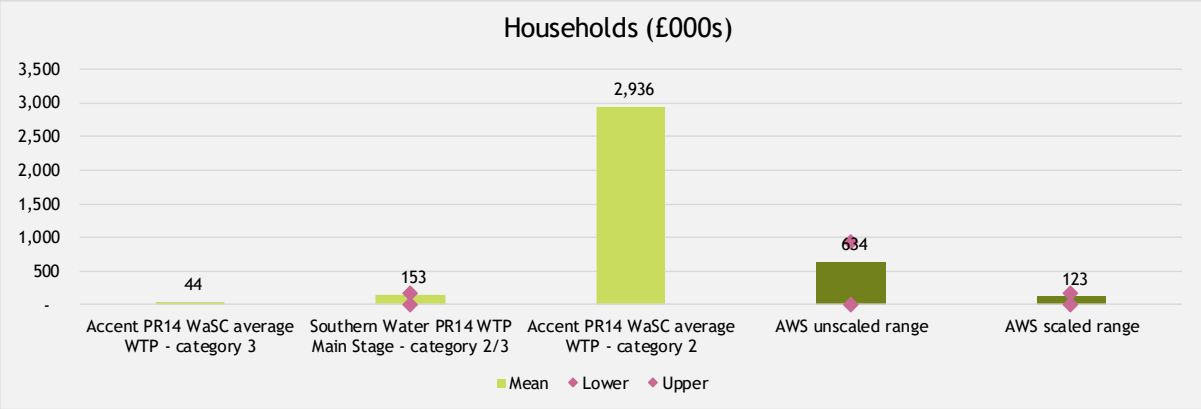
Given the challenge to the definition we have presented both the category 2 and 3 secondary sources. This shows that both the household and non-household recommended values appear higher than a category 3 incident in line with expectations. The category 3 Accent study values are thought to be scaled values.

The recommended ranges are lower than the category 2 comparator values. The individual study information shows that the category 2 sample includes a very high value that looks implausible when compared to other values such as flooding.

For household customers the scaled values are aligned with the Southern Water value, however, this is defined as a category 2/3 incident.

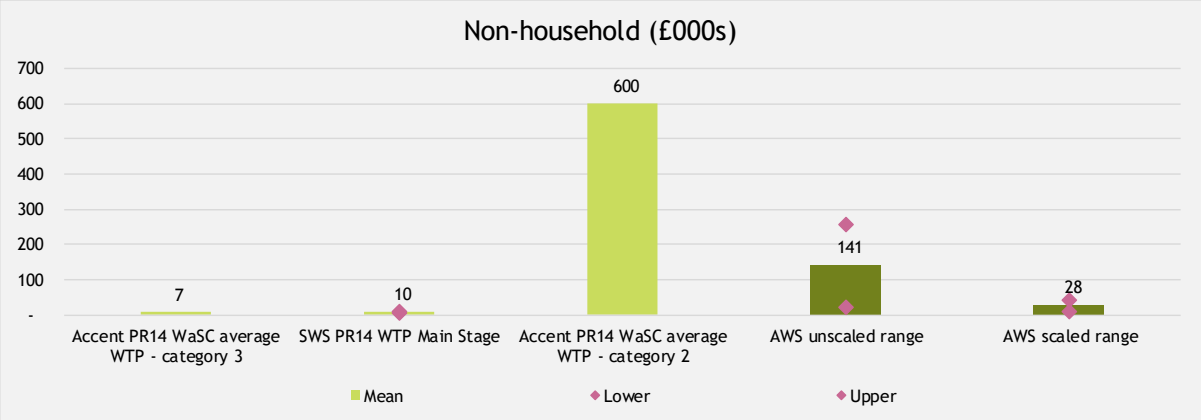
Overall, the secondary sources suggest the recommended category 2 values could be increased further. As the recommended values are set in line with the online community research we are not recommending any amendments as the AWS customer views are considered more robust and relevant than other companies PR14 values. This is a conservative approach applied; however, further evidence would be required to make adjustments.

Figure 13.5: Comparing to household secondary data - £ per category 2 incident (£000s)



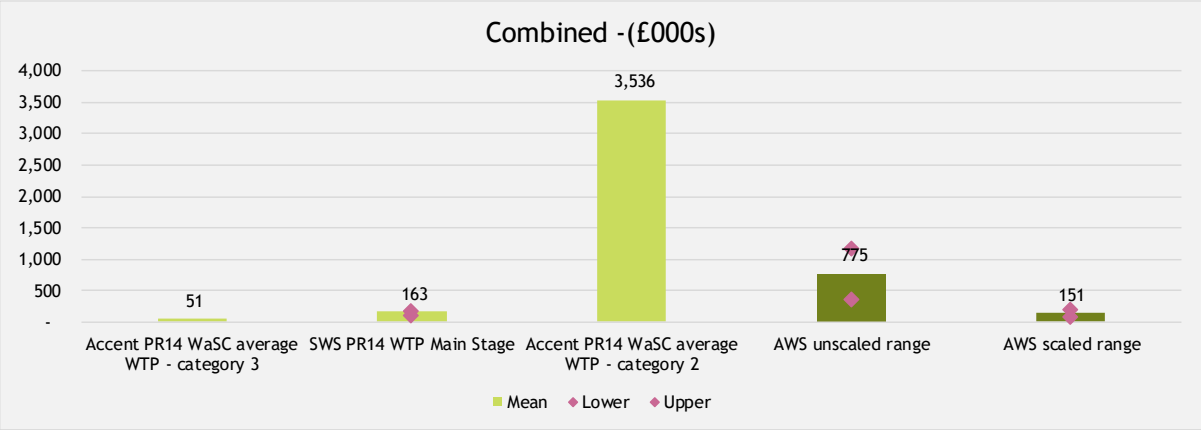
NB: Accent category 2 average unknown WaSC is based on 2 companies. The unadjusted (for customer numbers) values are £1.1m and £3.7m per incident (median is £2.3m). Accent category 3 average unknown WaSC is based on 2 companies. The unadjusted (for customer numbers) values are £28.5k and £42.7k per incident (median is £35.6k).

Figure 13.6: Comparing to non-household secondary data - £ per category 2 incident (£000s)



NB: Accent category 2 average unknown WaSC is based on 2 companies. The unadjusted (for customer numbers) values are £221k to £1,176k per incident (median is £698k). Accent category 3 average unknown WaSC is based on 2 companies. The unadjusted (for customer numbers) values are £5.7k to £11.5k per incident (median is £8.6k).

Figure 13.7: Comparing to combined secondary data - £ per category 2 incident (£000s)



NB: Accent category 2 average unknown WaSC is based on 2 companies. The unadjusted (for customer numbers) values are £1.3m to £4.8m per incident (median is £3.1m). Accent category 3 average unknown WaSC is based on 2 companies. The unadjusted (for customer numbers) values are £34.3k to £54.1k per incident (median is £44.2k).

13.2 Other pollution categories

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

The unscaled and scaled values for a category 2 pollution incident have been mapped to the wider service measures for pollution and the results are presented in the two tables below.

The category 2 pollution incident values have been mapped to category 1 and 3 pollution incidents using weights from Anglian Water PR14 Environment Stated Preference Study. These weights were tested in the recent PR19 relative preference focus groups and found to be highly valid.

To populate the SMF severity *Breach of Flow to Full Treatment (FFT)*[23], PR14 assumptions have been used to link a FFT failure to the pollution impact. The assumption is that these are 5% of category 2 and 45% of category 3 values. These assumptions have been taken from the Anglian Water PR14 valuation completion report (see this report for a detailed summary).

For the SMF severity *Chlorinated Water*, this has been set equal to category 2 incident as a chlorine failure would impact on wildlife. This is a new measure for PR19.

[23] Flow to Full Treatment is the maximum flow rate that a wastewater treatment works is designed to accept for treatment.

Table 13.6: Unscaled - Pollution, £ per incident

SMF band	Unit	Lower	Central	Upper
Category 3	£/incident	191,658	412,760	633,862
Category 2	£/incident	359,731	774,728	1,189,724
Category 1	£/incident	705,990	1,520,440	2,334,890
Breach of FFT (including storm)	£/incident	104,233	224,478	344,724
Chlorinated water	£/incident	359,731	774,728	1,189,724

Table 13.7: Scaled - Pollution, £ per incident

SMF band	Unit	Lower	Central	Upper
Category 3	£/incident	47,594	80,333	113,072
Category 2	£/incident	89,331	150,780	212,229
Category 1	£/incident	175,316	295,913	416,510
Breach of FFT (including storm)	£/incident	25,884	43,689	61,494
Chlorinated water	£/incident	89,331	150,780	212,229

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values for pollution to take forward to step 4 are the values in Table 13.6 and Table 13.7.

Step 4.0 - Assess and test valuations

The wider customer evidence for pollutions has been collated and reviewed by AWS (see annex 7). Some of this evidence has been discussed in Step 3 and has been used to amend the anchor value from a category 3 to a category 2 following further testing of the definitions with customers and hence the recommended values. In addition, customers are increasingly concerned about the environment including pollution incidents which has been especially evident in the high level of engagement through social media channels and the step change in the values from PR14. Pollution mitigation or avoidance is still seen to be a high customer priority (alongside flooding mitigation). This evidence aligns with the recommendations presented in this report.

14 River water quality

This section covers river quality, wastewater compliance, WTW compliance, water abstraction, priority substances, litter and STW growth.

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. All other measures shown are linked to this.

Figure 14.1:River quality valuation evidence

Importance & Valuation Sensitivity	Service	Measure	Types of valuation approach for PR19		
	WTW Discharge Compliance	Suspended solids	Linked to wastewater compliance values		
		Metals (iron)			
		Brine			
		Volumetric			
	Water Abstraction	Low flow - length of river affected, km	AW PR14 Benefits Transfer		
		TBC - could be ML or days abstraction lost	Loss of abstraction		
	Wastewater Compliance (number of incidents)	Nutrients (P) Compliance	AW PR14 Benefits Transfer		
		Sanitary (BOD, NH3-N, SS, Ammonia) - compliance			
		Sanitary (BOD, NH3-N, SS, Ammonia) - consent			
		Non Sanitary (metals)			
		Volumetric (DWF and FFT)			
	Priority substances compliance (number)	Bad	AW PR14 Benefit Transfer		
		Good			
High Priority	River water quality from quality programme anchor	Average non-good to good	AW PR14 Benefit Transfer	PR19 Main Stage Study	PR19 Second Stage Environment Study
	River water quality from quality programme	Fish and other animals: Bad to Poor	AW PR14 Benefit Transfer		
		Fish and other animals: Poor to Moderate			
		Fish and other animals: Moderate to Good			
		Plant life: Bad to Poor			
		Plant life: Poor to Moderate			
		Plant life: Moderate to Good			
		Water level and Flow: Bad to Poor			
		Water level and Flow: Poor to Moderate			
		Water level and Flow: Moderate to Good			
		Overal WFD: Bad to Poor			
		Overal WFD: Poor to Moderate			
		Overal WFD: Moderate to Good			
	Litter (£ per incident)	Litter	AW PR14 Benefit Transfer		
High Priority	STW Growth	PE (population equivalent value)	AW PR14 Benefit Transfer		

Step 2.0 Synthesis of research

Table 14.1 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 14.1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR19 main stage study	Stated preference - valuation	River water quality improvement, km to good status	Hhold, Non-hhold	H Large sample DCE & DCCV methodology	H Definition relevant, new study
PR19 Best-worst scaling	Stated preference - valuation	River water quality improvement, km to good status	Hhold	H Good sample size, BWS methodology	H Definition relevant, new study
PR14 main stage study	Stated preference - valuation	River water quality improvement, km to good status	Hhold, Non-hhold	H Very large sample DCE & DCCV methodology	H Definition relevant, PR14 study
PR14 2nd Stage Environment study	Stated Preference - customer preference weights	Weights for river water quality status & low flow.	Hhold, Non-hhold	H DCE methodology, good sample size	H Definition relevant, PR14 study

Table 14.2 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 PR14 and some additional stated preference sources.

In addition to the sources listed below the PR14 valuation completion report has been used to map the triangulated river water quality value to the wider service measures. This is not listed below as it does not provide a value or relative preference data.

Table 14.2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
NWEBS (2012)	Stated Preference valuation	River water quality improvement, set of values km to good status from bad, poor, and moderate status	Hhold	H/M CV package methodology, good sample size. Sample size is low at a catchment level.	H - National study with values at catchment level. Applied values for AW catchments
Thames PR09 WTP main stage (2008)	Stated Preference valuation	River water quality - ecological and recreational benefits, km to good status	Hhold	H/M DCE methodology, small sample size	L Old study, different company and area. Value converted to

					per km from % introducing uncertainty (as accurate km unknown)
Southern PR14 WTP Main Stage (2013)	Stated Preference valuation	River water quality improvement, km to good status	Hhold, Non-hhold	H CV package methodology, good sample size	M/L PR14 study, study from Different company and area
Accent joint study - Unknown companies (2013)	Stated Preference valuation	River water quality improvement, km to good status	Hhold, Non-hhold	M Mixed surveys, limited published information	M/L 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	Hhold	M Small sample size	M/L New study in AW region, Value for high quality not good and for a specific 20km stretch of the River Yare.

14.1 River quality

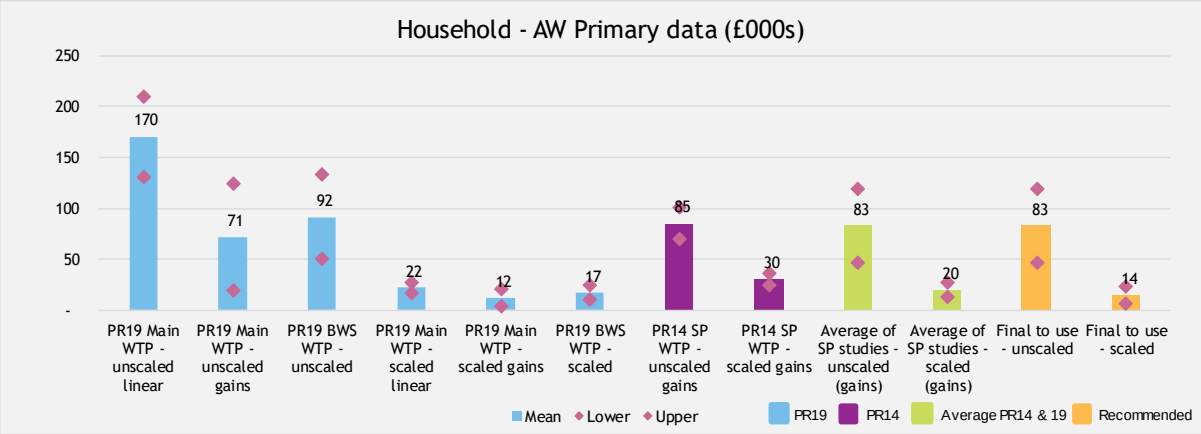
Step 3.0 Comparing valuations to produce recommendation

Step 3a: Primary data & initial recommended range

Households

The primary data for AWS household customers is shown in Figure 14.2. The recommended range is shown both in the graph below and in Table 14.3.

Figure 14.2: Household primary data - £ per km improved to good status (£000s)



Unscaled:
The unscaled central value and range is based on an average of the PR19 main stage unscaled gains value, PR19 BWS and the PR14 gain value. The PR14 value has been included as the mean is between the mean values for the two PR19 sources.

Scaled:
The scaled central value and ranges are based on the average of the PR19 scaled gains values and the PR19 BWS values. The PR14 value has not been used to inform the recommended range as it is higher than PR19 due to differences in the scaling factor.

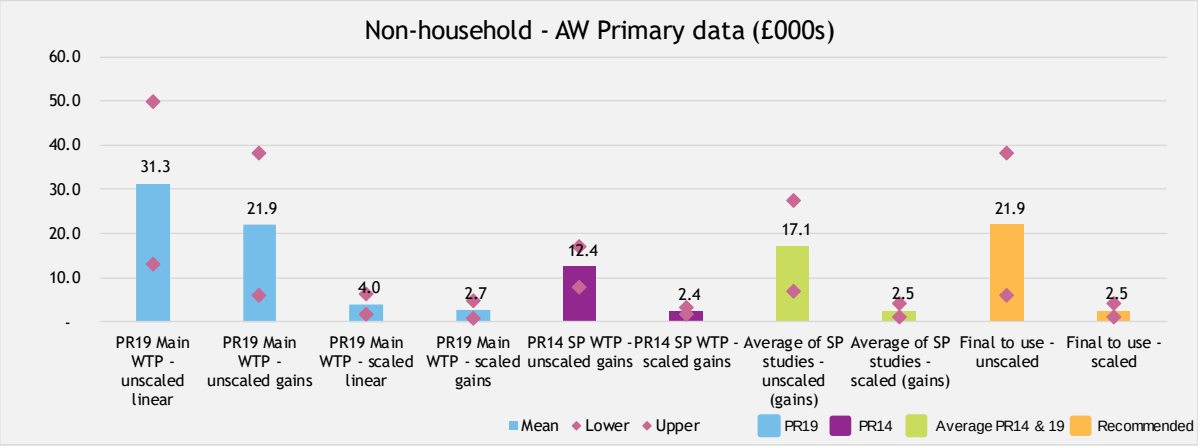
Overall, the PR19 gains value has been used in preference to the linear value as this is more conservative. The mean gains value is also below the confidence range of the linear value.

Table 14.3: Scaled and unscaled household values - £ per km improved to good status (£000s)

Value type	Lower	Central	Upper
Unscaled	46	83	119
Scaled	6	14	23

Non-households
The primary data for AWS non-household customers is shown in Figure 14.3. The recommended range is shown both in the graph below and in Table 14.4.

Figure 14.3: Non Household primary data - £ per km improved to good status (£000s)



Unscaled:
The unscaled central value and range are based on the PR19 unscaled gains values. Similar to the household approach the PR19 main stage unscaled gains value has been used in preference to the linear value as this is more conservative.

The PR14 value has not been used as the mean value is lower than PR19 suggesting a step change in the values. The PR19 range encompasses the PR14 range.

Scaled:
The scaled central value and ranges are based on the average of the PR19 scaled gains value and the PR14 gains values. The PR14 value has been used as the mean is similar and the confidence interval tighter.

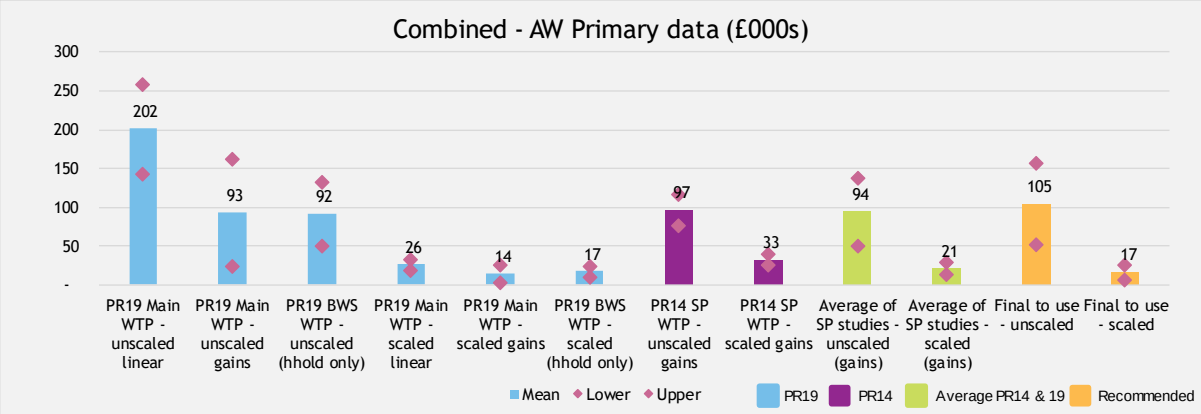
Table 14.4: Scaled and unscaled non-household values - £ per km improved to good status (£000s)

Value type	Lower	Central	Upper
Unscaled	5.8	21.9	38.0
Scaled	1.1	2.5	3.9

Combined (households and non-households)

The primary data for AWS combined customers is shown in Figure 14.4. The recommended range is shown both in the graph below and in Table 14.5.

Figure 14.4: Combined primary data - £ per km improved to good status (£000s)



The values presented are the household range plus non-household range. The recommended unscaled values are similar (mean is slightly higher) than the PR14 unscaled values. The recommended PR19 scaled values are lower than PR14 values due to the household value and the change in scaling factor.

Table 14.5: Initial recommended range - combined - £ per km improved to good status (£000s)

Value type	Lower	Central	Upper
Unscaled	52	105	157
Scaled	7	17	27

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

Figure 14.5 to Figure 14.7 show how the ranges compare to the secondary data sources available. The values presented are for a move to 'Good' status. For the household and combined graphs the scaled value look slightly low. However, once these are mapped to the WFD status categories (see Step 3c) the results look aligned with the NWEBS24 values (which are scaled gains values). The unscaled values look reasonable, if a little on the high side.

The non-household values look high when compared to other studies although the details behind the Accent study show that higher values have been observed at PR14.

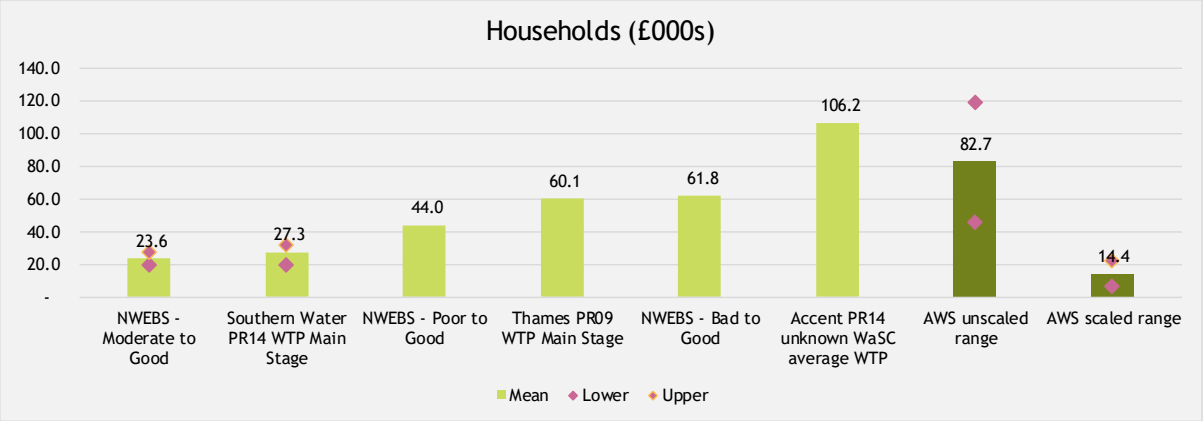
[24] EA/Defra: National Water Environment Benefit Survey values

The NWEBS values shown are specific to catchments in the Anglian Water region (provided as part of the PR19 2nd stage environment study) and therefore could be considered a primary value. Step 3c applies PR14 weights to the recommended range allowing comparison.

The NWEBS and Southern Water values are scaled values. The Thames Water value is an unscaled value and has been converted from a 'Per %' value into a 'Per km' value using Anglian Water km length (as Thames Water river length is not known). This value is therefore uncertain. The Accent study values are thought to be a mix of scaled and unscaled values.

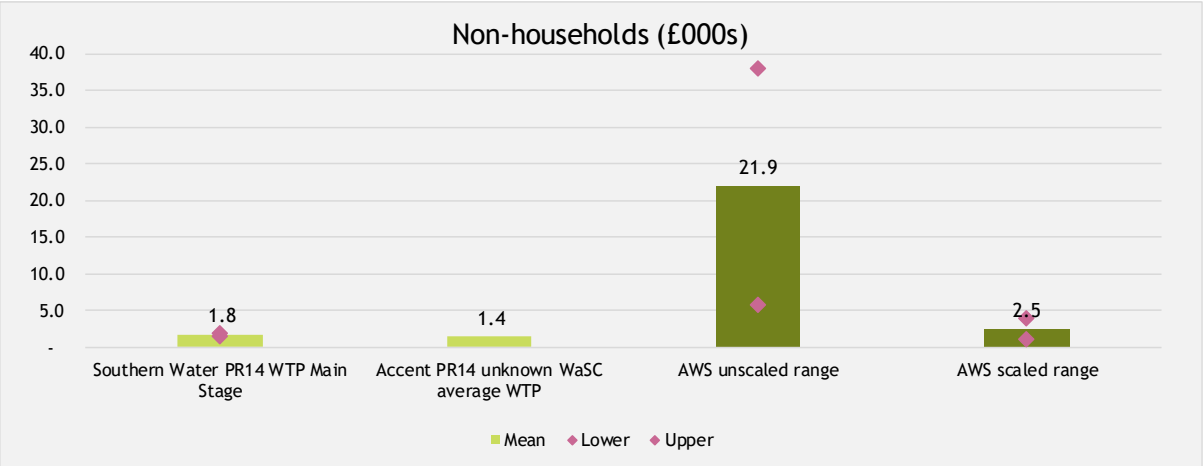
A further study was provided through the PR19 2nd stage Environment Study by UEA (2017)[25]. This study provided WTP values for a local river in the Anglian region. There are multiple values from this study. The lower value is a household / general public value living greater than 8km distance from the river for a change to high ecological and recreational quality (which is higher than good quality). This gives a large value of £4.3m per km; this value is not included in the household graph.

Figure 14.5: Comparing to household secondary data - £ per km (£000s)



NB: Accent average unknown WaSC is based on 4 companies. The unadjusted (for customer numbers) values range from £4k to £257k per km (median is £43.6k).

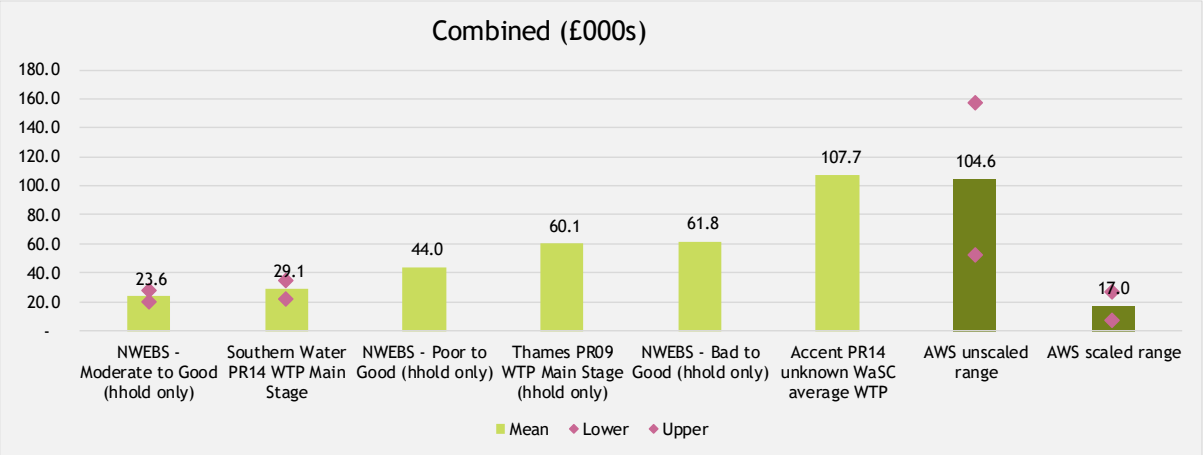
Figure 14.6: Comparing to non-household secondary data - £ per km (£000s)



NB: Accent average unknown WaSC is based on 4 companies. The unadjusted (for customer numbers) values from £0.8k to £93.7k per incident (median is £8k).

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

Figure 14.7: Comparing to combined secondary data - £ per km (£000s)



NB: Accent average unknown WaSC is based on 4 companies. The average value masks a wide range of value with the unadjusted (for customer numbers) values ranging from £4.8k to £351k per km (median is £50.6k).

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

The unscaled and 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 two tables 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 PR19 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[26]. Analysis shows that the PR14 environment customer survey weights places slightly more weight on the move from moderate to good than the NWEBs values and less weight on the lower quality changes.

[26] NWEBS values for the AW region are moderate to good £23.6k; poor to moderate £20.4k, bad to poor £17.8k in 2017 prices. Values for the AW catchment were provided as part of the PR19 Environment Study.

Table 14.6: River water quality: £ per km, by WFD category, unscaled

		Unit	Lower	Central	Upper
Fish and other animals	Bad to Good	£/km	93,974	189,330	284,685
	Bad to Poor	£/km	21,093	42,430	63,766
	Poor to Moderate	£/km	24,245	48,770	73,294
	Moderate to Good	£/km	48,636	98,131	47,625
Plant life	Bad to Good	£/km	34,060	67,924	101,788
	Bad to Poor	£/km	12,295	24,609	36,923
	Poor to Moderate	£/km	14,132	28,286	42,440
	Moderate to Good	£/km	7,633	15,029	22,426
Water level and flow	Bad to Good	£/km	43,371	86,529	129,687
	Bad to Poor	£/km	10,573	21,101	31,630
	Poor to Moderate	£/km	12,153	24,255	36,356
	Moderate to Good	£/km	20,644	41,173	61,701
Total WFD	Bad to Good	£/km	171,405	343,783	516,160
	Bad to Poor	£/km	43,962	88,140	132,318
	Poor to Moderate	£/km	50,531	101,310	152,090
	Moderate to Good	£/km	76,913	154,333	231,753

Table 14.7: River water quality: £ per km, by WFD category, scaled

		Unit	Lower	Central	Upper
Fish and other animals	Bad to Good	£/km	13,345	30,677	48,008
	Bad to Poor	£/km	2,993	6,881	10,769
	Poor to Moderate	£/km	3,441	7,910	12,379
	Moderate to Good	£/km	6,911	15,885	24,860
Plant life	Bad to Good	£/km	4,817	11,075	17,333
	Bad to Poor	£/km	1,741	4,003	6,266
	Poor to Moderate	£/km	2,002	4,602	7,202
	Moderate to Good	£/km	1,074	2,470	3,866
Water level and flow	Bad to Good	£/km	6,135	14,105	22,075
	Bad to Poor	£/km	1,496	3,439	5,382
	Poor to Moderate	£/km	1,719	3,953	6,186
	Moderate to Good	£/km	2,920	6,713	10,506
Total WFD	Bad to Good	£/km	24,297	55,856	87,416
	Bad to Poor	£/km	6,231	14,324	22,417
	Poor to Moderate	£/km	7,162	16,464	25,767
	Moderate to Good	£/km	10,904	25,068	39,232

CSO incidents: The value for CSO incidents will follow the approach set out in the Water UK guidance: Valuing the benefits of storm discharge improvements for use in cost-benefit analysis. This approach uses the river quality values as the starting point for the assessment, consistent with the guidance which starts with the NWEB values but highlights that WTP values from customer surveys can be used instead as the more relevant values.

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 (scaled) so they were expressed relative to an average assessment moving from non-good to good using the frequencies in each quality status category. To check the validity of the PR14 adjustment (for

application at PR19) the PR19 overall river assessment profile for the Anglian Catchment[27] is compared to the equivalent data from PR14[28]. The results are shown in
Table **14.8** below. It shows that the profile is broadly stable over time implying that the PR14 weights are likely to be valid for application at PR19.

Table 14.8: Changes to river water quality over time - good ecological status or potential

River basin management plan	Bad	Poor	Moderate	Good or high
2009 (PR14)	1%	9%	72%	18%
2015 (PR19)	1%	8%	73%	18%

To calculate more accurate updated weights a greater level of detail is required than that available from the river basin management plan documents. The PR14 adjustment used the separate status profiles for sanitary assessments, phosphorous and flow mitigation taken from the Reasons For Failure (RFF) database provided by the Environment Agency.

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values for river water quality improvements to take forward are the values in Table 14.6 and Table 14.7.

Step 4.0 – Assess and test valuations

The wider customer evidence for river water quality has been collated and reviewed by AWS (see annex 7). The review found that generally, while customers have little experience with river water quality issues, they do provide support for improving the quality of rivers across Anglian Water's region. This is in line with environmental issues being seen as a growing customer priority. This evidence aligns with the recommendations presented in this report. In addition, there is also further information in Section 25, looking at the values and how they change across different customer segments.

14.2 Compliance, priority substances, growth and litter

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

The unscaled and scaled values for river water quality have been mapped to the wider service measures for wastewater compliance, priority substances, growth and litter and the results are presented in the two tables below.

The SMF measures in the two tables have been linked to the river water quality values in the previous section based on the impacts each type of compliance failure causes. The high level assumptions on the type of failure are set out in the final column of the tables below. The links between the type of compliance failure and the river quality values are based on analysis completed for PR14[29]. As part of this project the PR14 assumptions have been reviewed and updated where better information is available.

[27] Defra/Environment Agency (2015) Water for life and livelihoods. Part 1 Anglian River Basin District. River Basin Management Plan. Table 14.
[28] Defra/Environment Agency (2009) Water for life and livelihoods. River Basin Management Plan Anglian River Basin District. Figure 3.
[29] ICS & eftec (2013) PR14 Customer Research: Completion Report

Further details are included in the supporting spreadsheet of values and the full details of the links and underlying assumptions can be found in the PR14 Valuation Completion Report. Annex 5 sets out where the assumptions have been updated.

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.

Note, the general litter value at PR14 was £60.6k scaled and £180k unscaled, the equivalent for PR19 is 32.7k scaled and £197.3k unscaled.

Table 14.9: Unscaled – Compliance, priority substances and growth, £

SMF band	Unit	Lower	Central	Upper	Notes on mapping
Nutrients (P) Compliance	£/incident	6,200	12,401	18,602	Mapped to P failure (assumes annual average P consent not spot P consents)
Sanitary (BOD, NH3-N, SS, Ammonia) – compliance	£/incident	27,708	55,760	83,811	This value assumes works failure
Sanitary (BOD, NH3-N, SS, Ammonia) – consent	£/incident	7,292	14,674	22,056	This value assumes sample failure.
Non Sanitary (metals)	£/incident	-	-	-	Mapped to PR14 Non sanitary consent.
Descriptive consent - inspection failure	£/incident	-	-	-	Mapped to Descriptive Flow to Full Treatment Failure.
Volumetric (DWF and FFT)	£/incident	27,708	55,760	83,811	Mapped to Consent failure (volume) one-off (inc. storm tanks).
Priority substance compliance (bad)	£/incident	-	-	-	Mapped to priority substances bad
Priority substance compliance (good)	£/incident	80,092	160,924	241,757	Mapped to priority substances good
PE (population equivalent value)	£/pe	45	90	135	Mapped to PE
Litter	£/incident	79,384	161,076	242,768	Mapped to sewage related debris

Table 14.10: Scaled – Compliance, priority substances and growth, £

SMF band	Unit	Lower	Central	Upper	Notes on mapping
Nutrients (P) Compliance	£/incident	878	2,018	3,159	Mapped to P failure (assumes annual average P consent not spot P consents)
Sanitary (BOD, NH3-N, SS, Ammonia) – compliance	£/incident	3,933	9,041	14,149	This value assumes works failure
Sanitary (BOD, NH3-N, SS, Ammonia) – consent	£/incident	1,035	2,379	3,723	This value assumes sample failure.
Non Sanitary (metals)	£/incident	0	0	0	Mapped to PR14 Non sanitary consent.
Descriptive consent - inspection failure	£/incident	0	0	0	Mapped to Descriptive Flow to Full Treatment Failure.
Volumetric (DWF and FFT)	£/incident	3,933	9,041	14,149	Mapped to Consent failure (volume) one-off (inc. storm tanks).
Priority substance compliance (bad)	£/incident	0	0	0	Mapped to priority substances bad
Priority substance compliance (good)	£/incident	11,361	26,118	40,874	Mapped to priority substances good
PE (population equivalent value)	£/pe	6	15	23	Mapped to PE
Litter	£/incident	11,305	25,985	40,664	Mapped to sewage related debris

Note that two compliance categories from the SMF are missing from the table. Breach of FFT (including storm) is covered under pollution and Bathing water (STW UV and CSO) is covered under bathing waters.

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final restriction values for wastewater compliance, priority substances, growth and litter improvements to take forward are the values in Table 14.9 and Table 14.10.

Step 4.0 – Assess and test valuations

The wider customer evidence for river water quality has been collated and reviewed by AWS (see annex 7). This found that customers generally support protecting the environment and environmental services and issues are increasingly becoming a priority for customers. No specific evidence is available for wastewater discharge compliance in addition to the high priority for preventing pollution.

14.3 Water abstraction

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

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

The value per incident, relates to over abstraction and the value uses the water flow value from the value for the WFD flow category from section 14.1. The number of incidents assumes a 1 level change in abstraction. The value is based on the proportion of good or moderate quality rivers for WFD flow assessment at PR14 moving to either moderate or bad.

Table 14.11: Unscaled - River water quality: Water abstraction (£s)

SMF band	Unit	Lower	Central	Upper
Over abstraction - number of Incidents	£/km	21,833	43,868	65,903

Table 14.12: Scaled - River water quality: Water abstraction (£s)

SMF band	Unit	Lower	Central	Upper
Over abstraction - number of Incidents	£/km	4,766	10,956	17,146

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values for abstraction to take forward are the values in Table 14.11 and Table 14.12.

Step 4.0 – Assess and test valuations

The wider customer evidence for river water quality has been collated and reviewed by AWS (see annex 7). No specific evidence is available for water abstraction compliance; however, the review has found that customers are increasingly supportive of protecting the environment.

14.4 WTW Discharge compliance

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

The unscaled and scaled values for river water quality have been mapped to the wider service measures for WTW discharge compliance and the results are presented in the two tables below.

These measures are new for PR19 and no research exists to link the impact of failures to the impact on river water quality. The wastewater compliance sanitary value has been used for Suspended solids, Metals and Brine. This assumes that these issues are chronic problems as opposed to acute problems that would be more akin to a pollution incident. For example, iron and salinity changes to the rivers impacts on wildlife. The wastewater volumetric value (DWF and FFT) has been applied for a volumetric failure.

Table 14.13: Unscaled - River water quality: WTW Discharge compliance (£s)

SMF band	Unit	Lower	Central	Upper
Suspended solids	£/incident	27,708	55,760	83,811
Metals (iron)	£/incident	27,708	55,760	83,811
Brine	£/incident	27,708	55,760	83,811
Volumetric	£/incident	27,708	55,760	83,811

* Values are set equal to wastewater sanitary value.

Table 14.14: Scaled - River water quality: WTW Discharge compliance (£s)

SMF band	Unit	Lower	Central	Upper
Suspended solids	£/incident	3,933	9,041	14,149
Metals (iron)	£/incident	3,933	9,041	14,149
Brine	£/incident	3,933	9,041	14,149
Volumetric	£/incident	3,933	9,041	14,149

* Values are set equal to wastewater sanitary value.

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final restriction values for WTW compliance to take forward are the values in Table 14.13 and Table 14.14.

Step 4.0 – Assess and test valuations

The wider customer evidence for river water quality has been collated and reviewed by AWS (see annex 7). No specific evidence is available for WTW discharge compliance in addition to the high priority for preventing pollution, however the review has found that customers are increasingly supportive of protecting the environment.

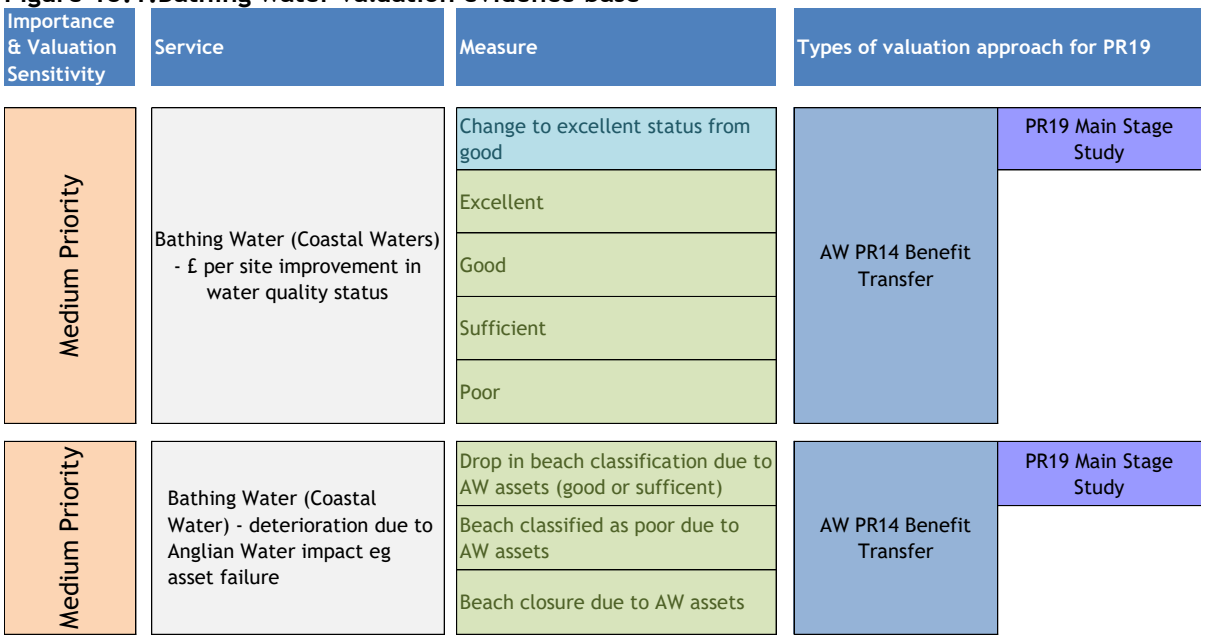
15 Bathing water quality (at beaches)

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 bathing water quality changes from good to excellent quality status. All other measures shown are linked to this.

Figure 15.1:Bathing water valuation evidence base



Step 2.0 Synthesis of research

Table 15.1 presents a summary of primary data. The table includes two Stated Preference studies.

Table 15.1: Primary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR19 main stage study	Stated preference – valuation	Bathing water, site good to excellent status	Hhold, Non-hhold	H Large sample DCE & DCCV methodology	H Definition different - converted from site movement to excellent status from average non-excellent status – (most non-excellent sites are good), new study
PR19 Best-worst scaling	Stated preference – valuation	Bathing water, site good to excellent status	Hhold	H Good sample size, BWS methodology	H Definition different - converted from site movement to excellent status from average non-excellent status – (most non-

					excellent sites are good), new study
PR14 main stage study	Stated preference – valuation	Bathing water, site good to excellent status	Hhold, Non-hhold	H Very large sample DCE & DCCV methodology	H Definition different - converted from site movement to excellent status from good or sufficient status, PR14 study

Table 15.2 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 PR14.

Table 15.2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
Southern PR14 WTP Main Stage (2013)	Stated Preference valuation, CV package method plus allocation from DCE	Bathing water, site good to excellent status	Hhold, Non-hhold	H CV package methodology, good sample size	M/L PR14 study, study from Different company and area
Accent joint study - Unknown companies (2013)	Stated Preference valuation	Bathing water, site good to excellent status	Hhold, Non-hhold	M Mixed surveys, limited published information	M/L Relevant definitions, PR14 study, unknown areas

15.1 Bathing water – good to excellent quality

Step 3.0 Comparing valuations to produce recommendation

Step 3a: Primary data & initial recommended range

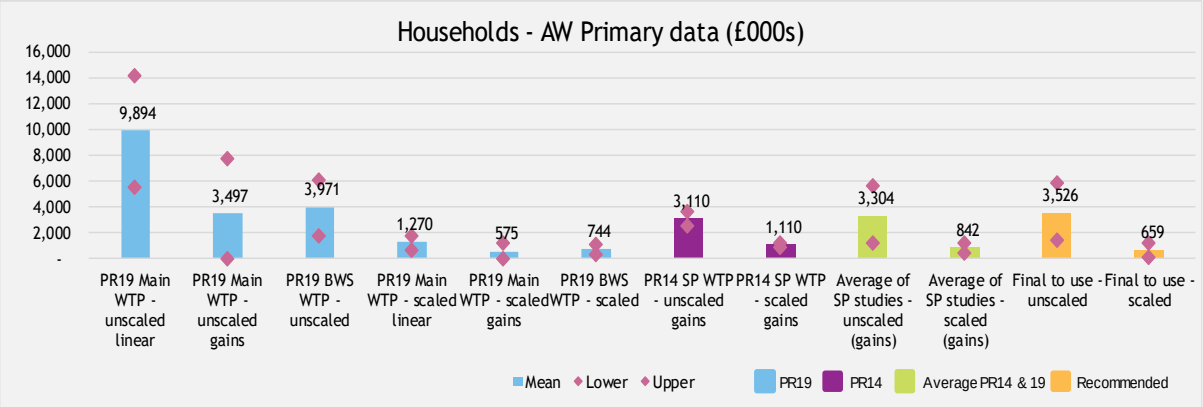
Households

The primary data for AWS household customers is shown in Figure 15.2. The recommended range is shown both in the graph below and in Table 15.3. To enable comparison with the secondary data the values have been adjusted to present a value for the change from good status to excellent status. The PR19 main WTP study value is the value for a change from non-excellent to excellent. A majority of the beaches that are not excellent status are good status. However, as not all non-excellent bathing waters are at good status an adjustment has been made to reduce the value. The calculation is set out in Annex 5. It uses the current frequency of the bathing waters at each status in the AWS region and the EA 2014 study[30] that estimated the proportion of value to allocate to changes in status. This data source was also used by AWS at PR14 so is consistent with previous assumptions.

A similar calculation has been completed for the PR14 value. The main difference is that the PR14 main WTP study captured the value for a change from sufficient or good status to excellent status.

[30] For full reference see Annex 1 on robustness and relevance

Figure 15.2: Household primary data - £ per site, good to excellent (£000s)



Unscaled:
The unscaled central value and range is based on the average of the PR19 unscaled gains values, the PR19 BWS values and the PR14 unscaled gains values. This is because the PR19 value is slightly higher but the confidence intervals are tighter for the PR14 value.

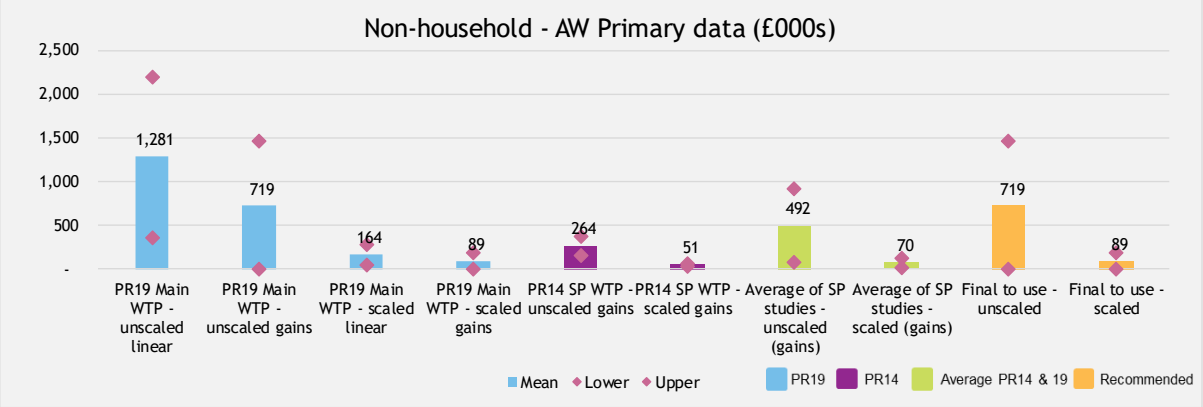
Scaled:
The scaled central value and ranges are based on the average of the PR19 scaled gains values and the PR19 BWS scaled value. The PR14 value has not been used to inform the PR19 recommended range as the mean is similar to the upper values of the PR19 studies. Overall, the gains value has been used 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 15.3: Scaled and unscaled household values - £ per site, good to excellent (£000s)

Value type	Lower	Central	Upper
Unscaled	1,142	3,526	5,869
Scaled	166	659	1,216

Non-households
The primary data for AWS non-household customers is shown in Figure 15.3. The recommended range is shown both in the graph below and in Table 15.4.

Figure 15.3: Non Household primary data - £ per site, good to excellent (£000s)



Unscaled:
The unscaled central and range values are based on the PR19 unscaled gains values. Similar to the household approach the PR19 main stage unscaled gains value has been used in preference to the linear value as this is more conservative. The PR14 has not been used to influence the recommended values as the PR14 mean value is lower than the PR19 value. However, the recommended range encompasses the PR14 range.

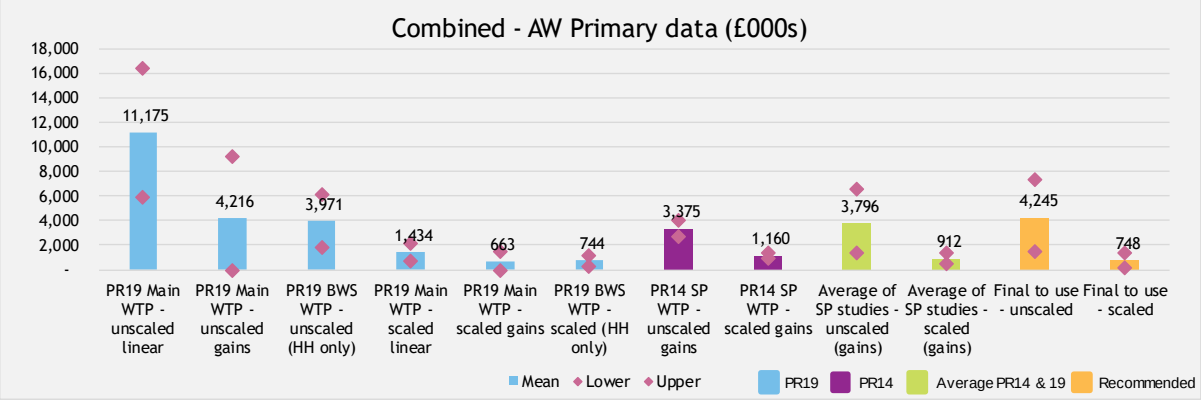
Scaled:
The scaled central value and ranges are based on the PR19 scaled gains values. Similar to the household approach the unscaled gains value has been used in preference to the linear value as this is more conservative. The PR14 has not been used to influence the recommended values. The same reasoning discussed for the unscaled values applies.

Table 15.4: Scaled and unscaled non-household values - £ per site, good to excellent (£000s)

Value type	Lower	Central	Upper
Unscaled	0	719	1,471
Scaled	0	89	181

Combined (households and non-households)
The primary data for AWS combined customers is shown in Figure 15.4. The recommended range is shown both in the graph below and in Table 15.5.

Figure 15.4: Combined primary data - £ per site, good to excellent (£000s)



The values presented are the household range plus non-household range. The recommended unscaled values are higher than the PR14 equivalent. The recommended scaled values are lower than the PR14 values due to the changes in the household scaling factor.

Table 15.5: Initial recommended range - combined - £ per site, good to excellent (£000s)

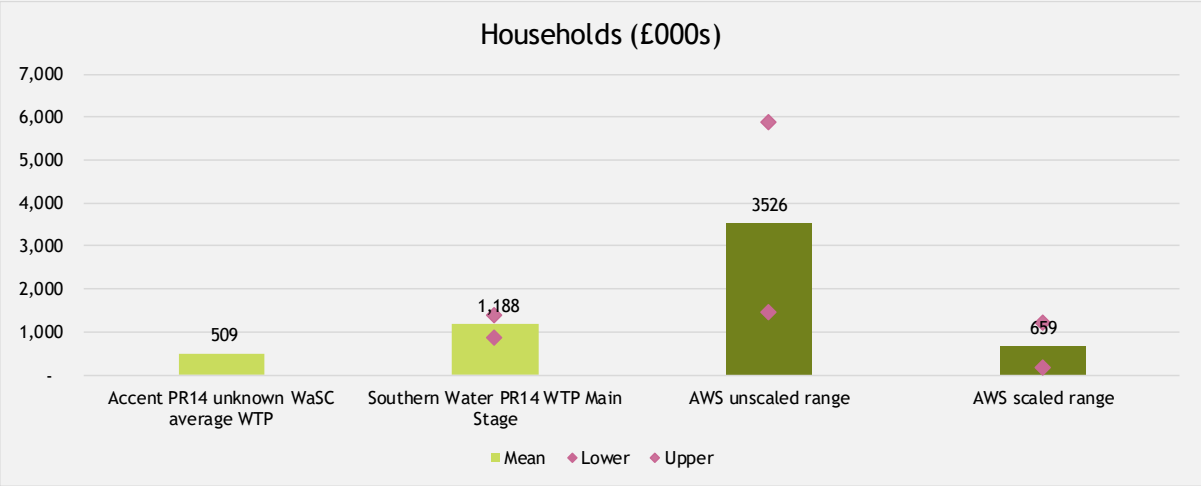
Value type	Lower	Central	Upper
Unscaled	1,442	4,245	7,340
Scaled	166	748	1,397

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

Figure 15.5 to Figure 15.7 show how the ranges compare to the secondary data sources available. Across all of the graphs the scaled value looks aligned. Unscaled range looks high but all of the comparators are thought to be scaled values and therefore not directly comparable.

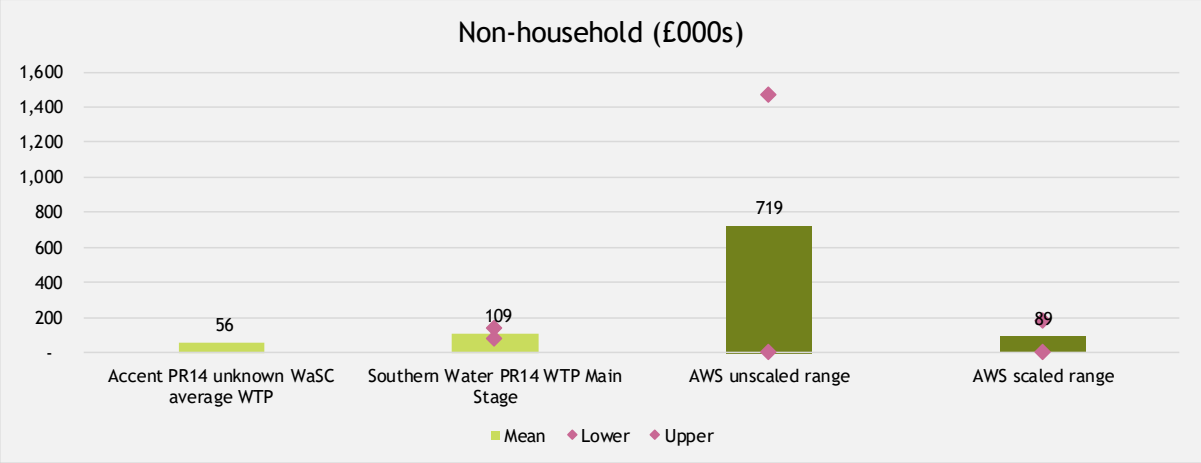
The Southern Water value is a scaled value. The Accent study values are thought to be scaled values.

Figure 15.5: Comparing to household secondary data - £ per site, good to excellent (£000s)



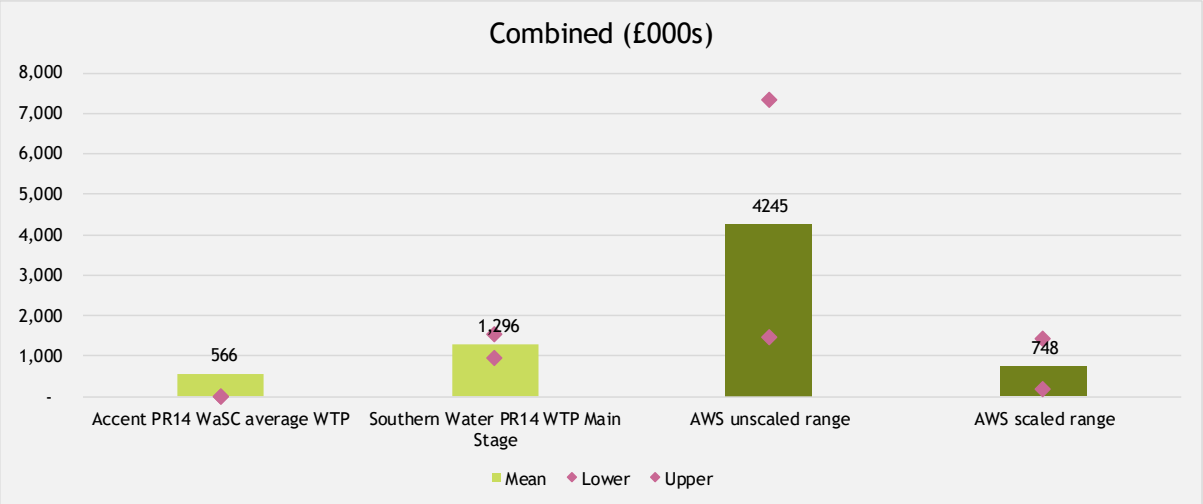
NB: Accent average unknown WaSC is based on 3 companies. Average values masks a wide range. The unadjusted (for customer numbers) values range from £140k to £960k per km (median is £146k).

Figure 15.6: Comparing to non-household secondary data - £ per site, good to excellent (£000s)



NB: Accent average unknown WaSC is based on 3 companies. Average values masks a wide range. The unadjusted (for customer numbers) values range from £27k to £140k per km (median is £30k).

Figure 15.7: Comparing to combined secondary data - £ per site, good to excellent (£000s)



NB: Accent average unknown WaSC is based on 3 companies. Average values masks a wide range. The unadjusted (for customer numbers) values range from £170k to £1,100k per bathing water (Median is £173k).

15.2 Bathing water SMF categories

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

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

The links are based on the 2014 EA Bathing Water study and frequency of current beach status. This is the same approach as applied at PR14. Beach closure is the value for beach classified as poor plus a category 2 pollution incident. The compliance in bathing waters value is based on the assumptions listed in the PR14 valuation completion report updated to use the current frequency of bathing waters in each quality category[31].

Table 15.6: Unscaled - Improvement in Bathing Water, £

SMF band	Unit	Lower	Central	Upper
Excellent	£/bathing water	7,211,647	21,227,286	36,699,726
Good	£/bathing water	5,769,318	16,981,829	29,359,781
Sufficient	£/bathing water	5,120,270	15,071,373	26,056,806
Poor	£/bathing water	-	-	-

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.

[31] The current frequency of bathing waters in each category is 32 excellent, 15 good, 1 sufficient and 1 poor quality water.

Table 15.7: Unscaled - Deterioration in Bathing Water, £

SMF band	Unit	Lower	Central	Upper
Drop in beach classification due to AW assets (good or sufficient)	£/bathing water	1,271,053	3,741,309	6,468,327
Beach classified as poor due to AW assets	£/bathing water	6,717,349	19,772,332	34,184,266
Beach closure due to AW assets	£/bathing water	7,077,080	20,547,060	35,373,990

Table 15.8: Unscaled - Compliance in Bathing Water, £

SMF band	Unit	Lower	Central	Upper
Bathing water (STW UV and CSO)	£/incident	189,667	558,278	965,204

Table 15.9: Scaled - Improvement in Bathing Water, £

SMF band	Unit	Lower	Central	Upper
Excellent	£/bathing water	830,905	3,739,010	6,986,123
Good	£/bathing water	664,724	2,991,208	5,588,899
Sufficient	£/bathing water	589,943	2,654,697	4,960,148
Poor	£/bathing water	-	-	-

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 15.10: Scaled - Deterioration in Bathing Water, £

SMF band	Unit	Lower	Central	Upper
Drop in beach classification due to AW assets (good or sufficient)	£/bathing water	146,447	659,001	1,231,304
Beach classified as poor due to AW assets	£/bathing water	773,954	3,482,732	6,507,283
Beach closure due to AW assets	£/bathing water	863,285	3,633,512	6,719,512

Table 15.11: Scaled – Compliance in Bathing Water, £

SMF band	Unit	Lower	Central	Upper
Bathing water (STW UV and CSO)	£/incident	21,853	98,336	183,735

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values for bathing waters to take forward are the values in Table 15.6 through to Table 15.11.

Step 4.0 – Assess and test valuations

The wider customer evidence for bathing beaches and environmental improvements has been collated and reviewed by AWS (see annex 7). This review found that whilst awareness of the Beachcare initiative is not well known, customers do support improvements to the environment and to bathing waters across the region. This evidence aligns with the recommendations presented in this report, in that bathing waters continues to attract a reasonable WTP and is a reasonably high priority for customers. Further information on improvements to the environment are discussed in the Section 25 on customer segments.

16 Shellfish

Step 1.0 - Specify and undertake research

The evidence base for shellfish waters is given below.

Figure 16.1: Shellfish evidence base

Importance & Valuation Sensitivity	Service	Measure	Types of valuation approach for PR19	
	Shellfish water compliance - improvement (Water Quality Status)	Water Quality Status A	AW PR14 Benefit Transfer	PR19 Second Stage Environment Study
		Water Quality Status B		
		Water Quality Status C		
		Water Quality Status D		
	Shellfish Water - deterioration due to Anglian Water impact eg asset failure	Number of incidents	AW PR14 Benefit Transfer	PR19 Second Stage Environment Study

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 PR14. The values are based on national average values from the Marine Management Organisation (2015) report on Sea Fishery Statistics 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 (£2k) from the Sea Fisheries Statistics report to remove potential duplication between sources and avoid double counting.

The improvement values are based on the average value of oysters produced in a shellfish water that is listed as producing oysters in England.

The Aquaculture statistics report provides the total value of oysters produced in England. This has been divided by the total number of shellfish waters in England that are listed as producing oysters.

The final shellfish values for improvements are shown in the table below. The table shows the value of a water relative to water quality status D, which is set as zero value. It has not been possible to link the values to quality of the beds. We have therefore set the value calculated as water quality status B. Water quality status C is set as 50% of this value and water quality status A as 150%. The values shown are the combined value for native and pacific oysters.

Table 16.1: Shellfish waters, £ per water

SMF band	Lower	Central	Upper
Water Quality Status A	103,836	129,796	155,755
Water Quality Status B	69,224	86,530	103,836
Water Quality Status C	34,612	43,265	51,918
Water Quality Status D	-	-	-
Deterioration due to Anglian Water impact eg asset failure	377,917	472,396	566,875

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values to take forward are the values in Table 16.1.

Step 4.0 – Assess and test valuations

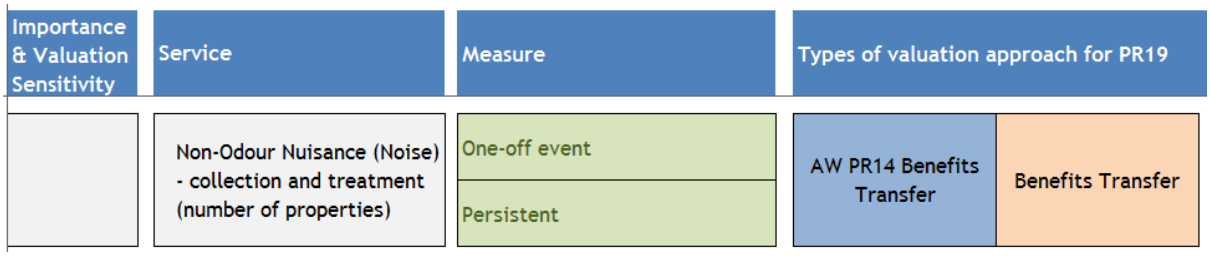
The wider customer evidence for environmental improvements has been collated and reviewed by AWS (see annex 7). There is no specific information on shellfish water's in addition to the general customer support to protect and improve the environment.

17 Noise

Step 1.0 Specify and undertake research

The evidence base covers non-odour nuisance, namely noise.

Figure 17.1: Noise 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 17.1 below.

Table 17.1: Data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
Defra (2014) Noise pollution economic analysis	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
AWS PR14 valuation completion	Value transfer	Noise for a range of locations	General value	H/M Partial value, uses Defra value plus analysis	H Relevant definition, PR14 study

Step 3.0 Comparing valuations to produce recommendation

The PR14 analysis has been updated with the latest values published by Defra. The analysis is based on the location and distance from source of noise and time of day. One-off assumes 1 day of impact.

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

Table 17.2: Noise, £

SMF band	Lower	Central	Upper
Non-Odour Nuisance (Noise) - collection and treatment: Persistent	65,398	81,747	98,097
Non-Odour Nuisance (Noise) - collection and treatment: One-off	179	224	269

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values to take forward are the values in Table 17.2.

Step 4.0 – Assess and test valuations

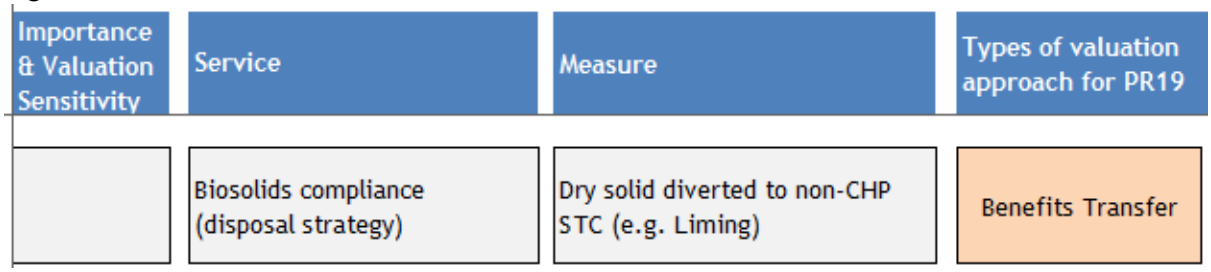
There is no further customer evidence on noise impacts in the wider evidence review.

18 Bioresources

Step 1.0 Specify and undertake research

The evidence base covers bioresources.

Figure 18.1: Bioresources evidence base



Step 2.0 Synthesis of research

The values are sourced from the value transfer literature and market prices. The sources are outlined in Table 18.1 below.

Table 18.1: Data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
EC (2002)	Value transfer - impact assessment of disposal routes	Disposal and recycling routes for a range of sludge types - including digested sludge to land, limed sludge to land.	General value	H Very comprehensive study	M Some relevance but treatment and disposal routes changed over time, old study
Data from AWS	Market value	Price of sludge cake per tonne, Cost saving to the farmer for digested sludge from CHP and raw sludge treated with lime	General value	H Market values	H Relevant to the AWS area
PR19 triangulated odour value	Triangulated value - stated preference	Odour per property	Hhold, Non-hhold	H Triangulated value, main source DCE, large sample	H Relevant definition, new study

Step 3.0 Comparing valuations to produce recommendation

The biosolids value is based on the difference between digested sludge that has been used in CHP and raw sludge that is limed.

The benefits or impact associated with these disposal routes are summarised below.

The analysis is based information from AWS to assess the impacts on farmers and properties being affected by odour and on a 2002 EC study for the impact on pollutants. Whilst this 2002 study is now quite old and the technology has changed to be more efficient the value of the pollutants has <1% impact on the overall value.

Table 18.2: Bioresources benefits

	Digestion and CHP	Non-CHP and Liming	Net effect of using digested and CHP over non-CHP and liming	Notes
Farmer cost savings	Benefit as cake is cheaper than alternative	Benefit as cake is cheaper than alternative	Benefit – digested sludge (no lime) produces greater cost savings for the farmer compared to digested sludge with lime	Data provided by AWS – average cost saving for CHP is 26% and 15-20% for liming
Pollutants	Negative pollutant	Negative pollutant	Cost – digested sludge produces more pollutants	Pollutant estimates and values from 2002 EC study. Doesn't include air emissions from CHP & uses standard digested sludge (may be different for sludge post CHP).
Odour	None	Odour problems to properties near fields	Benefit - limed sludge causes odour issues. This is not the case for digested sludge with no lime.	1 TDS with lime spread will affect 0.1 properties based on AWS information
Renewable	Renewable energy generated	No energy generated	Benefit – digested sludge and CHP produces renewable energy.	Any cost savings and subsidies are covered in the private costs so not included. Probably a customer value/premium over and above the costs for generating renewable energy. This is a gap in the valuation evidence. When applying a value would need to address the overlap with carbon emissions that are captured separately. There is customer support for AW to produce renewable energy.

The values estimated are outlined in Table 18.3 and Table 18.4 below. The values exclude carbon, congestion and some pollutants.

Table 18.3: Unscaled – Biosolids Compliance, £

SMF band	Unit	Lower	Central	Upper
Biosolids compliance (disposal strategy)	£/TDS	£1,065	£3,854	£6,663

Table 18.4: Scaled – Biosolids Compliance, £

SMF band	Unit	Lower	Central	Upper
Biosolids compliance (disposal strategy)	£/TDS	£194	£656	£1,121

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values to take forward are the values in Table 18.3 and Table 18.4 above.

Step 4.0 – Assess and test valuations

There is no further customer evidence on biosolids in the wider evidence review.

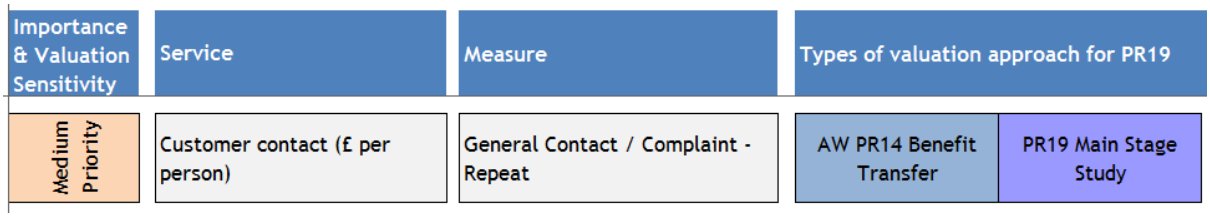
19 Customer contacts

This section covers repeat customer contacts.

Step 1.0 Specify and undertake research

The evidence base for customer contacts is given below. The anchor measure is general contact / complaint – repeat or enhanced.

Figure 19.1: Contacts valuation evidence



Step 2.0 Synthesis of research

Table 19.1 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 19.1: Primary data sources

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

Table 19.2 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 PR14.

Table 19.2: Secondary data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
Cambridge Water PR14 WTP Study	Stated Preference valuation	Customers resolving queries themselves via website or telephone, per customer	Hhold, Non-hhold	H DCE methodology, good sample size	L Different definition - converted to per customer from % but service description still not aligned, PR14 study

Accent joint study - WaSC A (2013)	Stated Preference valuation	Unsatisfactory customer service, improvement to satisfactory, per customer	Hhold, Non-hhold	M Limited published informati on	L Different definition, PR14 study

19.1 Customer contacts and repeat contacts

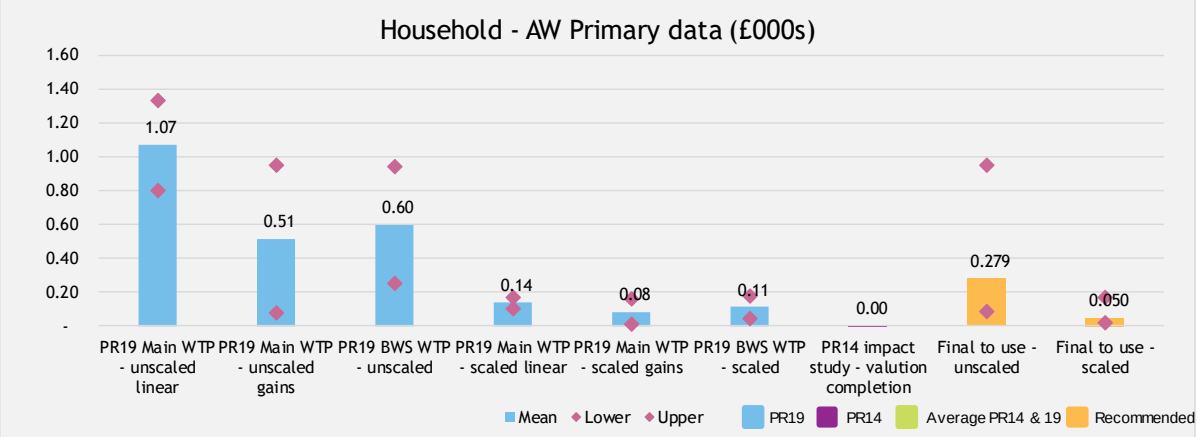
Step 3.0 Comparing valuations to produce recommendation

Step 3a: Primary data & initial recommended range

Households

The primary data for household customers is shown Figure 19.2. The recommended range is shown both in the graph below and in Table 19.3.

Figure 19.2: Household primary data - £ per contact, repeat contact (£000s)



NB: the PR14 impact study value is £2.

Unscaled:

The unscaled central value is based on the average of the PR19 main stage unscaled 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 unscaled lower value is based on the average of the PR19 main stage unscaled gains lower values, the PR19 BWS lower value and the PR14 impact study (mean value as there are no confidence intervals estimated). The unscaled 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.

Scaled:

The scaled central value and ranges use the same approach as unscaled but with scaled gains values in place of unscaled gains values.

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 19.3: Scaled and unscaled household values - £ per contact, repeat contact (£000s)

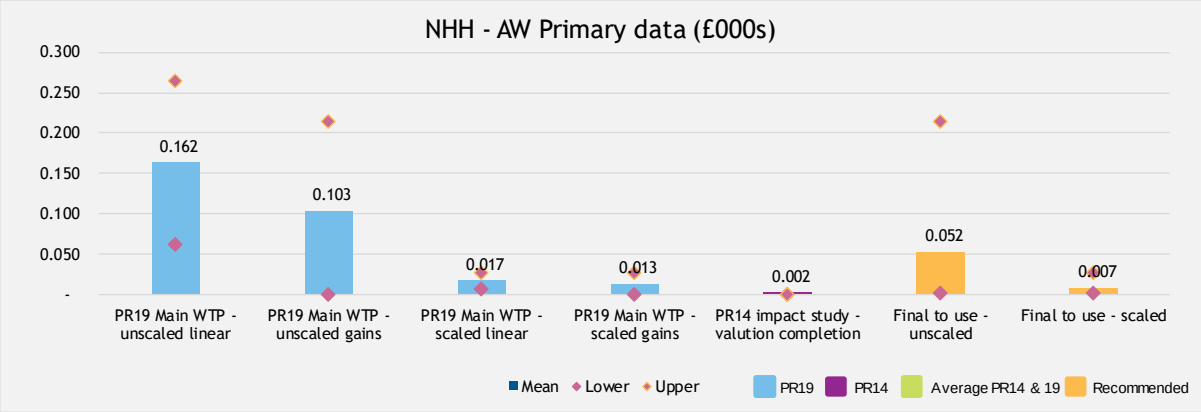
Value type	Lower	Central	Upper
Unscaled	0.083	0.279	0.946
Scaled	0.016	0.050	0.166

Non-households

The primary data for non-household customers is shown in

Figure 19.3. The recommended range is shown both in the graph below and in Table 19.4.

Figure 19.3: Non-household primary data - £ per contact, repeat contact (£000s)



Unscaled:

The unscaled 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 unscaled gains value has been used in preference to the linear value as this is more conservative.

Scaled:

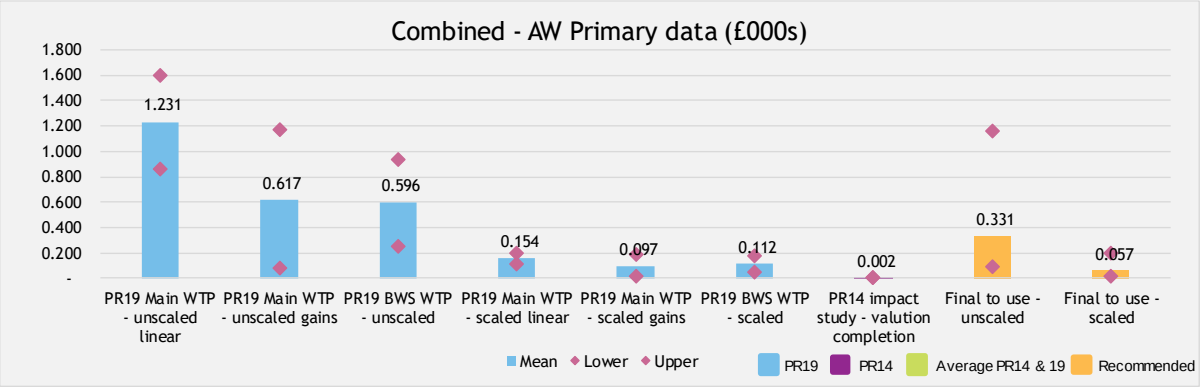
The scaled central and range values are based on the same approach as households (excluding the PR19 BWS value as one does not exist for non-households).

Table 19.4: Scaled and unscaled non-household values - £ per contact, repeat contact (£000s)

Value type	Lower	Central	Upper
Unscaled	0.002	0.052	0.215
Scaled	0.002	0.007	0.026

Combined (households and non-households)
The primary data for combined customers is shown in Figure 19.4 The recommended range is shown both in the graph below and in Table 19.5.

Figure 19.4: Combined primary data - £ per contact, repeat contact (£000s)



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. Values are higher than PR14 due to inclusion of stated preference values.

Table 19.5: Initial recommended range - combined - £ per contact, repeat contact (£000s)

Value type	Lower	Central	Upper
Unscaled	0.085	0.331	1.161
Scaled	0.018	0.057	0.193

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

Figure 19.5 to Figure 19.7 show how the ranges compare to the secondary data sources available.

The values across all of the graphs look high but the comparator studies do not explicitly cover repeat contacts so they are not directly comparable.

The Cambridge Water values are unscaled and relates to customers resolving queries themselves via website or telephone.

WASC 'A' is thought to be scaled and covers one customer affected by unsatisfactory customer service. WASC 'A' value is calculated by divided the unadjusted aggregate value by average WaSC customer numbers and multiplying by AWS numbers. This is less certain than named company numbers.

Figure 19.5: Comparing to household secondary data - £ per contact, repeat contact (£000s)

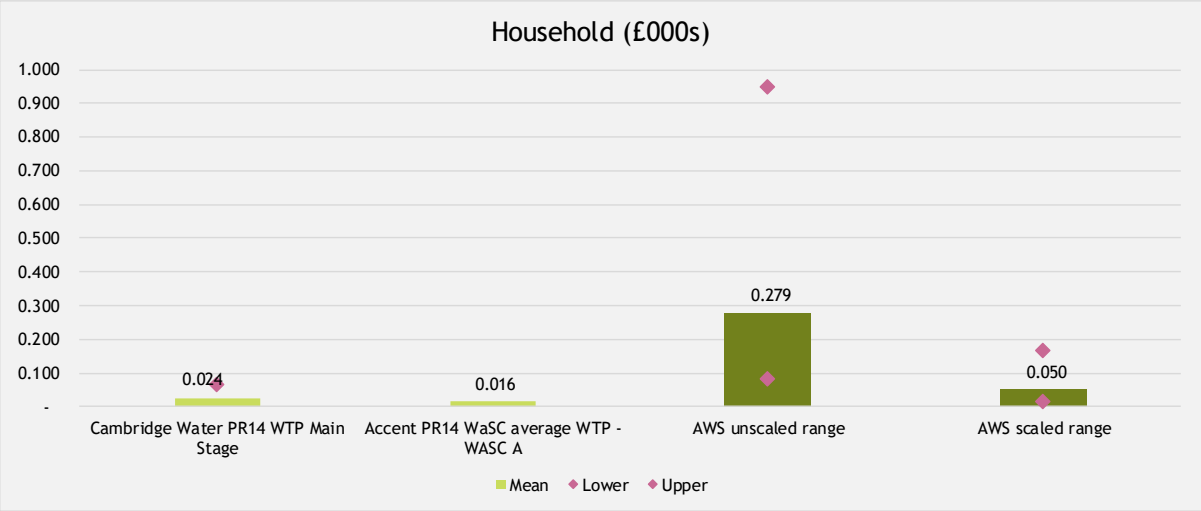


Figure 19.6: Comparing to non-household secondary data - £ per contact, repeat contact (£000s)

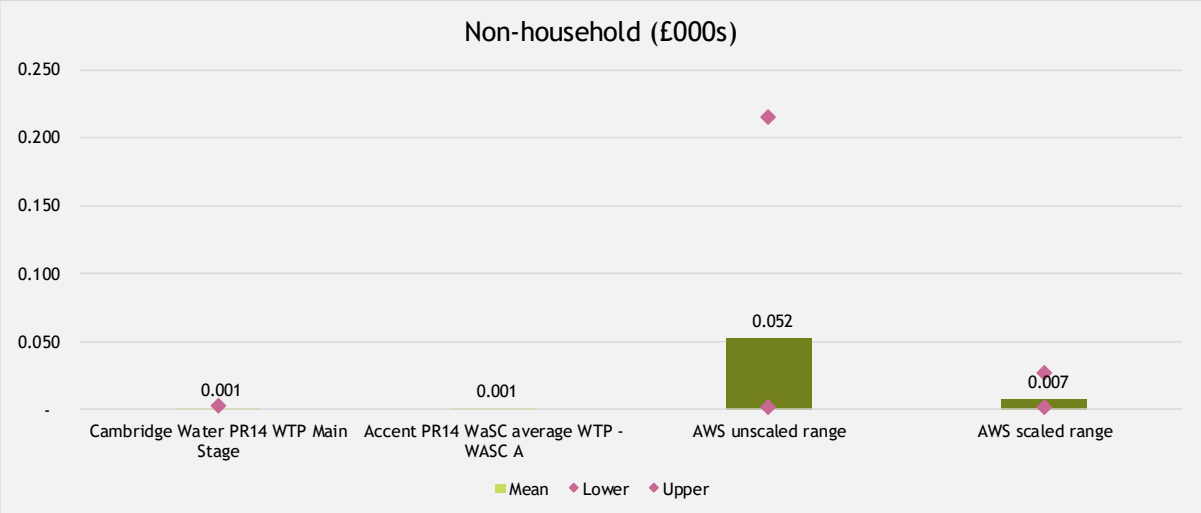
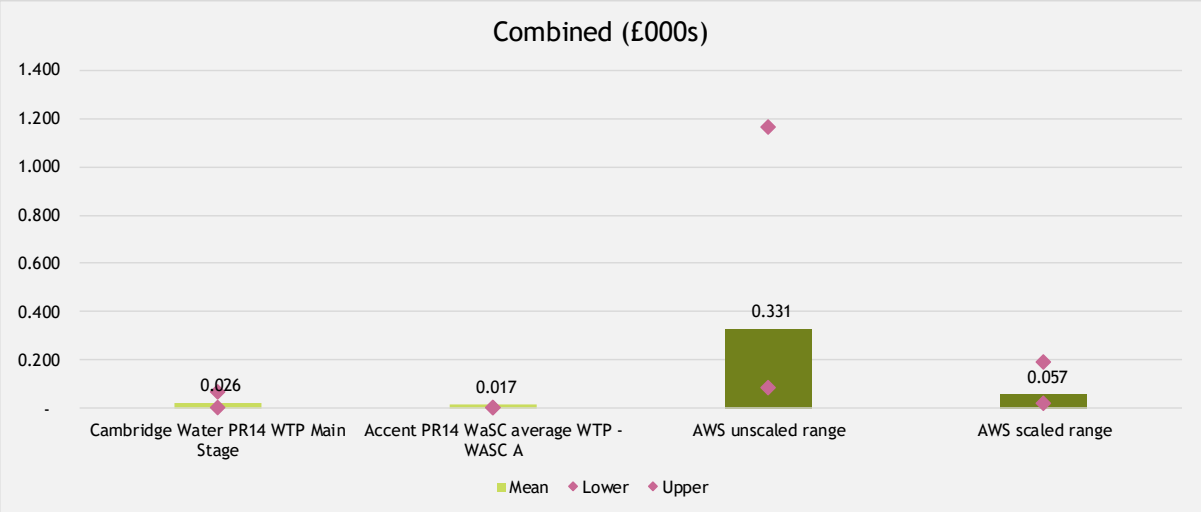


Figure 19.7: Comparing to combined secondary data - £ per contact, repeat contact (£000s)



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 3d Comparing valuations to produce recommendation – Final recommendation

The final values for contacts to take forward are the values in Table 19.5 above.

Step 4.0 – Assess and test valuations

The wider customer evidence for customer service has been collated and reviewed by AWS (see annex 7). This shows that customer service, particularly skilled staff who know how to respond to needs quickly, is important to customers. Customers are generally satisfied with the customer service provided by Anglian Water and have experienced little dissatisfaction. Customers also view customer service as a key part of what Anglian Water provides and want to see the level of service maintained. The review has found the evidence to align with the recommendations presented in this report.

20 Health and Safety

This section covers health and safety.

Step 1.0 Specify and undertake research

The evidence base for health and safety is given below.

Figure 20.1: Health and safety valuation evidence base

Importance & Valuation Sensitivity	Service	Measure	Types of valuation approach for PR19
	H&S (£ per person affected)	Minor injury - Lost Time Accident < 7 days	Benefits Transfer
		Significant injury - Lost Time Accident > 7 days	
		Major injury	
		Death	
		AW Category 1 injury (major/multiple fractures or permanent disability)	

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 values are based on the HSE 2015 published values inflated to 2017 prices with the exception of the major injury (permanent incapacitating injury) value which is not covered in this publication. The major injury value is instead based on 2003 HSE value inflated. This is consistent with the 2015 values as they us are based on the 2003 values but with updated assumptions.

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

Table 20.1: Scaled - H&S, £

SMF band	Unit	Lower	Central	Upper
Minor injury – Lost Time Accident < 7 days	£/person affected	733	916	1,099
Significant injury – Lost Time Accident > 7 days	£/person affected	24,318	30,397	36,476
Major injury	£/person affected	228,551	285,689	342,827
Death	£/person affected	1,329,982	1,662,477	1,994,972
AW Category 1 injury (major/multiple fractures or permanent disability)	£/person affected	228,551	285,689	342,827

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values to take forward are the values in Table 20.1 above.

Step 4.0 – Assess and test valuations

The recommended values are the values recommended by the Government. There was customer support for Anglian Water's goals in relation to workplace safety and wellbeing. This suggests the values are consistent with the key message from the wider customer evidence.

21 Congestion

This section covers congestion.

Step 1.0 Specify and undertake research

The evidence base for congestion is given below.

Figure 21.1: Congestion evidence base

Importance & Valuation Sensitivity	Service	Measure	Types of valuation approach for PR19	
High Priority	Water flooding - external (per area)	Motorway - manual assessment	AW PR14 Benefits Transfer	PR14 Flooding Study: Weightings Update
		Other road - manual assessment		
		(Asset Modelled) Motorway		
		(Asset Modelled) A Road		
		(Asset Modelled) B Road		
		(Asset Modelled) Other Roads		
High Priority	Waste flooding - external (number of areas)	Motorway - manual assessment	AW PR14 Benefits Transfer	PR14 Flooding Study: Weightings Update
		Other road - manual assessment		
		(Asset Modelled) Other Roads		
		(Asset Modelled) Motorway		
		(Asset Modelled) A Road		
		(Asset Modelled) B Road		
Medium Priority	Congestion (number of incidents)	Level 1 (highest)	AW PR14 Benefit Transfer	PR19 Wellbeing Study
		Level 2		
		Level 3		
		Level 4 (lowest)		

Step 2.0 Synthesis of research

The values are sourced from the available value transfer literature and the subjective wellbeing study, with assumptions applied to correspond to Anglian Water.

Table 21.1 presents a summary of the data sources. The table includes the PR19 subjective well-being study and the PR14 congestion study (undertaken as part of PR14 valuation completion study). This second source applies the Government value of time to road and speed data to estimate the impact of delays for a range of incident types.

Table 21.1: Data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
PR19 subjective wellbeing study	Subjective wellbeing	Congestion	Hhold	H/M New method.	H Definition relevant, new study.
PR14 valuation completion	Value transfer	Congestion at a range of locations	Does not distinguish between hhold and non-hhold	H/M Partial value, uses Govt. value of time.	H Relevant definition, PR14 study

Step 3.0 Comparing valuations to produce recommendation

Anglian Water defines 4 different categories of congestion from level 1 (the highest) to level 4)

Level 1 congestion value is based on the average of PR14 inflated values for a level 1 incident (average of motorway/rail, A road and B Road) and the subjective wellbeing value for an incident. This assumes the subjective wellbeing value applies to level 1 average of motorway, A road and B road value. The results may be sensitive to this assumption, however, it has been checked with Simetrica.

Other values are weighted to this 'anchor' using the PR14 relative values, as developed in the PR14 congestion calculator, i.e. the assumptions in the study are carried forward from PR14. The values are available for a more detailed breakdown of level of incident i.e. by road type.

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

Table 21.2: Congestion, £ per incident

SMF band	Unit	Lower	Central	Upper
Motorway - manual assessment	£/incident	55,153	68,941	82,729
Other road - manual assessment	£/incident	2,386	2,982	3,578
(Asset Modelled) Motorway	£/incident	55,153	68,941	82,729
(Asset Modelled) A Road	£/incident	2,386	2,982	3,578
(Asset Modelled) B Road	£/incident	244	305	366
(Asset Modelled) Other Roads	£/incident	2,386	2,982	3,578

Table 21.3: Congestion, £ per incident

SMF band	Unit	Lower	Central	Upper
Level 1 (highest)	£/incident	19,261	24,076	28,891
Level 2	£/incident	14,446	18,057	21,668
Level 3	£/incident	9,630	12,038	14,446
Level 4	£/incident	4,815	6,019	7,223

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values to take forward are the values in the tables above.

Step 4.0 – Assess and test valuations

The wider customer evidence has been collated and reviewed by AWS (see annex 7). This 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.

22 Disruption to other Infrastructure

This section covers disruption to other infrastructure.

Step 1.0 Specify and undertake research

The evidence base for disruption is given below. These are new service measures for PR19.

Figure 22.1: Disruption to other infrastructure evidence base

Importance & Valuation Sensitivity	Service	Measure	Types of valuation approach for PR19
Medium Priority	Disruption to other infrastructure	Motorway	Benefits Transfer
		Roads	
		Railway	
		Airport	
		Pipelines	
Medium Priority	Carbon	£ per tonne of CO2 equiv. - traded	Benefits Transfer
		£ per tonne of CO2 equiv. - non traded	

Step 2.0 Synthesis of research

The values are sourced from the available value transfer literature. Table 22.1 presents a summary of the data sources.

Table 22.1: Data sources

Study	Valuation type	Measure covered	Data	Robustness	Relevance
Department for Transport (2011)	Impact cost	Motorway	General value	H Direct costs, partial value.	H/M Assumptions required to extend to cover longer durations
The Environment Agency (2015)	Damage and compensation cost	Railway, Airport	General value	M Direct costs for 3 railway incidents & 1 airport incident, compensation costs not covered for all incidents, partial value.	M Incidents in other regions, new study
CBI (2015)	Foregone benefit estimate	Airport	General value	H/M Forecast value	H Relevant

PR14 valuation completion	Value transfer -	Congestion at a range of locations – used for relative values	General value	H/M Partial value, uses Govt. value of time.	H Relevant definition, PR14 study

Step 3.0 Comparing valuations to produce recommendation

The data sources have been applied in the following way:

Motorway:
The values are based on Government review of investigation and closure procedures for motorway incidents (2011)[32]. The literature includes an economic cost per incident of £500k and the data in the report assumes an average duration of 1 hour. This assumption has been extrapolated to cover longer incidents. The lower end value uses a duration assumption of 2 weeks and 12 hours a day and the upper end value uses a duration assumption of 1 month and 24 hours a day. The lower end use of 12 hours reflects that the incident value is likely to reflect peak times.

Roads:
The values are linked to the motorway disruption values using a relative weight of congestion impact from section 21.

Railway:
The values are based on the EA flooding costs for the 2013 and 2014 floods[33] and an assumption of an average of 3 site specific incidents. The costs include Dawlish at the higher end and Ryde at the lower end. The values covers damage and compensation where provided. The evidence probably underestimates the impacts on the wider economy however.

Airport:
The top end value is based on a 1 month economic benefit of a runway[34]. The lower end value is based on the impact of flooding at Gatwick airport[35]. The values aim to reflect that the location of an incident within an airport can have very different impacts.

Pipelines:
The values are based on the average of all the other disruption measures.

[32] Department for Transport (2011) Review of investigation and closure procedures for motorway incidents - preliminary report
[33] The Environment Agency (2015) Costs and impacts of the winter 2013 to 2014 floods
[34] CBI (2015) £31 billion cost to UK trade whilst waiting for new runway to be built
[35] The Environment Agency (2015) Costs and impacts of the winter 2013 to 2014 floods

Table 22.2: Disruption, £ per incident

SMF band	Unit	Lower	Central	Upper
Motorway	£/incident	93,600,000	247,400,000	401,200,000
Roads	£/incident	4,000,000	10,700,000	17,400,000
Railway	£/incident	1,100,000	16,200,000	36,400,000
Airport	£/incident	3,400,000	231,600,000	459,800,000
Pipelines	£/incident	25,500,000	126,500,000	228,700,000

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values to take forward are the values in Table 22.2 above.

Step 4.0 – Assess and test valuations

The wider customer evidence has been collated and reviewed by AWS (see annex 7), however no further specific evidence is available for disruption.

23 Carbon

This section covers carbon impacts.

Step 1.0 Specify and undertake research

The evidence base for carbon is given below.

Figure 23.1: Carbon evidence base

Service	Measure	Types of valuation approach for PR19
Carbon	£ per tonne of CO2 equiv. - traded	Benefits Transfer
	£ per tonne of CO2 equiv. - non traded	

Step 2.0 Synthesis of research

The values are sourced from the available value transfer literature.

The values are based on latest published Department for Business and, Energy and Industrial Strategy (BEIS) values for traded and non-traded carbon. These are 2015 values and have been inflated to 2017 prices.

Step 3.0 Comparing valuations to produce recommendation

To account for the change in values over time the range presented is an annualised value. The annualised value calculation applies the social rate of time preference over 40 years (to match optimisation assumptions)

Traded carbon assumes:

- Financial costs include taxes and carbon costs (CRC, CCL and EU ETS) in 2019 at 2017 prices. Values below are social costs in addition to those captured in energy costs. If this changes, these assumptions should be updated to reflect final assumptions for energy costs in C55.
- Costs assume that the carbon models in/feeding into C55 use a constant emission factor over time. A separate set of values is available if the emission factor changes over time.
- The current assumption is that the 2017 UK electricity emissions factor from the UK Government GHG Conversion Factors for Company Reporting is applied when calculating the carbon emissions used in C55.

Table 23.1: Carbon, £

SMF band	Unit	Lower	Central	Upper
Traded carbon	£/CO2e	1	12	24
Non-traded carbon	£/CO2e	66	133	201

Step 3d Comparing valuations to produce recommendation – Final recommendation

The final values to take forward are the values in the table above.

Step 4.0 – Assess and test valuations

The recommended values are the values recommended by the Government. Customers generally support Anglian Water in reducing its carbon footprint although is seen as a low customer priority. The values presented as consistent with the key message from the wider customer evidence.

24 Losses for Anchors

The values presented in Sections 5 to 23 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 tables below present the scaled and unscaled loss values for the key anchors. Further information on loss values across all service measures is available in the more detailed spreadsheets, provided separately.

Other key changes are for leakage where the Water Resources study values have been used for the first 44MLD value for household customers as this was found to be aligned with the losses value indicating a linear relationship up to this point.

Table 24.1: Unscaled Loss Values, Anchors, £

SMF band	Unit	Lower	Central	Upper
Interruption, 6 to 12 hours	£/property	4,287	7,048	9,810
Hosepipe ban	£/expected day/property affected	0.46	0.66	0.87
Level 4 restrictions	£/expected day/property affected	155	293	574
Discolouration	£/property	1,216	2,223	3,230
Leakage	£/MLD	420,959	908,944	1,396,921
Internal sewer flooding	£/property	188,533	505,559	868,918
External sewer flooding	£/area	2,692	10,772	22,863
Odour nuisance	£/property	21,598	46,520	71,443
Bathing water	£/site from good to excellent	3,659,244	6,939,621	10,220,000
River water quality	£/km to good status	123,919	180,472	237,025
Pollution category 2	£/incident	950,498	1,574,064	2,197,630
Repeat customer contacts	£/customer	501	823	2,160

Table 24.2: Scaled Loss Values, Anchors, £

SMF band	Unit	Lower	Central	Upper
Interruption, 6 to 12 hours	£/property	593	1,036	1,484
Hosepipe ban	£/expected day/property affected	0.45	0.55	0.66
Level 4 restrictions	£/expected day/property affected	41	66	108
Discolouration	£/property	378	570	763
Leakage	£/MLD	135,010	216,200	288,302
Internal sewer flooding	£/property	106,723	129,201	157,980
External sewer flooding	£/area	2,692	10,772	22,863
Odour nuisance	£/property	2,772	5,971	9,170
Bathing water	£/site from good to excellent	569,422	1,171,265	1,773,109
River water quality	£/km to good status	29,785	45,742	61,700
Pollution category 2	£/incident	163,339	264,619	365,898
Repeat customer contacts	£/customer	84	135	358

25 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 chapter 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 PR19 Main Stage WTP research[36]. In addition, analysis from the PR19 Second Stage Water Resources Options and Restrictions studies has also been considered.

25.1 Approach to segmentation

Bespoke modelling analysis was undertaken of the household results from the afore mentioned studies to explore if the estimated coefficients and weights differed across different household segments. This has included analysis of responses to the choice experiments in each study to highlight where different customer segments may hold different preferences. The topline responses from the Second Stage Water Resource study have also been reviewed by segment to highlight different attitudes towards both potential water resource options and restrictions.

Given the Ofwat methodology focuses on future generations, affordability and vulnerability we have analysed socio-economic group (SEG), age, WaterSure and households with disability or long-term illness. The Anglian Water customer segments[37] also provide another relevant method for understanding variations within the customer base.

A priori, based on economic theory it is expected that that a household customer's income will influence WTP where households with higher incomes are expected to pay more than households with lower incomes (on average). Other factors can be expected to influence WTP. Some factors will correlate to a degree with income levels (e.g. social status, age), while others may be independent of income. Ultimately the direction of any influence from factors not related to household income is not typically known a priori and is an empirical issue.

Analysis of household segmentation was undertaken for the following groups. The PR19 main stage study undertook analysis for all of these groups whereas the PR19 water resources studies focused on analysis of the socio-economic groupings and the Anglian Water customer segments.

Socio-Economic Groups

- SEG DE (= base);
- SEG AB;
- SEG C1; and
- SEG C2

Age

- 18-29;
- 30-64; and
- Over 65s

[36] The analysis was undertaken on the results from the DCE part of the study.
[37] See: Anglian Water Customer Behavioural Segmentation Final Report.

Receipt of WaterSure

- Yes; and
- No;

Disability within the household

- No
- Yes (respondent or household member)

Anglian Water customer segment

- Protective provincials;
- Comfortable & Caring;
- Tech Savvies;
- Eco-economisers;
- Careful budgeters and
- Family First

Detailed summaries of the modelling approaches employed are included within the econometric results annexes supporting the PR19 main stage study, PR19 water resources options study and the PR19 water restrictions study:

- Main stage study examined the WTP for the different customer groups to highlight where this differs from the average WTP. This analysis was undertaken for each of the anchor values considered in this report.
- Second stage studies: include two different types of analysis. Firstly, they considered how overall WTP for improvements varied by the customer groups. Secondly, they examined how customer preference weights for alternative water resource options and water restrictions varied across the customer groups. These customer preference weights are not WTP values but instead represent how customers prefer different options or water restriction events relative to each other.

The following sections set out the key outputs from the segmentation analysis for each group.

25.2 Socio-Economic Group DE

The WTP was examined for the different socio-economic groups to highlight where customers preferences diverge from the average WTP.

We might expect SEG DE customers to have lower than average WTP in general and SEG AB to have higher than average WTP given their respective incomes, but this was not uniformly so. Examining the results in detail found WTP for SEG DE customers to be the same for many service areas and lower in a few others.

SEG DE customers had a lower WTP[38] for the following service areas:[39]

- to reduce leakage (only 43% of average WTP)
- to reduce severe water restrictions (only 50% of average WTP) and
- to reduce odour from sewage treatment works (only 74% of average WTP)

In all other areas the WTP was not statistically different to the mean.

[38] Anglian Water PR19 Main Stage WTP Study Annex 10 Appendix 6

[39] This means that the 95% confidence interval for the SEG DE estimate does not overlap with the 95% confidence interval for the overall sample.

Further evidence

Water Resources study (options and restrictions) valuation
Analysis of the valuation data for the WTP package question in the Water Resources studies did not find a significantly lower WTP for the DE SEG group relative to the average. This may be due to the analysis being considered for a package of improvements as opposed to individual service areas. At a package level differences for individual service measures will be combined with service measures where no difference is observed and this may result in the overall difference for the whole package appearing less distinct.

However, the analysis did find that the SEG AB group had a significantly higher WTP for improvements compared to the average WTP. This result was only observed for the restrictions survey and is summarised in Figure 25.1 from *Anglian Water Second Stage WR Study V2.0* below

Figure 25.1: Household – Segmentations for Options and Restrictions package exercises

SEGMENTATION	RESTRICTIONS SURVEY			OPTIONS SURVEY		
SEG	WTP £/hh/yr	Is estimate significantly different to zero?	Is segment estimate significantly different to 'All' estimate?	WTP £/hh/yr	Is estimate significantly different to zero?	Is segment estimate significantly different to 'All' estimate?
All Respondents	34.23	✓✓✓		29.45	✓✓✓	
C2 & DE	26.45	✓✓✓	×	17.71	✓✓✓	×
C1	29.53	✓✓✓	×	36.68	✓✓✓	×
AB	50.78	✓✓✓	✓✓	43.05	✓✓✓	×

Key:
✓ Significant at p < 0.1
✓✓ Significant at p < 0.05
✓✓✓ Significant at p < 0.01
× Not significant

Water Resources Options Study
In this study the differences by socio-economic group were considered for each option separately. This additional modelling concluded that there is very limited evidence of any difference in the option preference weights across the household socio-economic groups.

The one exception was leakage reduction.

Relative to the average preference, the study shows that only for the SEG AB group in the case of leakage reduction is there any evidence of a stronger preference (compared to the average weight) and there is no evidence that the SEG DE group has a lower preference.

Weaker evidence suggests that there may be some variance for the option 'incentivise and educate to save water' as here the AB SEG group may have a stronger preference than the average.

Other differences in opinion on water restriction options not linked to WTP included:

- **Leakage:** SEG DE group focused more on the length of time a leak is left unfixed whereas other SEGs thought more about the associated cost and water losses

- **Using sea water:** SEG DE group were more open to the idea and less concerned about the carbon impacts related to this option

Water Restrictions Study
Whilst not a severe restriction, DE customers were more likely to state being 'not at all' affected by hosepipe bans.

25.3 WaterSure customers

WaterSure tariff is one of a number of tariffs Anglian Water offer for metered properties where customers may be experiencing particular hardship and need to use large amounts of water.[40] WTP was examined for this specific customer group to highlight if customers preferences diverge from the average WTP. The analysis was undertaken for the PR19 Main Stage study only due to sample size.

There were no statistically significant differences in WTP for this group between customers in receipt of WaterSure and customers on other predominantly standard tariffs.

This may have been down to a relatively small sample size for this segment. There were between 58 and 65 customers in this sub-sample (dependent on variations in the small number of don't know/prefer not to say responses which were excluded), increasing the uncertainty around the estimates.

WaterSure responses were not examined by toplines due to the problem of splitting a small sample over questions with multiple response options.

25.4 Age

WTP was examined for the different customer groups to highlight where customers preferences diverge from the average WTP.

This segment warrants consideration as we may expect differences in WTP to occur for customers over a life time and this analysis can provide evidence to inform the theme of future generations;

- Income profiles can change as job experience increases
- Retirement can prompt a step change in income
- Commitments such as financial dependents and mortgages vary

Despite this, there were no statistically significant differences in WTP for 18-29 years, 30-64 years and 65+ years.

Further evidence

There were some differences in opinion expressed related to views on infrastructure health and resilience, though not sufficient to change WTP.

- 18-29 years felt more strongly customers should pay more today to help ensure that customers in the future do not experience worse levels of service.
- 65+ years saw more value in network maintenance than those aged 18-29.
- A service resilient to extreme events such as drought and floods was a little more important to 65+ years with those aged 18-29 less concerned.

25.5 Disability within household

Again, WTP was examined for the different customer groups to highlight where customers preferences diverge from average WTP.

Samples in the Main Stage study ranged from 157 to 176 households with at least one person having a disability or long-term illness, providing a good base for investigation. However, even with a large

[40] The WaterSure scheme is available to qualifying customers with a water meter. To qualify a customer must be in receipt of a qualifying benefit and either be responsible for 3 or more resident children under the age of 19 and in full time education or have a medical condition that requires significant additional use of water. Details are available at: https://www.ofwat.gov.uk/households/customer-assistance/watersure/

sub sample there were no statistically significant differences in WTP between households with or without disabilities.

Further evidence

There were some differences in opinion expressed related to water restrictions, though not sufficient to change WTP.

- Household with disabled customers were more likely to state being 'not at all' affected by hosepipe bans. This cohort may be less likely to be washing cars, watering gardens etc.
- These differences were similar for non-essential use bans as well.
- Households with disabled customers were slightly less aware of rota cuts. At the same time rota cuts are a tipping point for households with disabled customers as they become more concerned than households with no disability, reversing the trend previously observed.

25.6 Anglian Water customer segments

In the main stage study, when the WTP was examined for the AW customer segments, 'Protective provincials'[41] were the only group whose preferences diverge from the average WTP. For five out of the eleven measures in the Main Stage Study Protective provincials had below average WTP where the differences were statistical significant, see Table 25.1. For these improvements, Protective provincials' WTP were half or less than half the average WTP of all customers.

Table 25.1: WTP for Protective provincials (n= 76 except sewer flooding where n =84)

SERVICE MEASURE	Protective provincials	
	WTP £/hh/yr/unit	**% of average WTP***
Unplanned interruptions	0.0017	46%
Severe water restrictions	0.0489	50%
Discolouration	0.005	41%
Leakage	1.9879	39%
Sewer flooding inside properties	0.1177	41%

*Significant at $p < 0.05$

Water Resources study (options and restrictions) valuation

A combined grouping of Comfortable & Caring / Family First / Tech-Savvies have a higher than average WTP that was found to be statistically significant in the Restrictions survey for the package exercise. The corollary is that the estimated package WTP for the base group of Protective Provincials / Eco-economisers is below the overall sample average. This is summarised in Figure 25.2 from *Anglian Water Second Stage WR Study V2.0*.

[41] 'Protective provincials' see water as a precious resource and wouldn't like water to go elsewhere in the country, Anglian Water Customer Behavioural Segmentation Final Report.

Figure 25.2: Household – Segmentations for Options and Restrictions package exercises

SEGMENTATION	RESTRICTIONS SURVEY			OPTIONS SURVEY		
SEG	WTP £/hh/yr	Is estimate significantly different to zero?	Is segment estimate significantly different to 'All' estimate?	WTP £/hh/yr	Is estimate significantly different to zero?	Is segment estimate significantly different to 'All' estimate?
All Respondents	34.23	✓✓✓		29.45	✓✓✓	
Protective Provincials & Eco-Economisers	23.83	✓✓✓	✓	22.48	✓✓✓	×
Comfortable & Caring / Family First / Tech-savvies	48.97	✓✓✓	✓✓	37.58	✓✓✓	×

Key:
- ✓ Significant at p < 0.1
- ✓✓ Significant at p < 0.05
- ✓✓✓ Significant at p < 0.01
- × Not significant

Further evidence

Water Resource Options Study

The segmentation analysis in the Water Resources study choice exercise (Annex 8 of Anglian Water Second Stage WR Study V2.0*)* examined whether the customer preference weights for the different Water Resource options varied by Anglian Water customer segment.

This study found that there were no options where differences from the average household group were jointly significant at the 95% level of significance. The same finding was true for the equivalent analysis of the Water Restrictions choices.

Weaker evidence suggests that there may be some variance for two of the Water Resource options:

- The Family first segment that had a stronger preference than average for the water transfer option.
- The Tech-savvies have a lower preference than average for the 'encourage metering' option.

There were some differences in opinion expressed related to Water Resource options, though not sufficient to change the WTP, specifically for;

- ***Leakage:*** Tech-savvies thought more about the associated costs and water losses whereas Protective provincials focused more on the time the leak is left unfixed.

- ***Education and incentives:*** Protective provincials compared to Comfortable and Caring may be less receptive to this option whilst still broadly liking education and incentives.

- ***Reservoirs:*** Comfortable and Caring are perhaps more appreciative of habitat benefits than Tech-savvies.

- ***Water transfer:*** Tech-savvies were less concerned about bill and service changes as a result of water transfers than Protective provincials. Large numbers of both however still held reservations about the option.

Water Resource Restrictions Study

There were also some differences in opinion expressed related to water restrictions, however again not sufficient to change the WTP.

Awareness:

- Comfortable and Caring customers were more aware of hosepipe bans than Tech-savvies
- Protective provincials were slightly less aware of rota cuts than Comfortable and Caring as well as Tech-savvies

- Awareness of no tap water was low across the board, but relatively higher for Comfortable and Caring customers compared to Tech-savvies

Impact:

- Protective provincials are more likely to register a significant impact from rota cuts than Comfortable and Caring or Tech-savvies
- Tech-savvies were more likely to state no-tap water would impact them severely

Anglian Water Customer Segmentation Research

The Anglian Water segmentation research found some differences between customer segments in terms of levels of concern about the quality of rivers and coastal waters. However, these differences do not appear to be observed in the WTP data.

The research found that after affordability, protecting the environment was one of the key reasons for supporting a package of service improvements. On average 67% of customers strongly agreed that it was important to improve river and coastal waters but differences were observed for Tech savvies (39%) and Eco-economisers (81%).

Hartlepool Water customers

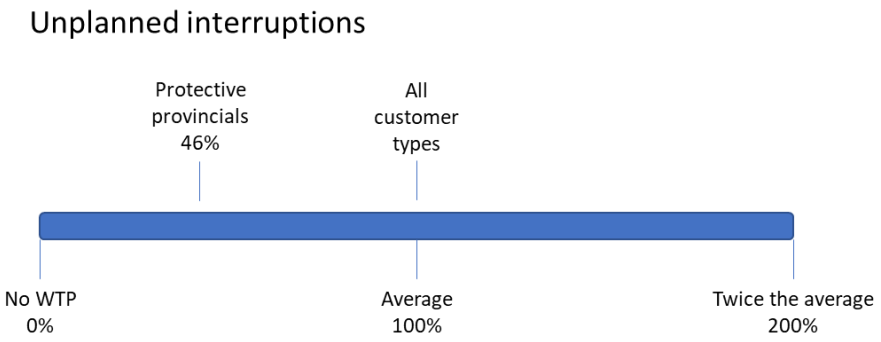
The main stage study provided separate results for Hartlepool Water respondents to understand if priorities vary between Hartlepool Water and Anglian Water household customers and what these differences are. The full set of results can be found in Annex 10 Appendix 8 of the main stage study report.

In summary, the analysis found customer priorities for both groups to be similarly aligned with the main difference being through Hartlepool Water customers placing a lower level of importance on 'severe water restrictions'. While the WTP values for Hartlepool Water are generally lower than Anglian Water values, the confidence intervals overlap making it not possible to conclude that the two sets of values are statistically different.

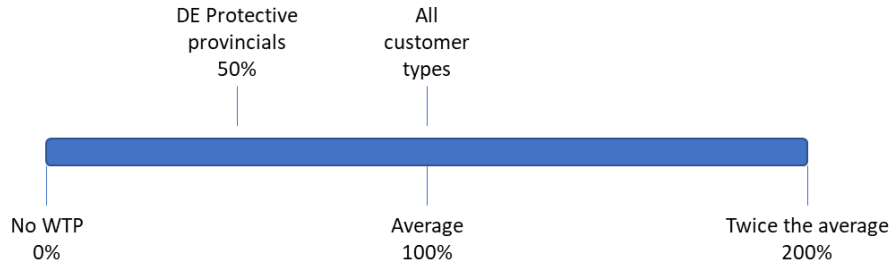
25.7 Summary

Although different customer groups showed some variation in opinion this was only sufficient to drive differences in WTP for SEG DE and Protective provincials. These specific customer segments held below average WTP for the Main Stage study; however the WTP values were only statistically different from the average for a subset of service measures summarised below.

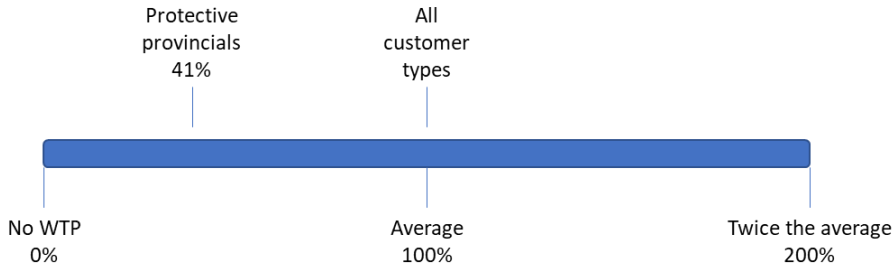
Figure 25.3: PR19 Main Stage WTP segmentation modelling results - differences in WTP



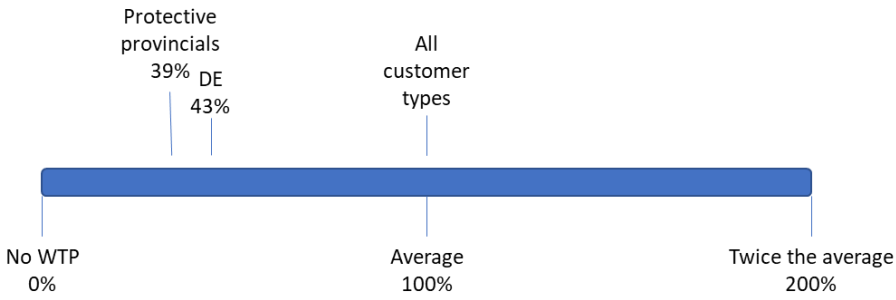
Severe water restrictions



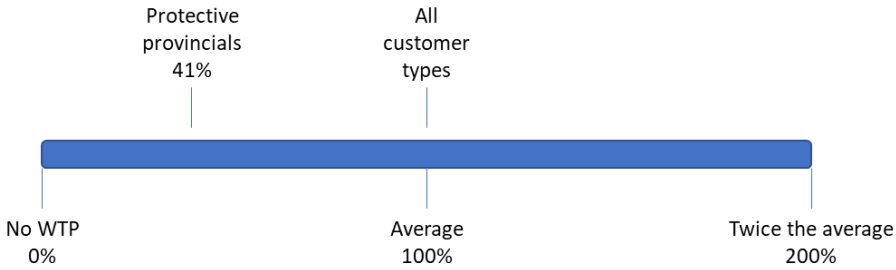
Discolouration

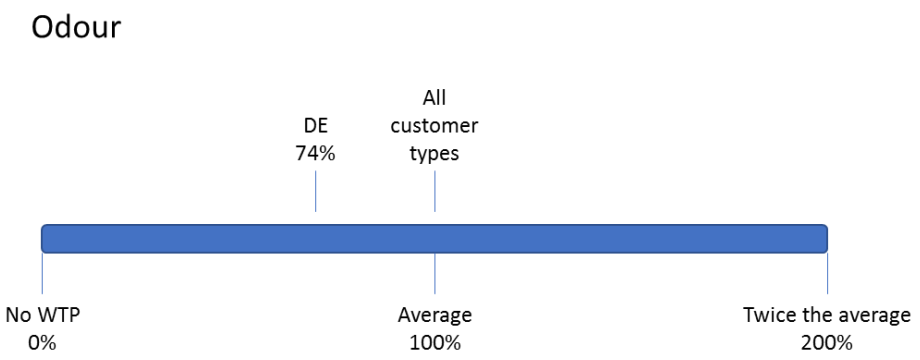


Leakage



Internal sewer flooding





Segmentation analysis within the Second Stage Water Resources Options and Restrictions studies revealed:

- Modelling analysis of the Water Resource option preferences by customer segments found:
  - Strong evidence that leakage control preferences varied with socio economic group
  - Weak evidence that preferences for the option to 'incentivise and educate to save water' varied with socio economic group
  - Weak evidence that 'water transfers' and 'encouraging metering' may vary by Anglian Water customer segment.
- The equivalent analysis of Water Restrictions preferences found no significant differences
- Analysis of the package exercises that measured customers WTP found some differences:
  - Evidence that the SEG AB have a higher than average WTP
  - Comfortable & Caring / Family First / Tech-Savvies have a higher than average WTP. This infers the estimated package WTP for the base group of Protective provincials / Eco-economisers is below the overall sample average.
- In addition, the analysis found no differences when the non-household package responses were tested to compare non-household customers split by public sector and other businesses.

Table 25.2, Table 25.3 and Table 25.4 summarise the modelling results of the segmentation analysis from the PR19 Main Stage Study. The tables show the blocks of service measures (water services, sewerage services and wider services) explored with customers in the survey. Those highlighted in green show a WTP which is statistically different at the 95% level from the average WTP, as discussed above.

PR19 Main Stage WTP segmentation modelling results[42]

Table 25.2: Segmentation analysis - Household DCE - Water services

SEGMENTATION	Unplanned interruptions		Severe water restrictions		Discolouration		Leakage		SAMPLE SIZE
	WTP £/hh/yr/unit	% of All Respondent's WTP*	WTP £/hh/yr/unit	% of All Respondent's WTP*	WTP £/hh/yr/unit	% of All Respondent's WTP*	WTP £/hh/yr/unit	% of All Respondent's WTP*	
All Respondents (i.e. the average)	**0.0037**		**0.0974**		**0.0013**		**5.1614**		**550**
SEG AB	No difference		No difference		No difference		No difference		136
SEG DE	No difference		0.0488	50%	No difference		2.2110	43%	139
WaterSure									
Yes	No difference		No difference		No difference		No difference		65
Age									
18-29 years	No difference		No difference		No difference		No difference		98
30-64 years	No difference		No difference		No difference		No difference		328
65+ years	No difference		No difference		No difference		No difference		124
Disability									
Yes	No difference		No difference		No difference		No difference		157
Customer segmentation									
Careful budgeters	No difference		No difference		No difference		No difference		4
Comfortable and caring	No difference		No difference		No difference		No difference		79
Eco economisers	No difference		No difference		No difference		No difference		28
Family first	No difference		No difference		No difference		No difference		42
Protective provincials	0.0017	46%	0.0489	50%	0.0005	41%	1.9879	39%	76
Tech-savvies	No difference		No difference		No difference		No difference		321

*Significant at p < 0.05

[42] For further details, see main stage report, Annex 10 appendix 3-7.xls

Table 25.3: Segmentation analysis - Household DCE - Sewerage services

SEGMENTATION	Sewer flooding inside properties		Sewer flooding to external areas		Odour from sewage treatment		Bathing water quality at beaches		SAMPLE SIZE
	WTP £/hh/yr/unit	% of All Respondent's WTP*	WTP £/hh/yr/unit	% of All Respondent's WTP*	WTP £/hh/yr/unit	% of All Respondent's WTP*	WTP £/hh/yr/unit	% of All Respondent's WTP*	
All Respondents (i.e. the average)	**0.2878**		**0.0204**		**0.0159**		**2.3943**		**558**
SEG AB	No difference		No difference		No difference		No difference		120
SEG DE	No difference		No difference		0.0118	74%	No difference		147
WaterSure									
Yes	No difference		No difference		No difference		No difference		61
Age									
18-29 years	No difference		No difference		No difference		No difference		147
30-64 years	No difference		No difference		No difference		No difference		291
65+ years	No difference		No difference		No difference		No difference		120
Disability									
Yes	No difference		No difference		No difference		No difference		162
Customer segmentation									
Careful budgeters	N/A		N/A		N/A		N/A		
Comfortable and caring	No difference		No difference		No difference		No difference		76
Eco economisers	No difference		No difference		No difference		No difference		32
Family first	No difference		No difference		No difference		No difference		46
Protective provincials	0.1177	41%	No difference		No difference		No difference		84
Tech-savvies	No difference		No difference		No difference		No difference		320

*Significant at $p < 0.05$

Table 25.4: Segmentation analysis - Household DCE - Wider services

SEGMENTATION	River water quality		Pollution incidents		Customer service		SAMPLE SIZE
	WTP £/hh/yr/unit	% of All Respondent's WTP where differences are significant*	WTP £/hh/yr/unit	% of All Respondent's WTP where differences are significant*	WTP £/hh/yr/unit	% of All Respondent's WTP where differences are significant*	
All Respondents (i.e. the average)	**4.5982**		**0.4458**		**1.8869**		**542**
SEG AB	No difference		No difference		No difference		143
SEG DE	No difference		No difference		No difference		134
WaterSure							
Yes	No difference		No difference		No difference		58
Age							
18-29 years	No difference		No difference		No difference		87
30-64 years	No difference		No difference		No difference		293
65+ years	No difference		No difference		No difference		162
Disability							
Yes	No difference		No difference		No difference		176
Customer segmentation							
Careful budgeters	N/A		N/A		N/A		
Comfortable and caring	No difference		No difference		No difference		66
Eco economisers	No difference		No difference		No difference		28
Family first	No difference		No difference		No difference		45
Protective provincials	No difference		No difference		No difference		82
Tech-savvies	No difference		No difference		No difference		321

*Significant at $p < 0.05$

25.8 Conclusions

The segmentation analysis has aimed to provide additional detail on how customer preferences and WTP values may vary by different customer segments which contributes to a richer triangulation of the evidence.

A wide-ranging review of both the PR19 Main Stage Study and Second Stage Water Resources Study has found that while differences in opinion exist amongst customers, preferences or values for core service do not vary across different customer groups that often.

Rather than being uniformly lower, WTP for SEG DE customers was found to be below that of the average customer only for a handful of service measures which were seen to be less important.

For the PR19 Main Stage study SEG DE customers had a lower WTP:

- to reduce leakage (only 43% of average WTP)
- to reduce severe water restrictions (only 50% of average WTP) and
- to reduce odour from sewage treatment works (only 74% of average WTP)[43]

For the same study Protective provincials had below average WTP for the five of the eleven service measures which are highlighted in Table 25.2 to Table 25.4.

The implications for triangulation of the valuation evidence are in general that the average WTP values are representative across a wide range of customer segments with only a few exceptions for consideration.

[43] Anglian Water PR19 Main Stage WTP Study Annex 10 Appendix 6

26 Summary and conclusions

The purpose of this report is to provide the recommended societal values for use in the PR19 business planning and WRMP appraisal processes. It draws together the available valuation information that is available to produce a recommended set of values. 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 an interim report delivered in January 2018 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, further analysis and trialling different approaches (Best-worst scaling results)
- Further engagement with customers to test the interpretation of the valuations
- Challenge, review and updating assumptions based on the recommendations included in the interim report.
- More detailed cross check with the Anglian Water PR19 Customer Engagement Synthesis report.

26.1 Findings

The final gains values are shown in the two tables below. The report is supplemented by a workbook detailing the values for the 178 measures that make up Anglian Water's societal valuation framework. Based on discussions with Anglian Water and the peer reviewer the preferred approach is to test the scaled values first and then to test the unscaled values as part of the business plan testing or sensitivity testing process.

Table 26.1: Scaled Gains Values, Anchors, £

SMF band	Unit	Lower	Central	Upper
Interruption, 6 to 12 hours	£/property	353	902	1,508
Hosepipe ban	£/expected day/property affected	0.45	0.55	0.66
Severe water restrictions	£/expected day/property affected	42	59	89
Discolouration	£/property	268	484	748
Leakage	£/MLD	106,193	172,405	231,765
Internal sewer flooding	£/property	41,353	98,805	116,331
External sewer flooding	£/area	1,782	10,234	22,863
Odour nuisance	£/property	1,922	6,551	11,205
Bathing water	£/site from good to excellent	166,181	747,802	1,397,225
River water quality	3/km to good status	7,383	16,972	26,561
Pollution category 2	£/incident	89,331	150,780	212,229
Repeat customer contacts	£/customer	18	57	193

Table 26.2: Unscaled Gains Values, Anchors, £

SMF band	Unit	Lower	Central	Upper
Interruption, 6 to 12 hours	£/property	2,128	5,232	8,783
Hosepipe ban	£/expected day/property affected	0.46	0.66	0.87
Severe restrictions (Rota cuts and standpipes)	£/expected day/property affected	66	106	174
Discolouration	£/property	579	1,423	2,612
Leakage	£/MLD	320,120	717,232	1,114,339
Internal sewer flooding	£/property	180,709	375,047	626,443
External sewer flooding	£/area	9,885	29,785	57,800
Odour nuisance	£/property	10,639	38,530	66,629
Bathing water	£/site from good to excellent	1,442,329	4,245,457	7,339,945
River water quality	3/km to good status	52,047	104,575	157,103
Pollution category 2	£/incident	359,731	774,728	1,189,724
Repeat customer contacts	£/customer	85	331	1,161

26.2 Recommendations and next steps

It is considered appropriate that all of the recommended values in this report are taken forward as part of the business planning process. The range of values can be used to both understand the societal impact of proposed plans and test the sensitivity. Further customer evidence can be compared to these findings.

The recommended ranges have been compared to other company values from PR14. Going forward it would be useful to source PR19 other company data (pre or post triangulation) as a useful comparator. This would be particularly useful for the unscaled ranges. This is currently being taken forward through participation in a study by Accent with the results to be available shortly.

In the longer term, further research is recommended to reduce reliance on stated preference studies including building further on some of the new areas of innovation in valuation approaches and

continuing to develop the evidence on values on an on-going basis between price reviews. Areas include:

- Revealed preference/post incident research into a number of service areas such as interruptions, low pressure, discolouration, odour nuisance, environmental recreation (pollution, river water quality and bathing waters).
- Application of wellbeing approaches to other service areas.
- Collecting additional information on damage costs for measures such as:
    - Hardwater and how this relates to avertive expenditure; and
    - Internal flooding (water or wastewater) particularly for non-domestic customers that are flooded.
- Collecting information on the size of an external area flooded of agricultural land. This would allow valuation evidence that is available for agricultural land in £/ha to be utilised more effectively.

26.3 Peer review

The process and application has been subject to peer review by Professor Ken Willis. In response to questions posed, Professor Willis provided guidance on the integration of traditional stated preference valuations with alternative sources. The advice provided has included considering studies on a case by case basis and identifying the circumstances when it is appropriate for stated preference values to be amended or to use studies to influence the range for sensitivity testing.

The peer review recognises that scaled and unscaled values are appropriate in different contexts and decisions may not just be conceptual but should also consider the relative validity of the different sources.

26.4 Summary conclusions

This report draws together a range of valuation evidence set out in the Anglian Water societal valuation framework to produce a set of recommended societal values for use in the PR19 business planning and WRMP appraisal process. This value evidence includes traditional value methods used in the water industry such as stated preference surveys and integrates these with sources that are more innovative or have had less focus in the past. Overall this has provided a robust set of triangulated final recommended values that can be taken forward by Anglian Water to understand the societal impacts and implications for strategic investment business planning. The values can also be used to undertake sensitivity testing and the results can be compared to wider customer evidence.

