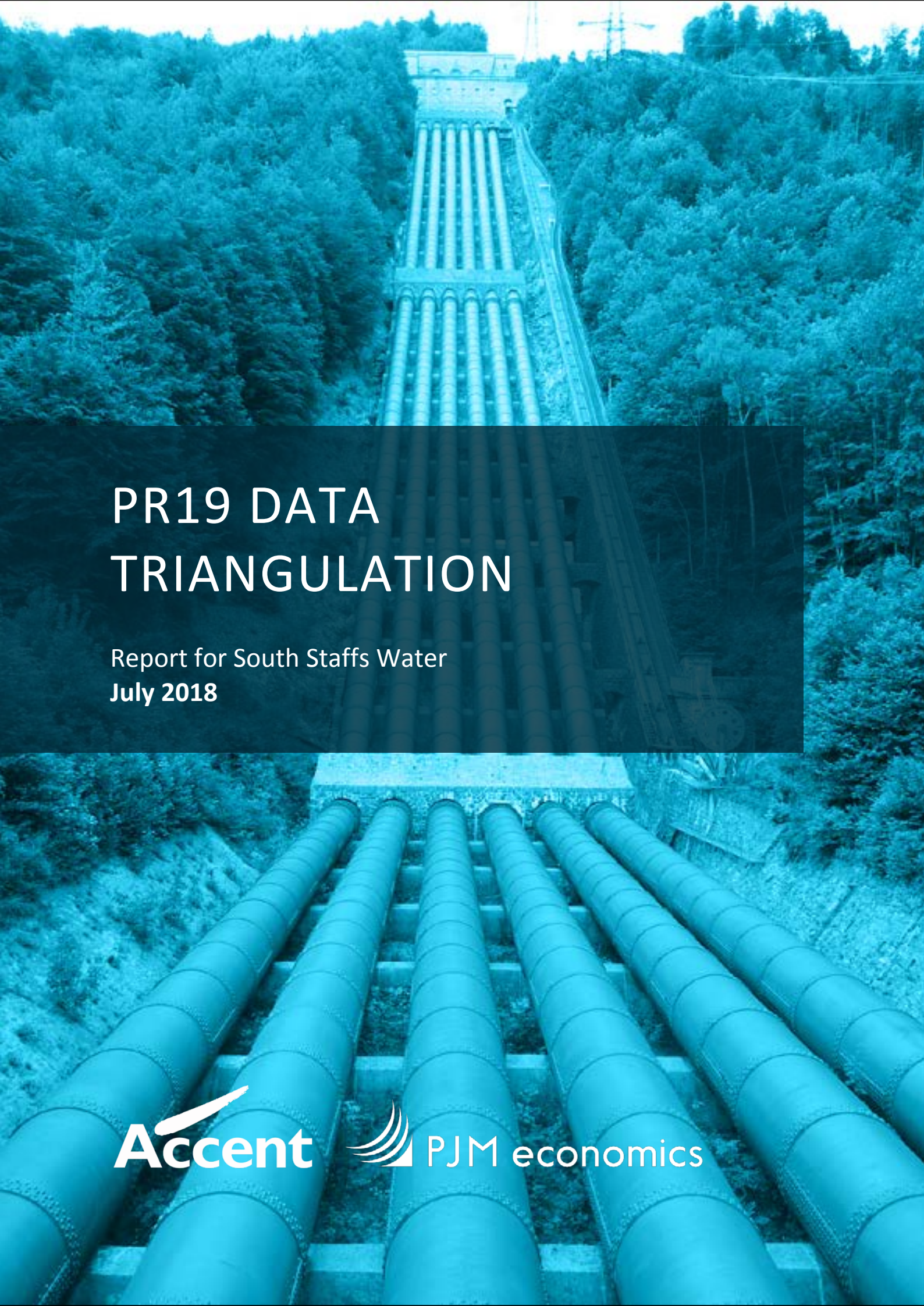

PR19 DATA TRIANGULATION

Report for South Staffs Water

July 2018

Accent

PJM economics

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EXECUTIVE SUMMARY

Following the 2014 price review (PR14), a challenge levelled against water companies was that they were too reliant on willingness to pay (WTP) surveys when setting their performance commitment (PC) levels and outcome delivery incentive (ODI) rates. Ofwat's PR19 customer engagement policy statement consequently included the guideline that companies should draw evidence from a wider range of customer data sources (internal and external) to supplement their stated preference willingness to pay survey results. By so doing, companies should generate new perspectives and insights to help better understand their customers' preferences.

As part of its PR19 research programme, South Staffs Water & Cambridge Water (SSC) asked PJM and Accent to conduct the present study to 'triangulate' evidence from a wide range of sources. There were two key areas where SSC required triangulation support:

- **WRMP priorities:** Developing a robust customer priority index, by region, with respect to water resources management plan (WRMP) supply and demand supply options. This index is to be used to fully reflect customers' preferences within SSC's Multi Criteria Analysis investment tool.

- **WTP:** Developing a robust and proportionate evidence base on customers' WTP for different areas of investment. The triangulated values are to be used within SSC's investment optimise tool to undertake Cost Benefit Analysis of investment options and as part of the process of setting ODI rates.

A key report for CCWater, ICF (2017) *Defining and applying 'triangulation' in the water sector*, sets out a suggested triangulation framework for PR19. We build upon and extend this approach to develop a triangulation methodology that involves the following six steps.

- **SCREEN** data sources to identify those with potentially comparable measures
- **MAP** non-core evidence to core measures where possible to enable comparison
- **ASSESS** theoretical and statistical validity of the resulting measures
- **RATE** measures as Red/Amber/Green (RAG) depending on how well they perform with respect to the validity measures
- **TRIANGULATE** to conclude on the values to take forward based on applying RAG weights to obtain central values and ranges.
- **SENSITIVITY TEST** the results based on amending the weights to conform with alternative reasonable perspectives.

With respect to WRMP priorities, we find several studies conducted by SSC containing evidence suitable for triangulation. This includes qualitative and quantitative 'core' WRMP priorities research, quantitative willingness to pay research, and a quantitative 'Customer Priorities' research study.

With respect to WTP, an even wider range of evidence sources could be included within the triangulation. In addition to the SSC PR19 WTP core research, which itself included results from a two discrete choice experiments (Wave 1 and Wave 2) as well as a MaxDiff choice exercise, data sources included the WRMP research, Customer Priorities research, Customer Contacts/complaints, Customer Satisfaction, Performance Commitment service improvement Sliders and External WTP evidence (PR14, PR19, academic and grey literature).

After mapping the comparable measures derived from the supplementary sources against the core WRMP and WTP measures, we assess the validity of these measures and rate them against our appraisal criteria. Overall RAG (Red/Amber/Green) ratings are assigned to each source and weights are used based on these ratings to combine measures across sources.

For WRMP triangulation we find:

- `Increased water metering' is the highest priority for South Staffs while 'Building a new water reservoir' is the highest priority for Cambridge Water' followed very closely by 'Reducing Leakage'. 'Taking more groundwater' is the least desired option for both South Staffs and Cambridge regions.

- There are also interesting insights to be gained from comparison of the various sources. WRMP research (workshop and online) generated lower values for 'Leakage' in comparison to some of the other data sources. For metering, we find that WRMP workshop generated lower values for SSW and CAM in comparison to some of the other data sources. For smart metering, WRMP workshop generated higher values for both SSW and CAM in comparison to the other data sources.

For WTP triangulation we find:

- The triangulated values are reasonably close to their WTP DCE values for some service measures, but the range is very significant in many cases.

- Overall, we find that the `COMBINED SSC' Unit values seem to have a significant range due to the significant ranges associated with the `Combined NHH' values.

We tested the sensitivity of our triangulated results by considering alternative sets of weights for the RAG ratings as well as alternative overall RAG ratings for the different sources. Overall, for SSC the triangulated WRMP priority indices as well as the triangulated WTP estimates for all the core service measures were largely invariant across the sensitivity tests. However, there were more differences across sensitivity cases for the CAM region.

In the case of WRMP priorities, four sensitivity cases were considered. Across these cases:

- For SSW and CAM, there were no differences in priority scores across sensitivity cases larger than 20% of the original score. This should give confidence in the main results as a robust measure of customers' priorities.

In the case of WTP estimates, only one sensitivity case was considered.

- None of the core measures were found to have a value more than 20% different in the sensitivity case than in the main case for SSW.
- The only exceptions were Taste and Smell, Leakage and Unexpected Temporary Loss of Water Supply in the CAM region.

The differences were all fairly low in the context of WTP measurement, where value estimates can often vary by an order of magnitude or more for the same good (see Accent, 2014, for examples.) This should give SSC and its stakeholders confidence in applying these as measures as a sensitivity checkpoint in CBA and Performance Commitment level and ODI target setting.

In summary, the findings of this study should provide valuable insight into customers' preferences with respect to WRMP priorities and WTP for service improvements and we recommend them to SSC for this purpose.

1 INTRODUCTION

1.1 Background

As part of its PR19 business planning process, South Staffs Water & Cambridge Water (SSC) has undertaken a large and broad-ranging customer research programme, including core WTP and WRMP research, engagement around performance commitments, plus general customer priorities research, and a targeted study focussed on metering. In addition, it has assembled evidence on customer contacts and satisfaction from a range of sources. Added to this evidence base on customer priorities and values are WTP studies conducted by other water companies and from the energy sector.

SSC asked PJM and Accent to conduct the present study to 'triangulate' evidence from this wide range of sources. There were two key areas where SSC required triangulation support:

- **WRMP priorities:** Developing a robust customer priority index, by region, with respect to water resources management plan (WRMP) options. This index is to be used to reflect customers' preferences within SSC's WRMP.

- **WTP:** Developing a robust and proportionate evidence base on customers' WTP for different areas of investment. The triangulated values are to be used within CBA as part of the process of setting ODI rates.

The purpose of the present study was to deliver against these twin objectives via a review of SSC and external data relating to priorities amongst the supply augmentation and demand management options SSC is considering for its WRMP, and in relation to WTP.

1.2 Structure of Report

The remainder of the report is split into 4 sections. Section 2 presents our proposed methodology for triangulation. Sections 3 and 4 present the triangulation results for WRMP priorities and WTP respectively, obtained by applying our methodology. Section 5 concludes the report. Further details regarding each of the data sources considered for this study are provided in Appendix A.

2 METHODOLOGY

2.1 Rationale for Triangulation

Following the 2014 price review (PR14), a challenge levelled against water companies was that they were too reliant on willingness to pay (WTP) surveys when setting their performance commitment (PC) levels and outcome delivery incentive (ODI) rates. Ofwat highlighted the wide range of results that emerged across companies for the same service measures as a reason to question their validity, while others argued that the questions asked were too complex for customers to answer meaningfully (Accent-PJM, 2015).

More generally, WTP estimates are subject to various sources of errors; significant sources of such errors include sampling errors, sensitivity to elicitation formats and scope of service level changes, estimates are stated rather than revealed via actual survey respondent behaviour, potential misconceptions of respondents about different service issues and focussing effects (i.e. what respondents focus on when asked about their preferences between different choice scenarios, may not be what they actually pay attention to in their real lives).

Ofwat's customer engagement policy statement for the 2019 price review (PR19) consequently included the guideline that companies should draw evidence from a wider range of customer research sources (internal and external) and, in addition, operational data including contacts and complaints, to supplement their stated preference WTP survey results. By so doing, companies should generate new perspectives and insights to help better understand their customers' preferences.[1]

More generally, triangulation can be seen as a good practice to follow as part of business planning for all decisions where evidence on customers' preferences is relied upon to justify important decisions. By using multiple independent measures, overall errors should be smaller than when the results from an individual study are used in isolation (ICF, 2017). This is dependent, of course, on having an effective methodology for utilising the evidence. Consequently, there is reason to look further than a single set of results from the WTP survey in order to derive better estimates of the true WTP that can be utilised within CBA as part of the process of setting PC levels, and for setting ODI rates. Note that the purpose for such triangulation is to augment the existing CBA approach rather than replacing it with an alternative decision support framework.

2.2 Guidelines for Triangulation

Despite calling for triangulation, Ofwat has not itself provided any detailed guidelines for companies to follow. Instead, the key reference point for the present study is a report commissioned by CCWater, ICF (2017) *Defining and applying 'triangulation' in the water sector*, which sets out a suggested triangulation framework for PR19.

ICF (2017) identified six different types of triangulation, as shown in the figure below, (extracted from ICF (2017), p.8).

[1] Ofwat (2016), p.14-16.

Types of triangulation

This study identified several types of triangulation.

- Methodological triangulation – combining two or more methods to gather multiple datasets relating to the same subject matter.
- Temporal/time triangulation – collecting longitudinal data (over time) in an attempt to identify external influences on what is being measured.
- Data / source triangulation – collecting data using the same method, but from alternative sources.
- Geographical triangulation – collecting evidence in different geographical locations to compare evidence across different groups.
- Investigator triangulation – based on different observers / researchers gathering evidence to investigate the same research questions or objectives, possibly using the same methods.
- Theoretical triangulation – drawing on different theories in the analysis phase to identify alternative interpretations of evidence.

Sources: ICF analysis and adaptation from Cohen, L et. al (2000)[7] and Farquhar and Michels (2016)[8]

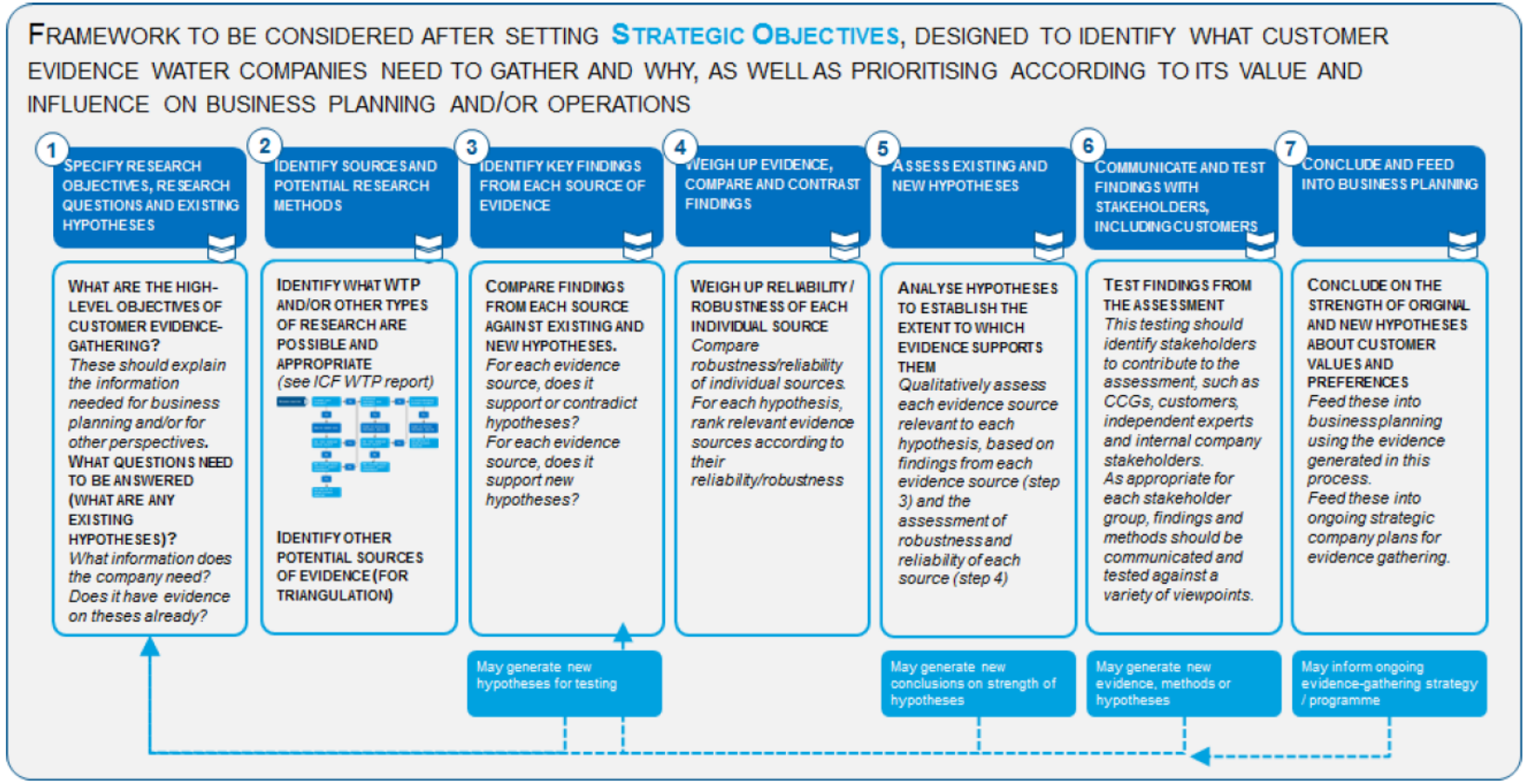
ICF (2017) further set out a recommended framework for triangulation based on the following four principles for effective triangulation, which were themselves outcomes from an industry workshop.[2]

- **Strategic planning** – make a research plan in advance including being clear about the objectives and purpose of evidence gathering as a whole and for individual studies. This is intended to ensure that the relative strengths and weaknesses of evidence sources are recognised and built into evidence gathering.
- **Research expertise and understanding** – understand the range of research tools available, choose and apply the most appropriate tool for each specific purpose (and relate that to the objective);
- **Proportionality** – adapt the level of triangulation to the specific circumstances of the research, i.e. conduct more research for more important investment decisions and less where the decisions are less important; and
- **Transparency** – triangulation must not be a black box, and approaches must be explained and justified to relevant stakeholders (such as CCGs) throughout the research cycle and it must generate an appropriate audit trail for the evidence gathered and the way it is used.

The framework itself is reproduced from ICF (2017) in the figure overleaf. The framework covers the span of activities from strategic planning of research priorities through to concluding and feeding into business planning. As such, the framework is more broad ranging than the present study, the focus of which is on tasks 2, 3 and 4.

[2] ICF (2017), p.19.

Figure 1: ICF (2017) Recommended Framework for Triangulation



Source: ICF (2017), p.24.

2.3 Our Approach

Our approach to triangulation for the present study is influenced by the ICF (2017) guidelines but is further developed to deliver against the specific objectives for the study. In particular, we aim to derive quantitative measures of WRMP priorities and WTP that can be used formally within business plans. This includes, in the case of WTP evidence, the objective of obtaining measures that can be used directly within CBA and in the calculation of ODI rates.

ICF (2017) recognises the potential need for this type of information: in further guidance with respect to step 7 of the framework, the report notes the following:

> *The following interactions with business planning should be considered:*
> - *the need for customer evidence-gathering to consider the specific information requirements of business planning from the outset (e.g. which water/wastewater service attributes does the company need information on?). This should inform the hypotheses formed at the beginning of the process; and*
> - *the need for customer evidence gathering to generate some specific quantitative information to inform quantitative assumptions for cost-benefit analysis.* (ICF, 2017, p.32., emphasis added.)

However, the ICF (2017) framework provides no guidance on how to combine evidence from multiple sources in such a way as to arrive at a set of numbers based on the evidence as a whole. The focus is instead on the use of multiple sources of evidence to challenge pre-specified hypotheses and potentially generate new hypotheses. As such, our approach needed to build on the ICF (2017) framework to allow us to derive the required quantitative measures for business planning.

Our approach to triangulation for the present study not only utilises supplementary data sources to identify and validate the WRMP priorities as well as the range of customers' preferences and willingness-to-pay (WTP) values for service improvements but also uses that additional perspective to make a number of adjustments to the core WRMP priorities/WTP values to derive their "triangulated" values. These triangulated values are obtained as a *weighted average* of the comparable measures derived from the various supplementary data sources. Each of these data sources have certain strengths and weaknesses so that the comparable measures or estimates derived from these sources are subject to errors. However, since the errors in the different estimates are independent, a weighted average of these estimates is expected to lead to a lower overall error. Since it is difficult to determine the sizes of these errors, we use our reasoning and judgement to evaluate the evidence across all the data sources and conduct sensitivity tests with respect to the key areas where judgement has been applied. Therefore, we believe that the triangulated values derived using our approach yields better estimates of the true priorities/WTP values that can be utilised to reflect customers' preferences within SSC's Multi Criteria Analysis investment tool and used within SSC's CBA approach as part of the process of setting PC levels, and for setting ODI rates.

A key innovative feature of our approach is that we focus on the extent to which non-WTP data, e.g. on contacts, satisfaction and priorities, can provide information on WTP.

Our approach in full consists of the following six steps:

- **SCREEN** data sources to identify those with potentially comparable measures – including SSC, other water company and other cross sector reports

- **MAP** non-core evidence to core measures where possible to enable comparison

- **ASSESS** specific strengths and weaknesses of the resulting measures based on:
    - Theoretical validity (e.g. definition, context, assumptions etc.)
    - Statistical validity (e.g. sampling biases, statistical techniques)

- **RATE** measures as Red/Amber/Green (RAG) depending on how well they perform with respect to the theoretical and validity measures

- **TRIANGULATE** i.e. conclude on a judicious range of values to take forward based on reasoning and judgement.

- **SENSITIVITY TEST** results based on amending the weights to conform with alternative reasonable perspectives.

The main criteria that we use to **screen** data sources to determine their suitability for triangulation is ensure that each data source contains relevant information that can provide us with a measure of priority for at least two service measures. If a data source provides a relative preference between at least two of the core measures for triangulation then it can potentially be used to provide further insight.

To **map**, we convert the evidence from each data source into a form that is comparable to the core WRMP/WTP measures. This step is necessarily source-specific and requires assumptions in some cases to enable the comparison. Further details of the approach taken in each case are given in the relevant part of this report.

To **assess** the measures, we consider two broad classes of issues: (i) theoretical and (ii) statistical. The following table sets out the key questions relevant to each class.

Table 1: Theoretical and statistical validity appraisal issues

Theoretical validity issues	Statistical validity issues
Are definitions of candidate and target measure the same?	How large is the sample?
Are contextual conditions the same between candidate and target measures?	How representative is the sample? • Are the populations the same and, if not, how different are they? • How old is the data? • Are there any biases due to the timing of the research?
If no to either of these, what issues do the differences give rise to?	How wide are the confidence intervals?
	Have the results been derived using best practice techniques?

To **rate**, we assign an overall red/amber/green (RAG) rating for each source for both WRMP and WTP measures, against the above appraisal criteria. These ratings are based on our judgment in light of the balance of evidence across all data sources being evaluated. The ratings are thus intended to be meaningful in a comparative sense rather than an absolute sense.

To **triangulate**, we combine measures across all data sources using weights associated with the RAG ratings. Table 2 below presents our preferred set of weights corresponding to each of the RAG ratings. These weights are based on our judgement as to the relative validity of measures in the different categories.

Table 2: RAG ratings and weights

Overall RAG rating	Weight
Green	100%
Green / Amber	50%
Amber	25%
Amber / Red	10%
Red	0%

Finally, **sensitivity tests** are conducted with respect to the key areas where judgement has been applied. This includes testing the sensitivity to the choice of weights in Table 2 above.

The following sections present our application of this methodology to the generation of a triangulated WRMP priorities index, amongst the options under consideration for SSC's WRMP, and a triangulated set of WTP numbers for the core service measures relevant to SSC's business plan. In each case, the full range of values is reported in addition to the central triangulated values, and sensitivity analysis results. By so doing, this report should be seen as providing transparency to stakeholders over how the evidence from different sources has been combined, and how sensitive the combined results are to the key assumptions.

3 WRMP TRIANGULATION

In this section, we apply our proposed triangulation methodology to derive the triangulated results with respect to WRMP Priorities.

In contrast to the WTP objective, a target measure for WRMP prioritisation is not well defined. Several alternatives could potentially be used to measure 'customer priorities', depending on what measure of priorities is initially obtained from customers, and how that data is aggregated over customers. For example, one could consider the proportion of times each supply-demand measure is recorded as the first choice amongst all the supply-demand measures over a sample of customers; or, if customers rated each supply-demand measure on a preference scale, then one could consider the average scores for each supply-demand measure as an index of customers' priorities.

In general, there are many such potential measures of customers' priorities. Our approach to triangulation is to consider each one equally rather than focus on one particular definition alone. Thus, in Section 3.1, we screen for any potential measure of customer priorities amongst supply-demand measures from the set of candidate studies available; in Section 3.2 we use the raw data from the screened-in studies to derive indices corresponding to each measure; in Section 3.3, we assess and rate each source; in Section 3.4 we present our main results; and in Section 3.5 we present results from a suite of sensitivity tests.

3.1 Screen

With respect to WRMP priorities, we find several studies conducted by SSC containing evidence suitable for triangulation. After reviewing all data sources, we conclude that the following pass the screening test of including a potentially comparable measure:

- WRMP core research workshops
- WRMP core research online survey
- Customer priorities research
- Core WTP research

The following two tables present the sources considered and the reasons (in brief) for screening them in/out for purposes of WRMP triangulation.

Table 3: WRMP Triangulation: Data Sources Screened In

Source	Reasons for screening in
WRMP Workshops	All 8 WRMP options; scored via Overall score (1 to 5); Votes allocated; and Least preferred option vote.
WRMP Online	7/8 WRMP options (not Increased metering); scored via Mean score (-2 to +2); Proportion for; Most preferred and Least preferred.
Customer Priorities	3 service measures relevant to WRMP options: Leakage, Smart meters and Educating customers. 1st, 2nd and 3rd most important areas for SSW/CAM to be concentrating on in the next 5-10 years.
WTP Core: DCE	Leakage, Increased metering and Installing smart meters; Leakage and Increased metering scored via Wave 2 DCE for 'S0 to S2' improvement and Installing smart meters scored via Wave 1 DCE for 'S0 to S2' improvement.
WTP Core: MaxDiff	Leakage, Increased metering and Installing smart meters; Leakage and Increased metering scored via Wave 2 DCE for 'S0 to S2' improvement and Installing smart meters scored via Wave 1 DCE for 'S0 to S2' improvement.

Table 4: WRMP Triangulation: Data Sources Screened Out

Source	Reasons for screening out
Foundation priorities	Customers priorities for service delivery both at present and over the longer term (prompted and spontaneous). Purely qualitative and discursive hence no useable measure.
Metering study	Focussed on customers' reasons for not switching to a meter, hence not comparable.
Customer Service tracker	Satisfaction measures relating to discoloured water, taste and smell, low water pressure and interruptions to water supply. No comparable measures.
Bright and SIM surveys	Measures customers' satisfaction of the key interaction points i.e. billing and operations. No comparable measures.
CCWater studies	Qualitative research about attitudes to water use/saving, behaviours and messaging. No comparable measures.
SSC contacts/complaints	Focussed on customer contacts data pertaining to billing and operational. No comparable measures.
SSC Web Surveys	Satisfaction measures relating several service measures. No comparable measures.
PC slider research	Only one common attribute i.e. leakage so cannot be used to obtain a relative preference ordering
External WTP evidence	PR14 and PR19 Unit WTP values for different service measures. No comparable measures.

3.2 Map

WRMP Core Research (Workshops and Online Survey)

Based on the WRMP online research results, we can define three measures of customer priority. The first two scales (Scale 1 and Scale 2) are based on responses to the following question in the WRMP online survey:

Q16.To what extent are you for or against Cambridge Water / South Staffs Water doing this? [2=Strongly for; -2=Strongly against]

1. **Scale 1 online = Proportion in favour (>0 score)**
2. **Scale 2 online = Mean score**

The third scale (Scale 3) is based on responses to the following questions in the WRMP online survey i.e.

Q17. Now that you have looked at all the options, which of the options do you like the best? and Q19. And which of the options do you like the least?

1. **Scale 3 online = 'Most' – 'Least'**

Each of the aforementioned scales are potentially valid. Scale 1 is akin to voting; Scale 2 weights votes by strength of preference, which is more akin to CBA; Scale 3 weights even more strongly by strength of preference.

Based on the WRMP workshop research results, we can define 2 core research scales i.e.

1. **Scale 1 workshop= Overall score**
2. **Scale 2 workshop= Votes Allocated-Least preferred**

Table 5 presents the data underlying these scales. In the following paragraphs we present the preference ordering of the various options based on the aforementioned research scales and examine if there is any divergence in rankings across these measures and/or surveys.

SSW:

Based on the workshop results, we find the following:

- **Scale 1 workshop**: leakage and metering are the highest ranked options and abstracting groundwater is the lowest ranked option
- **Scale 2 workshop**: increased metering is the highest ranked option and abstracting groundwater is the lowest preferred option

Based on the online survey results, we find the following:

- **Scale 1 online:** reducing leakage and customer education are the highest ranked options and trading with another water company is the lowest ranked option.
- **Scale 2 online:** reducing leakage and customer education are the highest ranked options and abstracting groundwater is the lowest ranked option based on the mean score
- **Scale 3 online:** reducing leakage and smart metering are the highest ranked options and abstracting groundwater is the lowest ranked option based on the "best minus worst scores".

Overall, therefore, the findings from the workshops seem to be largely in line with the online survey results, with metering (particularly smart metering) and reducing leakage being the most preferred options and abstracting groundwater being the least preferred option.

CAM:

Based on the workshop results, we find the following:

- **Scale 1 workshop**: reducing leakage, metering and building new reservoirs are the highest ranked options while abstracting groundwater is the lowest ranked option.
- **Scale 2 workshop**: smart metering and building new reservoir are the highest ranked options and abstracting groundwater is the lowest ranked option.

Table 5: WRMP workshop and survey results

South Staffs Water (SSW)	Workshop summary results				
Option	Overall score	Votes allocated		Least preferred	Votes-Least
Leakage 1*	1	21		0	21
Increased metering**	1	43		1	42
Smart metering	1	34		1	33
Trading with another water company	2	31		3	28
Reducing customer water usage	2	17		1	16
Increasing Blithfield	3.5	9		3	6
Taking water from River Trent	3.5	16		14	2
Abstracting groundwater	5	7		10	-3
South Staffs Water (SSW)	**Online survey summary results**				
Option	Mean score	Proportion for	Most preferred	Least preferred	Most-Least
Reducing leakage	0.59	56%	29%	7%	22%
Customer education	0.46	51%	10%	12%	-2%
Smart metering	0.22	43%	27%	19%	8%
Increasing Blithfield	0.18	39%	10%	6%	4%
Trading with another water company	0.08	30%	5%	15%	-10%
Taking water from River Trent	0.01	34%	13%	16%	-3%
Abstracting groundwater	-0.03	35%	7%	25%	-18%
Cambridge Water (CAM)	**Workshop summary results**				
Option	Overall score	Votes allocated		Least preferred	Votes-Least
Leakage 1*	1	4		0	4
Increased metering**	1	2		4	-2
Smart metering	1	42		3	39
New surface water/combined reservoir	1	34		0	34
Reducing customer water usage	2	13		1	12
Trading water	2.75	9		1.5	7.5
Abstracting groundwater	5	2		15	-13
Cambridge Water (CAM)	**Online survey summary results**				
Option	Mean score	Proportion for	Most preferred	Least preferred	Most-Least
Reducing leakage	0.48	54%	29%	5%	24%
Smart metering	0.34	51%	27%	20%	7%
Building a new reservoir	0.34	52%	19%	16%	3%
Customer education	0.28	48%	11%	17%	-6%
Trading with another water company	-0.02	29%	7%	16%	-9%
Abstracting groundwater	-0.30	26%	8%	25%	-17%

Sources: WRMP and Long-Term Resilience Customer Engagement Insight Full Report (Oct 2017). Note: SSW: *Could only choose Leakage 2 if had chosen Leakage 1 **Could only choose Smart metering if had chosen Increased metering; CAM: *Could only choose Leakage 1 OR Leakage 2 **Could only choose Increased metering OR Smart metering. *Workshop results*: Overall score = a qualitative measure based on all feedback (1 = very positive, 2 = positive, 3 = neutral / polarising, 4 = negative, 5 = very negative); Votes allocated = the number of overall votes an option received (participants had six votes each to spread out as they saw fit); Least preferred = the number of people who chose this as the option they liked least (participants could vote for one option only); *Online survey results*: [Participants were asked to what extent they were for or against each option from +2 = 'strongly for'; -2 = 'strongly against' and 0= neutral midpoint]; Mean score = an average figure considering all responses to the above question, Proportion for = the proportion of people scoring the option 1 or 2 in the above question, Most preferred = the proportion of people choosing this as the option they liked best overall, Least preferred = the proportion of people choosing this as the option they liked least overall. Leakage 1: Reducing leakage above and beyond the current targets and Leakage 2: Significantly reducing leaks above and beyond current targets by using new approaches. We consider only Leakage 1 for our analysis. Note that the values for New surface water/combined reservoir in the CAM workshop results are average values of New surface water reservoir and New combined reservoir values. Similarly, the values for Trading water in the CAM workshop results are average values of Trading1 and Trading2 values.

Based on the online survey results, we find the following:

- **Scale 1 online**: reducing leakage, metering and building new reservoir are the highest ranked options.
- **Scale 2 online**: reducing leakage, metering and building new reservoir are the highest ranked options and abstracting groundwater is the lowest ranked option based on the mean score
- **Scale 3 online**: reducing leakage is the highest ranked option and abstracting groundwater is the lowest ranked option based on the "best minus worst scores".

Overall, therefore, the findings from the workshops seem to be largely in line with the online survey results, with reducing leakage, metering and building new reservoir being the most preferred options and abstracting groundwater being the least preferred option.

All these research scales are potentially valid measures of customer support and there is no absolute reason in principle to prefer one measure over the other. Each can be considered as a lens to gauge customer preferences. For ease of comparison with other triangulation data sources, we rescale each of the above mentioned WRMP research scales as follows:

- We rescale each of the WRMP core research scales such that each of their sum equals 100 (see Table 6 and Table 7)
- We use the average of the 3 WRMP online scales to define a combined WRMP online scale and use the average of the 2 WRMP workshop scales to define a combined WRMP workshop scale (see Table 78) (This step was taken so as to avoid giving weight to a study in proportion to the number of scales derived from it.)

Table 6: SSW WRMP workshop and online rescaled results

SSW WRMP option	WRMP workshop		WRMP online		
	Overall score	Votes For-Least	Mean score	Proportion for	Most-Least
Reducing leakage	17.2	13.2	16.7	19.4	20.5
Increased metering (not smart meters)	17.2	18.6			
Installing smart meters	17.2	16.3	14.3	14.9	16.5
Reducing customer water usage/More education campaigns	13.8	12.0	15.9	17.7	13.7
Increasing the amount of water in the Blithfield reservoir	8.6	9.4	14.1	13.5	15.4
Building a new water reservoir					
Taking water from the River Trent	8.6	8.4	13.0	11.8	13.4
Taking more groundwater	3.4	7.1	12.7	12.2	9.1
Trading with another water company	13.8	15.0	13.4	10.4	11.4
	100	**100**	**100**	**100**	**100**

Table 7: CAM WRMP workshop and online rescaled results

WRMP option	WRMP workshop		WRMP online		
	Overall score	Votes For-Least	Mean score	Proportion for	Most-Least
Reducing leakage	17.7	11.5	18.9	20.8	24.5
Increased metering (not smart meters)	17.7	9.2			
Installing smart meters	17.7	24.4	17.8	19.6	18.9
Reducing customer water usage/More education campaigns	14.2	14.4	17.4	18.5	14.6
Building a new water reservoir	17.7	22.6	17.8	20.0	17.5
Taking more groundwater	3.5	5.2	13.0	10.0	10.9
Trading with another water company	11.5	12.8	15.1	11.2	13.6
	100	**100**	**100**	**100**	**100**

Table 8: WRMP online and workshop combined scales

WRMP option	SSW WRMP online combined	SSW WRMP workshops combined	CAM WRMP online combined	CAM WRMP workshops combined
Reducing leakage	15.2	18.9	14.6	21.4
Increased metering (not smart meters)	17.9		13.5	
Installing smart meters	16.8	15.3	21.0	18.8
Reducing customer water usage/More education campaigns	12.9	15.7	14.3	16.8
Increasing the amount of water in the Blithfield reservoir	9.0	14.3		
Building a new water reservoir			20.1	18.5
Taking water from the River Trent	8.5	12.7		
Taking more groundwater	5.3	11.3	4.4	11.3
Trading with another water company	14.4	11.7	12.1	13.3
	100	**100**	**100**	**100**

The combined scales presented in the above table are used for triangulation against the different supplementary data sources as discussed in the following section.

Customer Priorities

The Customer Priorities online survey asked customers, uninformed, to choose their top 3 priorities from 3 areas: water quality & water supply, customer service & bills and planning for the future and then asked customers to choose their top 3 priorities from all the options together. One of the questions asked in the survey that contained information on some service measures common to the WRMP research was the following:

Q16. Which do you think are the most important areas that SSW/CW should be concentrating on in the next 5-10 years. Please rank your top 3 areas.

The service measures in the Customer priorities research that are common to the WRMP options are presented in the following table.

Table 9: Mapping of Customer priorities options to WRMP options

Customer Priorities	WRMP option name
Reducing the amount of water that leaks from our pipes	Reducing leakage
Educating customers on how to use water more responsibly (and save money)	Reducing customer water usage/More education campaigns
Investing in new technology and ways of working that help customers better control their water usage: such as smart meters & apps	Installing smart meters

There were two issues with the Customer priorities research data:

- The demographic breakdown of respondents was different to the UK population and to the SSC Customer Services tracker data.
- The research data did not include a robust preference scale that could be used to incorporate responses on all the 3 most important areas.

To address the first issue, we reweighted the responses to the customer priorities survey based on the age and gender breakdown of all bill payers reported in the SSC Customer Services Tracker data. To address the second issue, we used an econometric model (rank ordered logit) to derive a priorities scale based on all the 3 choices. The ranked ordered logit model which uses

ranked preference data, differs from the usual logit model of qualitative choice which considers only the most preferred alternative. Therefore, the ranked ordered logit model uses richer information about the comparison of alternatives i.e. how decision-makers rank the alternatives rather than focussing on only the alternative that they like best.

The priority ordering based on the ranked ordered logit model is presented in the table below.

Table 10: Customer Priorities scales

Options	SSW Priorities scale	CAM Priorities scale
Providing a high-quality water supply that is always safe to drink	26%	24%
Making sure water always comes out of the tap - ie no supply interruptions	6%	8%
Offering fair and accurate billing	6%	8%
Reducing the amount of water that leaks from our pipes	6%	7%
Having plans in place to ensure we have enough water for a growing population	6%	6%
Ensuring the water always tastes and smells good	6%	4%
Making sure we fix all leaks as quickly as possible	6%	7%
Making sure we balance offering affordable bills against the need to invest in our network for the long-term	5%	3%
Installing systems that capture rainwater and non-toxic used water for use in flushing toilets and the garden	4%	5%
Making sure the water is never discoloured / cloudy / has particles in it	4%	2%
Offering great customer service	3%	3%
Investing in new technology and ways of working that help customers better control their water usage: such as smart meters & apps	3%	2%
Managing the impact of climate change – such as increased heavy rainfall leading to flooding, burst pipes due to extreme temperatures	3%	5%
Protecting and improving the natural environment for wildlife and plants	3%	3%
Assisting more customers who need extra support the most: financial and/or special services	3%	1%
Educating customers on how to use water more responsibly (and save money)	2%	2%
Reducing our carbon footprint (i.e. using less electricity)	2%	2%
Making sure the water does not cause appliances, taps, tiles, etc to scale - which can reduce their usable life	2%	2%
Removing all lead pipes from the water network (a harmless additive is added to the water to ensure lead pipes pose no risk to health)	2%	2%
Keeping customers regularly updated about our plans and how changes might impact on them	1%	1%
Ensuring we manage our company finances carefully	1%	1%
Ensuring your water pressure is not too high or low (e.g. a slow dripping tap)	1%	1%
Ensuring we minimise traffic disruption caused by repairing our network of pipes	1%	0%

To facilitate comparison with other measures, the common service measures in the Customer priorities research were transformed to sum to 100 as follows:

Table 11: Mapping of Customer priorities to WRMP Priorities

WRMP option	SSW Priorities index		CAM Priorities index	
	Raw	Scaled	Raw	Scaled
Reducing leakage	5.6%	53.4	7.4%	61.9
Installing smart meters	3.2%	30.8	2.4%	20.0
Reducing customer water usage/More education campaigns	1.6%	15.8	2.2%	18.1
	10.4%	**100**	**12.0%**	**100.0**

WTP Core Research (DCE and MaxDiff)

The SSC core WTP research consisted of two large quantitative surveys (Wave 1 and Wave 2) in order to study customers' willingness and ability to pay for different service and investment

levels for water services. The Wave 1 survey included a discrete choice experiment (DCE) and a MaxDiff choice exercise to assess customers' willingness to pay for significant service improvements across 17 service measures. The Wave 2 survey was a 'follow-up' customer valuation study carried out to further explore results for specific attributes and refine the scope of attributes included.

The Wave 2 survey included a discrete choice experiment (DCE) to assess customers' willingness to pay for significant service improvements across 17 service measures. In Wave 2, the levels of improvements displayed to respondents were amended, and new attributes relating to retail/community included (i.e. investing in community projects, educating future generations and supporting customers facing difficult situations). In addition, around one third of respondents completed the SP exercise in the context of a lower bill (see Section 4 for a more detailed description of the WTP surveys).

For the purposes of this study, we considered the 16 service measures presented in the table below.

Table 12: WTP Core service measures

Attribute group	WTP Attributes
Water quality	Taste and smell of water
	Discolouration of your tap water
	Lead pipes
	Water hardness
	Water not safe to drink
Reliability of supply	Unexpected temporary loss of water supply
	Temporary use ban
	Drought restrictions
	Low water pressure
	Flooding from a burst pipe
	Traffic disruption
Environment	Leakage
	Water metering
	Giving customers control of their water usage
	Protecting wildlife habitats
	Managing impacts on rivers & streams

The service measures in the WRMP research that were common to the WTP options are presented in the following table.

Table 13: Mapping of WTP core options to WRMP options

WTP core options	WRMP options
Leakage	Reducing leakage
Water metering	Increased metering (not smart meters)
Giving customers control of their water usage	Installing smart meters

The final output from both the Wave 1 and Wave 2 WTP core DCE included the following:

- Attribute levels for the status quo situation and two possible levels of improvement from the current level (S0): 'some improvement' (S1) and 'significant improvement' (S2).
- WTP values for each of these levels, together with the confidence intervals around the average values
- Total pot values together with confidence intervals around the values
- Unit WTP values (for improvement from S0 to S2) together with confidence intervals around these values.

When participants in the Wave 1 survey were presented with alternative investment options in the WTP DCE, half of them saw the choices expressed in terms of the impact on the region as a whole (e.g. 'number of households affected') and half saw them in terms of the impact it would have on them personally (e.g. 'you will experience this once over the next 20 years'). However, participants in the Wave 2 survey saw the choices expressed in terms of the impact on the region as a whole (i.e. public) only. In order to be consistent across the two waves, the final output of both the Wave and Wave 2 WTP core DCE are calculated based on only the public WTP values.

As mentioned above, the service level improvements shown to respondents in Wave 2 were different to those shown in Wave 1. In order to combine the Wave 2 and Wave 1 values in a meaningful manner, we took the Wave 2 (S2) service level to be the correct range for the combined case and used either the intermediate level or the best level from Wave 1 to be consistent with this assumption. For example, for leakage and water metering, the unit values in Wave 1 were recalculated based on service level improvements from base to the Wave 1 intermediate level (S1). However, for smart metering, which was not included as an attribute in the Wave 2 WTP study, we calculated the unit values based on service level improvements from base to the Wave 1 best level (S2).

The WTP core MaxDiff choice exercise required customers to initially indicate their choices among different sets of potential service improvements, five at a time from a total of 17 different service measures (15 for NHH customers). This choice exercise required the customers to choose each time the option of highest priority and the option of lowest priority. The customers were presented with three levels of service (current service level and two levels of improvement) for each of these service measures. The responses obtained from this choice exercise were used to estimate an econometric model of the average impact of each service measure on these choices[3]. The final output from the WTP core MaxDiff choice exercise was an index that summarised the relative priority given to each service improvement, with the sum of the index equal to 100.

In order to convert WTP core research output to a comparable measure for the WRMP options we took the following steps:

- We took mean WTP values from the relevant DCE research for the common service measures i.e. Leakage, Water metering and Smart metering, for 'S0 to S2' improvement and divided by the bill impact per customer for moving from S0 to S2. This translated WTP into a benefit-cost ratio which is a standard economic measure of customer priority[4]. Note that for leakage and water metering we used the mean WTP values from the Wave 2 research while for smart metering we used the mean WTP values from the Wave 1 research.
- We then rescaled the resulting values so that their sum equalled 100. This derived priority index was therefore based on the assumption that the WRMP options were equivalent to the S0 to S2 improvement for the corresponding service measure.
- Similarly, we used the MaxDiff mean values for 'S0 to S2' improvements for the common service measures, Leakage, Metering and Smart metering, and rescaled the resulting values so that their sum equalled 100. (We did not divide through by cost in this case

[3] This model was estimated and reported in "Willingness-to-pay research to support PR19": Technical Report prepared for SSW by Impact Utilities (January 2018)

[4] The information on the bill impact per customer for moving from S0 to S2 is provided by the SSW. For metering the bill impact per customer is estimated to be £5.75 for SSW and £0.60 for CAM customers. For leakage the corresponding values are £20.37 and £12.41 respectively.

because the exercise did not explicitly control for costs in the survey, so participants could potentially have considered costs when answering these questions.)

Table 14: Mapping WTP core values to WRMP Priorities

WRMP option name	DCE		MaxDiff	
	WTP (S0-S2) (£/hh/yr	Scaled priority index	Raw priority index	Scaled priority index
SSW				
Reducing leakage	£1.7	8.7	5.0	71.8
Increased metering (not smart meters)	£4.5	83.1	1.3	19.2
Installing smart meters	£0.4	8.2	0.6	8.9
Total	*£6.6*	*100*	*6.9*	*100*
CAM				
Reducing leakage	£3.1	2.8	4.8	70.8
Increased metering (not smart meters)	£2.4	43.6	1.2	18.0
Installing smart meters	£2.9	53.6	0.7	11.2
Total	*£8.4*	*100*	*6.7*	*100*

The next steps to triangulation involved weighting the derived scales with respect to theoretical and statistical measures of validity. This is discussed in the following section.

3.3 Assess and Rate

In this section we compare the strengths and weaknesses of the core WRMP research as well as the measures of comparison (based on two key measures of validity i.e. theoretical validity and statistical validity) and then assign each measure a RAG rating against the appraisal criteria.

Overall RAG ratings are assigned for each source and weights are then used based on these ratings to combine measures across sources. Table 15 below presents the set of weights corresponding to each of the RAG ratings. These weights are based on our judgement as to the relative validity of measures in the different categories. We will explore sensitivity testing using alternative set of weights post WRMP triangulation in Section 3.5.

Table 15: RAG ratings and weights

Overall RAG rating	Weight
Green	100%
Green / Amber	50%
Amber	25%
Amber / Red	10%
Red	0%

WRMP Workshops

Table 16 presents the key considerations in the assessment of the WRMP workshop measures and the associated RAG ratings

Table 16: WRMP Triangulation: Assessment and rating of WRMP Workshop measures

Validity measures	Key considerations	RAG rating
Theoretical validity	i. Workshop measures are based on a survey in which the demand management and supply side options included were far fewer than what the companies really faces. They are simplified hybrid options, taken from the real process the company is going	AMBER

	through as part of WRMP and PR19. ii. The criteria and the information shared about each of the demand management and supply side options are necessarily at a high level. Some key elements are not covered at all (e.g. timescale / phasing of delivery.) iii. Each option provided participants with a feel for the relative service measures of each option in terms of volume, cost, environmental impact and future proofing, using verbal and visual scales iv. Workshop measures are based on an informed dialogue process involving quiz, handouts and animations. This enabled the participants to make informed choices of the various priorities v. The 2 priority scales derived based on WRMP core workshop research i.e. Overall score and Votes For-Least are all theoretically valid	AMBER GREEN GREEN GREEN
Statistical validity	i. Workshop measures are based on a representative sample. ii. Results based on recent survey (2017) iii. Workshop measures based on very small sample sizes: 31 (SSW) and 27 (CAM).	GREEN GREEN RED
Overall validity	Theoretically strong set of measures; lots of information provided and room for debate. However, sample size is small due to the qualitative nature of this phase of the project.	GREEN/AMBER

WRMP Online Survey

Table 17 presents the key considerations in the assessment of the WRMP online measures and the associated RAG ratings.

Table 17: WRMP Triangulation: Assessment and rating of WRMP Online measures

Validity measures	Key considerations	RAG rating
Theoretical validity	i. Online sample measures based on survey in which the demand management and supply side options included were far fewer than what the companies really faces. They were simplified hybrid options, taken from the real process the company is going through as part of WRMP and PR19. ii. The criteria and the information shared about each of the demand management and supply side options were necessarily at a high level. Some key elements were not covered at all (e.g. timescale / phasing of delivery.) iii. Each option had a short description and gave respondents a feel for its service measures in terms volume, cost and environmental impact, using verbal scales iv. Fewer options and fewer details about each option could be shared in the online survey than in the workshop hence online measures based on less informed choices. v. The 3 priority scales derived based on WRMP core online research i.e. Proportion for each of the options; Mean score of each of the options and (Most Preferred-Least preferred) scores for the options are all theoretically valid. Scale 1 is akin to voting; Scale 2 weights votes by strength of preference, which is more akin to CBA; Scale 3 weights even more strongly by strength of preference.	AMBER AMBER AMBER AMBER GREEN
Statistical validity	i. Online measures based on representative data (after weighting) of each of the two regions ii. Online measures based on mid-size representative sample bases: 300 (SSW) and 200 (CAM). iii. Results based on recent survey (2017)	GREEN AMBER GREEN
Overall validity	Theoretically strong set of measures, although less information provided due to survey format; Mid-size representative (after weighting) sample.	GREEN/AMBER

Customer Priorities

Table 18 presents the key considerations in the assessment of the customer priorities measures and the associated RAG ratings.

Table 18: WRMP Triangulation: Assessment and rating of Customer Priorities

Validity measures	Key considerations	RAG rating
Theoretical validity	i. Definition of service measures/options in the WRMP study match with the definition of service measure/options being assessed. *Exception is:* *WRMP: Installing smart meters vs. Customer Priorities: Investing in new technology and ways of working that help customers better control their water usage: such as smart meters & apps* ii. To mirror earlier qualitative Foundation Research, customer priorities measures based on survey in which the participants were uninformed; they viewed the options presented to them with no context setting (e.g. how much each option might cost). There was also no comparative data provided (e.g. how SSC is performing relative to other water companies).	AMBER RED
Statistical validity	i. Survey respondents recruited via a pop-up link to the online survey on the SSW/CAM websites and hence not based on a random sample of the wider customer base. However, data made representative (after weighting) of each of the two regions ii. Results based on recent survey (2017/2018) iii. Mid-size representative sample: 291 SSW customers and 166 CAM customers completed the surveys iv. Customer priorities scale derived via rigorous statistical analysis of responses (ranked ordered logit model)	AMBER GREEN AMBER GREEN
Overall validity	Larger sample size but only 3 out of 23 areas relevant to WRMP prioritisation and not much detail given to inform choices	AMBER

WTP Core Research (DCE) & MaxDiff

Table 19 presents the key considerations in the assessment of the WTP core measures and the associated RAG ratings.

Table 19: WRMP Triangulation: Assessment and rating of WTP core data

Validity measures	Key considerations	RAG rating
Theoretical validity	i. Definition of service measures in the WRMP study match with the definition of service measures being assessed. ii. WTP surveys involved customers in the design of survey and service measures for inclusion in the main survey hence the core measures are based on more informed choices iii. Unlike the WTP core DCE, the MaxDiff measures are weaker on validity (no scope sensitivity, and no explicit controlling for bill impacts) iv. Only 3 service measures i.e. leakage, water metering and smart metering, out of a total of 17 service measures were relevant to WRMP options iv. Priority index derived on the basis of WTP core data assumes that the WRMP options are equivalent to the S0 to S2 improvement for the corresponding service measure v. Priority index based on dividing WTP by cost estimate, which is an economic rule for prioritisation and not how customers may themselves choose to prioritise.	GREEN GREEN AMBER AMBER AMBER AMBER
Statistical validity	i. Robust sample frame to ensure representation of all customer types (including hard to reach) ii. WTP measures based on large sample sizes. iii. Results based on recent survey (2017 and 2018)	GREEN GREEN GREEN
Overall validity	Only 3 areas relevant to WRMP prioritisation but more detail given to inform choices. Larger sample size.	AMBER

The next step to triangulation involved applying the relevant weights to each of the sources (based on the RAG ratings discussed above) and combining them to derive a robust WRMP priorities weighting scale. This step is discussed in the next section.

3.4 Triangulate

The final steps to triangulation consist of applying weights to each of the data sources based on their overall RAG rating and combining the measures to derive a robust WRMP priorities scale. The weights to be applied to the core WRMP research as well as each of the data sources used for WRMP triangulation has been discussed in the previous section. The various measures are combined as follows:

- The sum of the priority indices derived from each source is reweighted to account for the fact that not all the data sources include sufficient information to derive a priority ordering for all the WRMP options.
- The priority indices from each of the sources are then rescaled with respect to the reweighted sums obtained in the above step.
- Finally, a Combined Priority Index is obtained for each of the WRMP options by taking a weighted average of the priority indices derived from each of the data sources and then rescaling them to ensure that they sum to 100. Further, the range for the priority index for each of the WRMP options is defined as the difference between their minimum and maximum values.

Figure 2 and Figure 3 present the final WRMP triangulated values and their associated range for SSW and CAM respectively. We find that `Increased water metering' is the highest priority for SSW while 'Building a new water reservoir' is the highest priority for CAM. However, 'Taking more groundwater' is the least desired option for both SSW and CAM.

Figure 2: SSW WRMP Triangulated Values and Range

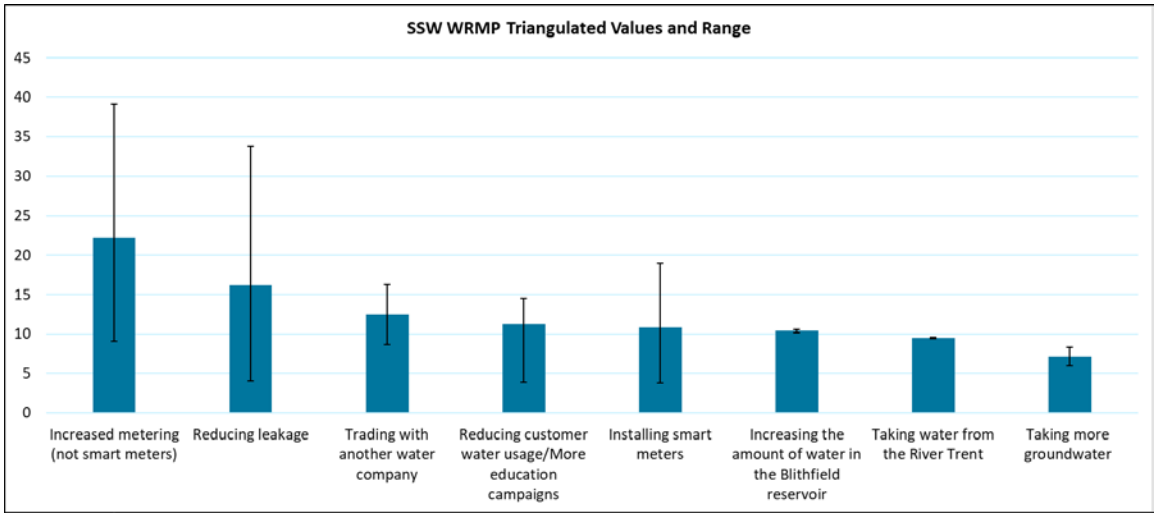


Figure 3: CAM WRMP Triangulated Values and Range

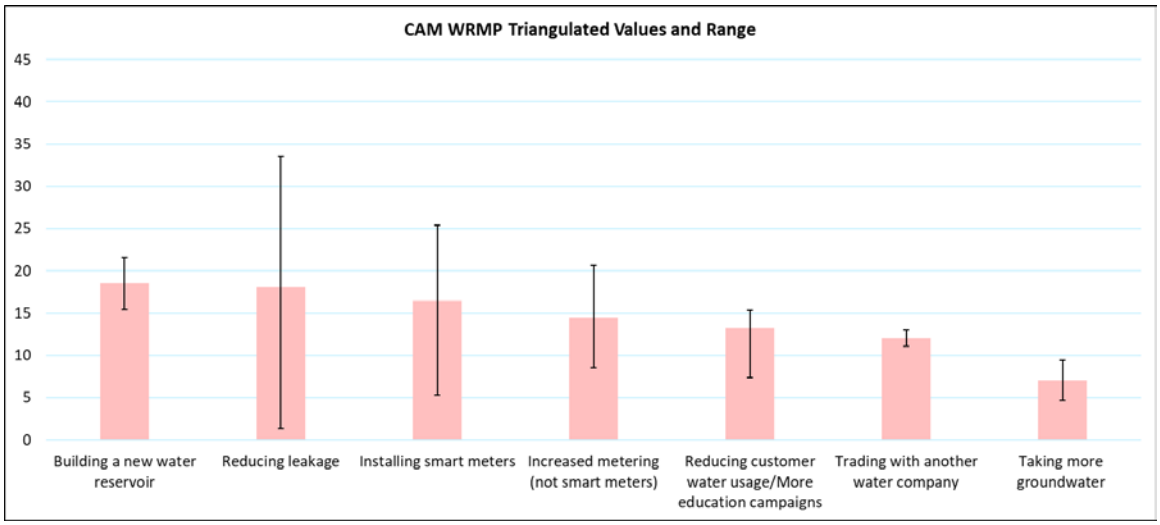
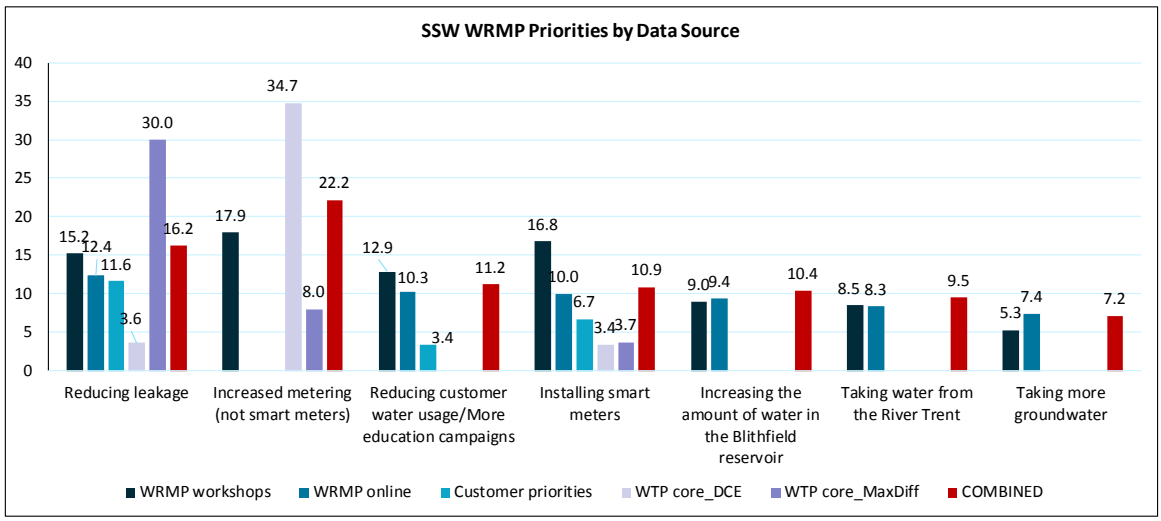


Figure 4 and Figure 5 present the final WRMP triangulated values by data source for SSW and CAM respectively. Overall, we find that the WRMP research (workshop and online) found lower values for Leakage in comparison to the Combined value for both South Staffs (SSW) and Cambridge water (CAM). For metering, we find that WRMP workshop found lower values for SSW and CAM in comparison to the Combined value. For smart metering, WRMP workshop found higher values for SSW and CAM in comparison to the Combined values.

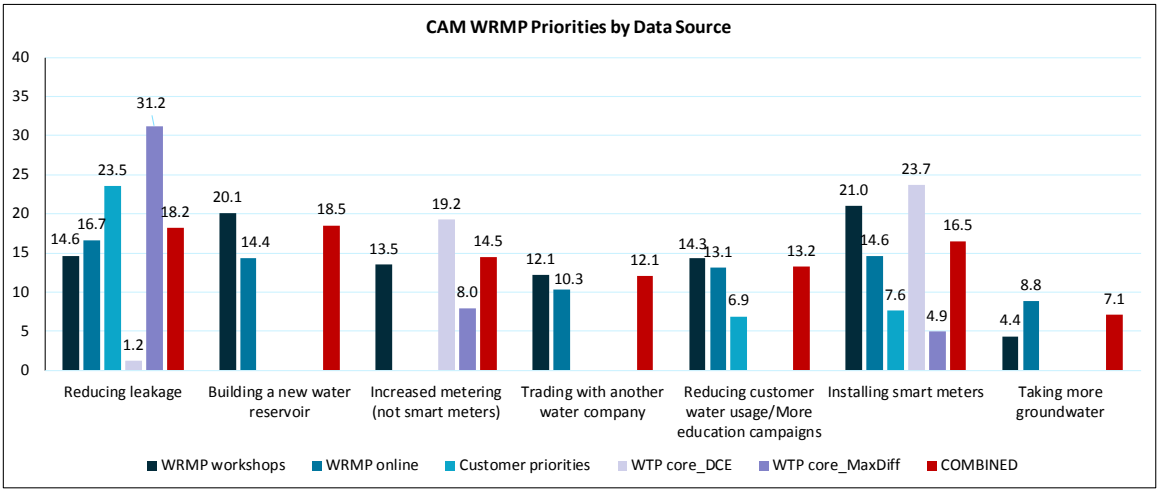
The triangulated priority indices (red bar labelled 'COMBINED' in the figures below) reflect customers' preferences for each of the WRMP options and will be used within MCA as part of the process of setting SSC investment levels for their demand and supply side options.

Figure 4: SSW WRMP Priorities by Data Source



Note: The triangulated priority indices (red bar labelled 'COMBINED') will be used within the SSC MCA.

Figure 5: CAM WRMP Priorities by Data Source



Note: The triangulated priority indices (red bar labelled 'COMBINED') will be used within the SSC MCA.

3.5 Sensitivity Test

We present the following cases below to test the sensitivity of our results with respect to the weights for the RAG ratings as well as the overall RAG ratings for the different sources.

CASE 1: Alternative weights

The first case for sensitivity testing of the WRMP priorities is based on using alternative weights with respect to the RAG ratings. Table 20 below shows the original weights vs. new weights assigned to the RAG ratings.

Table 20: WRMP Sensitivity Analysis: Alternative sets of weights

Overall RAG rating	Original weight applied	New weight applied
Green	100%	100%
Green / Amber	50%	75%
Amber	25%	50%
Amber / Red	10%	25%
Red	0%	0%

Figure 6 and Figure 7 present the final WRMP triangulated values and their associated range for SSW and CAM respectively based on the new weights assigned to the RAG ratings. We find that `Increased water metering' is still the highest priority for SSW and 'Building a new water reservoir' is still the highest priority for CAM. Similarly, 'Taking more groundwater' is still the least desired option for both SSW and CAM.

Figure 6: SSW WRMP Triangulated Values and Range: Alternative Weights

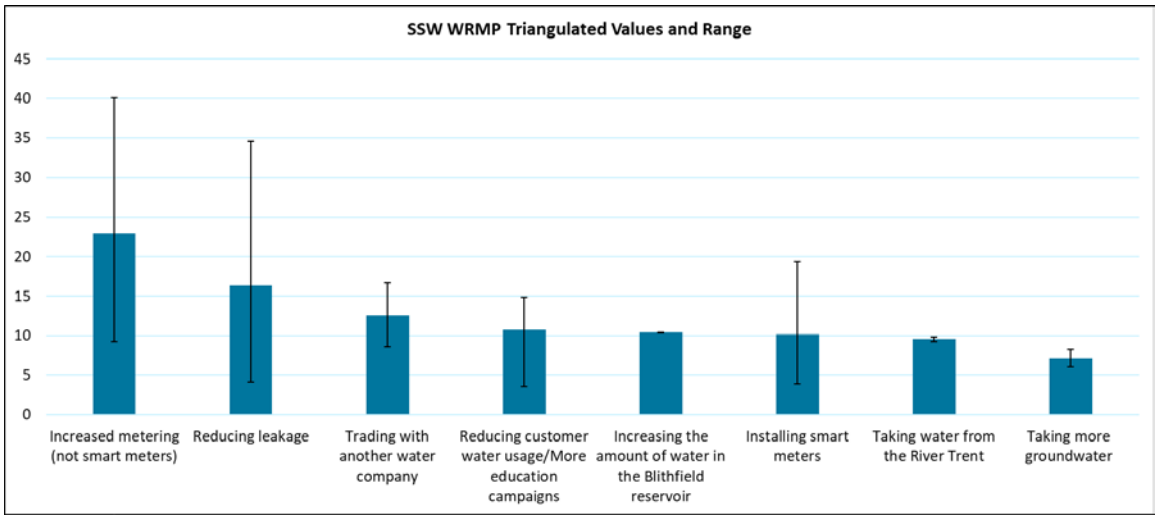


Figure 7: CAM WRMP Triangulated Values and Range: Alternative Weights

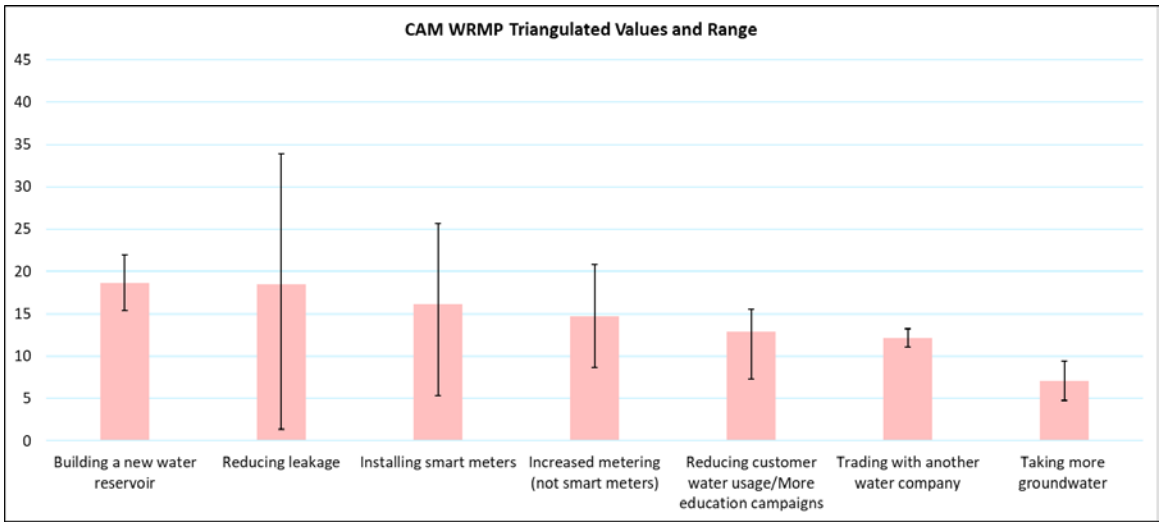


Figure 8 and Figure 9 present the final WRMP triangulated values by data source for SSW and CAM respectively based on the new weights assigned to the RAG ratings. Overall, we find similar results as presented earlier in Figure 4 and Figure 5.

Figure 8: SSW WRMP Priorities by Data Source: Alternative Weights

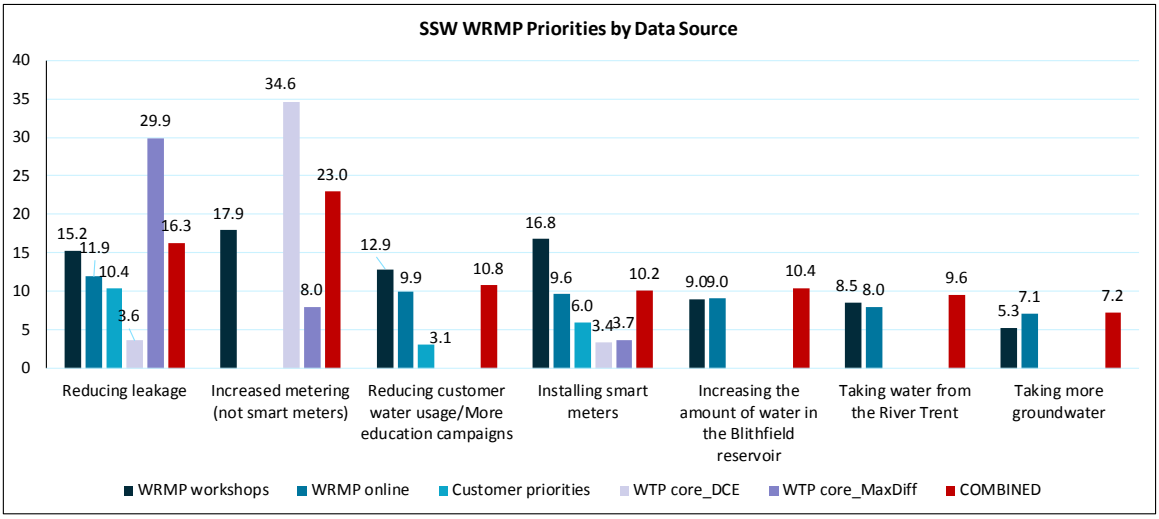
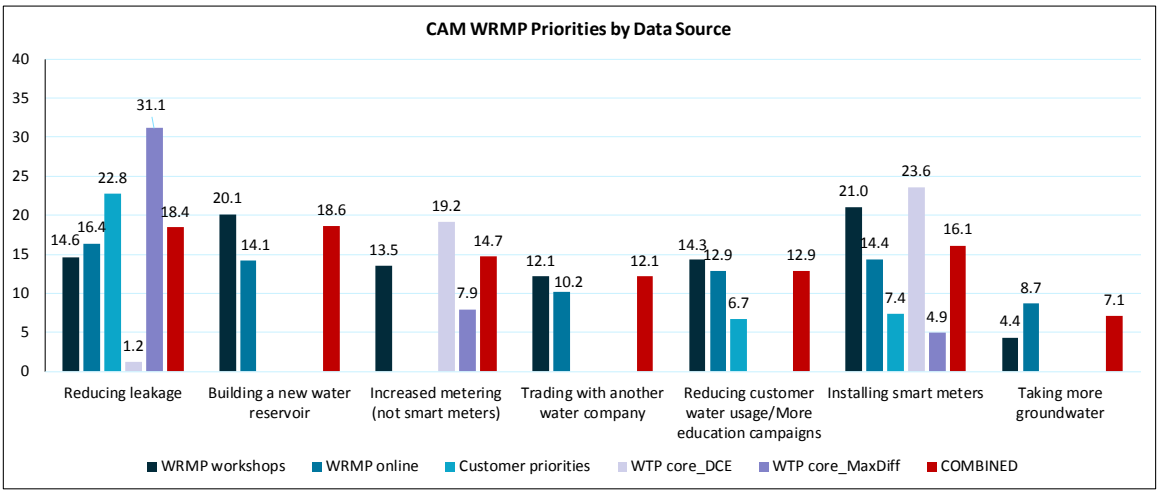


Figure 9: CAM WRMP Priorities by Data Source: Alternative Weights



CASE 2: Alternative RAG Ratings for Qualitative Research

The second case for the sensitivity testing of the WRMP priorities is based on down-weighting vs. up-weighting of the WRMP (qualitative) workshops data source. Note that we apply the same weights to the RAG ratings in this case as was presented in Table 15.

As discussed in Table 16, WRMP workshop results are based on small sample sizes. If we were to assign more importance to statistical validity, then it seems reasonable to down-weight the workshop results. Table 21 (second column) presents the RAG ratings and Figure 10 and Figure 11 present the triangulated values and range for SSW and CAM that result from such down-weighting of the WRMP workshop results.

Table 21: WRMP Sensitivity Analysis: Alternative RAG ratings for WRMP workshops

Data source	Original RAG rating	RAG rating (down weighting WRMP workshop)	RAG rating (up weighting WRMP workshop)
WRMP Workshop	Green / Amber	Amber	Green
WRMP Online	Green / Amber	Green / Amber	Green / Amber
Customer Priorities	Amber	Amber	Amber
WTP core DCE	Amber	Amber	Amber
WTP core MaxDiff	Amber	Amber	Amber

Figure 10: SSW WRMP Triangulated Values and Range: Down-weighting WRMP workshops

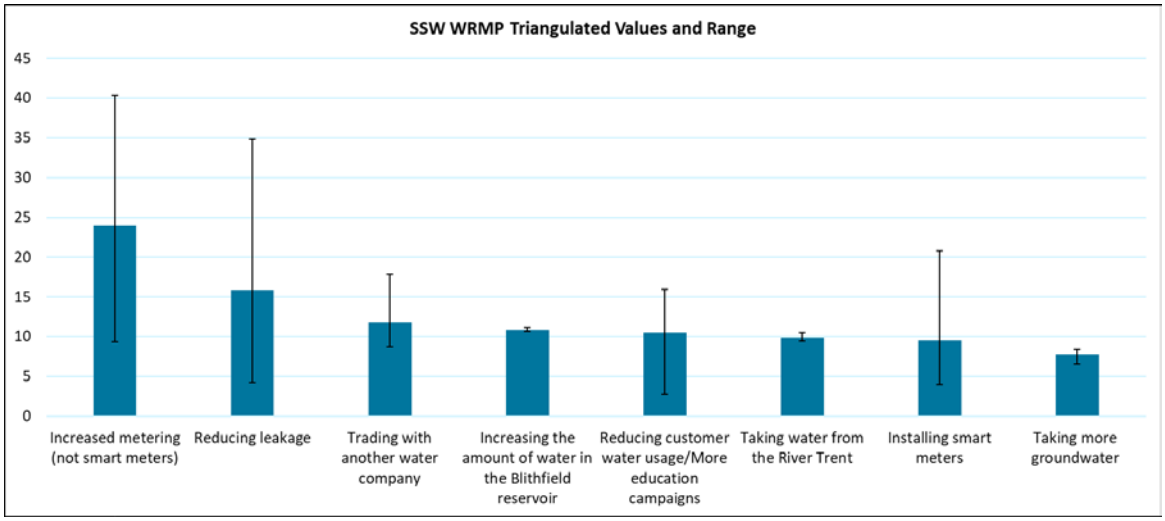
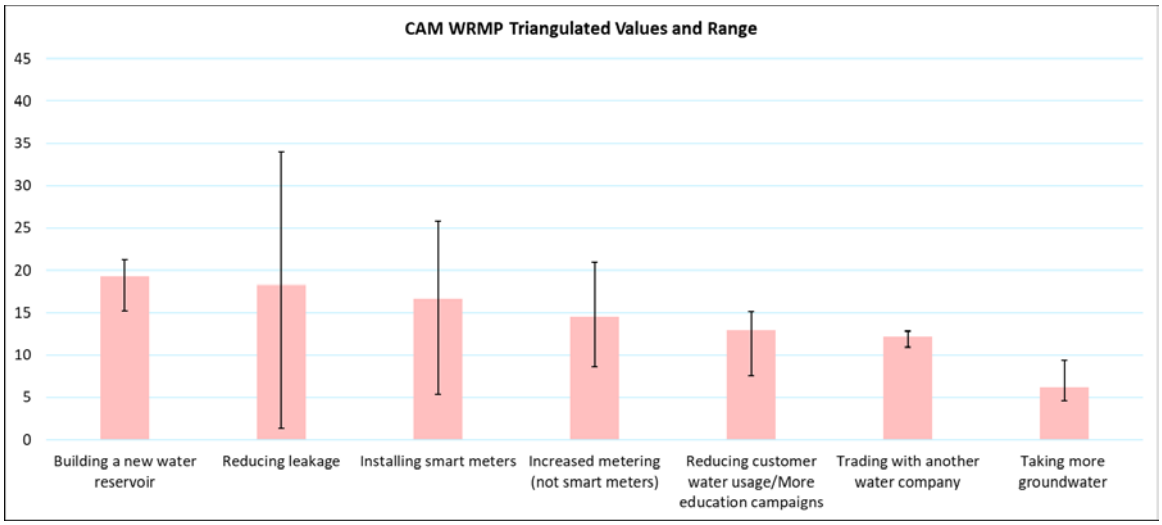


Figure 11: CAM WRMP Triangulated Values and Range: Down-weighting WRMP workshops



Again, as discussed in Table 14, WRMP workshop results are based on an informed dialogue process involving quiz, handouts and animations which enabled the participants to make informed choices of the various priorities. If we were to assign more importance to theoretical validity, then it seems reasonable to up-weight the workshop results. Table 21 (third column) presents the RAG ratings and Figure 12 and Figure 13 present the triangulated values and range for SSW and CAM that results from such up-weighting of the WRMP workshop results.

Figure 12: SSW WRMP Triangulated Values and Range: Up-weighting WRMP workshops

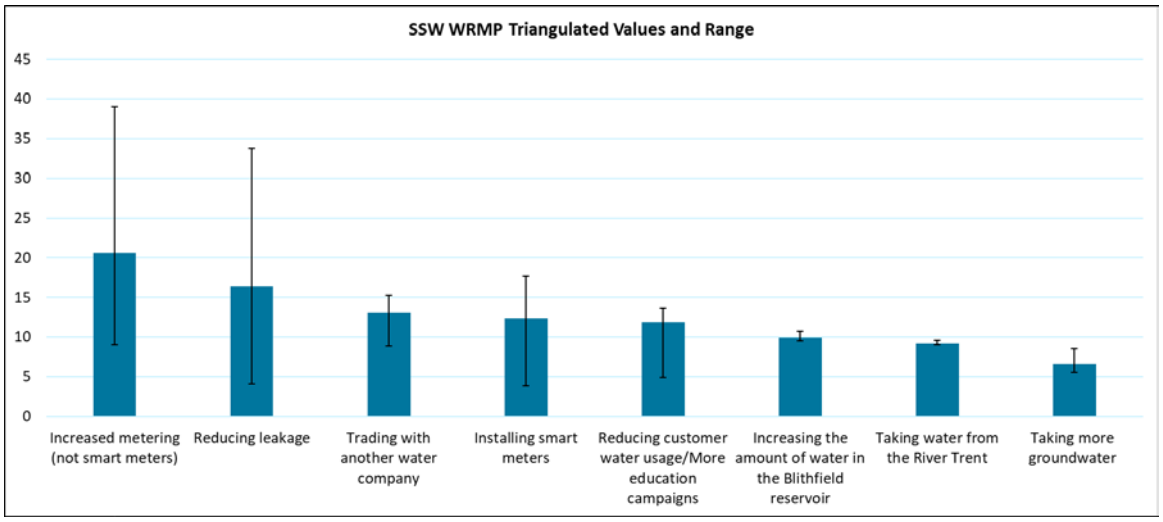


Figure 13: CAM WRMP Triangulated Values and Range: Up-weighting WRMP workshops

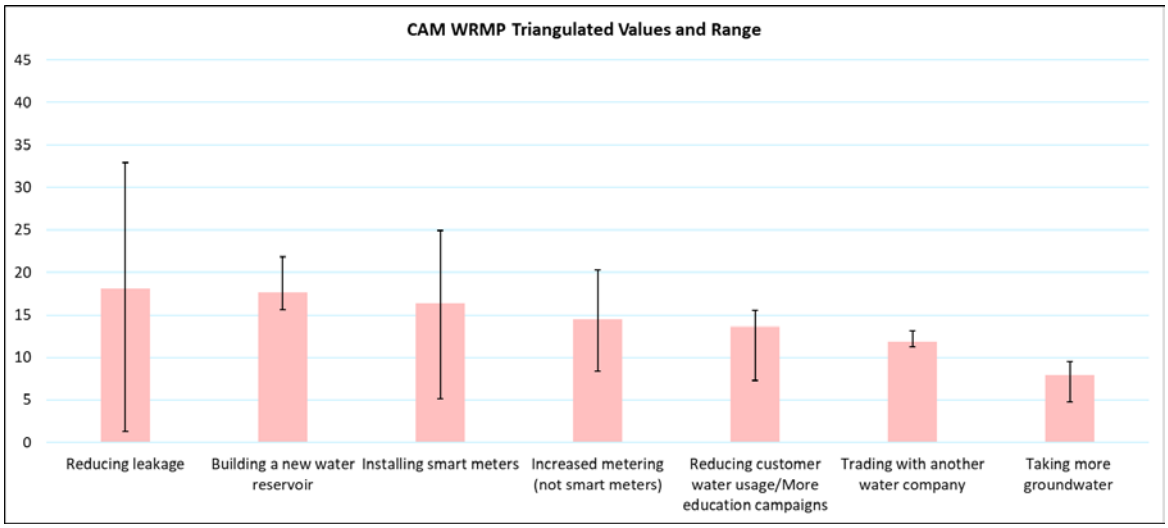


Figure 10 and Figure 12 shows that 'Increased metering' is still the highest priority and 'Taking more groundwater' is still the least desired option for SSW when WRMP workshop results are down-weighted and up-weighted respectively.

Figure 11 shows that 'Building a new water reservoir' is still the highest priority for CAM when WRMP workshop results are down-weighted. However, Figure 13 shows that` Reducing leakage' becomes the highest priority and 'Taking more groundwater' is still the least desired option for CAM when WRMP workshop results are up-weighted.

CASE 3: Giving Greater Weight to Uninformed Priorities

The final case for the sensitivity testing of the WRMP priorities is based on up-weighting Customer priorities and down-weighting everything else on the basis that uninformed might be better from the customer-in-the-street perspective. Note that we apply the same weights to the RAG ratings in this case as was presented in Table 15.

Table 22: WRMP Sensitivity Analysis: Up-weighting Customer priorities and Down-weighting all else

Data source	Original RAG rating	RAG rating (up weighting WRMP workshop)
WRMP Workshop	Green / Amber	Amber
WRMP Online	Green / Amber	Amber
Customer Priorities	Amber	Green / Amber
WTP core DCE	Amber	Amber/Red
WTP core MaxDiff	Amber	Amber/Red

Figure 14: SSW WRMP Triangulated Values and Range: Up-weighting Customer priorities and Down-weighting all else

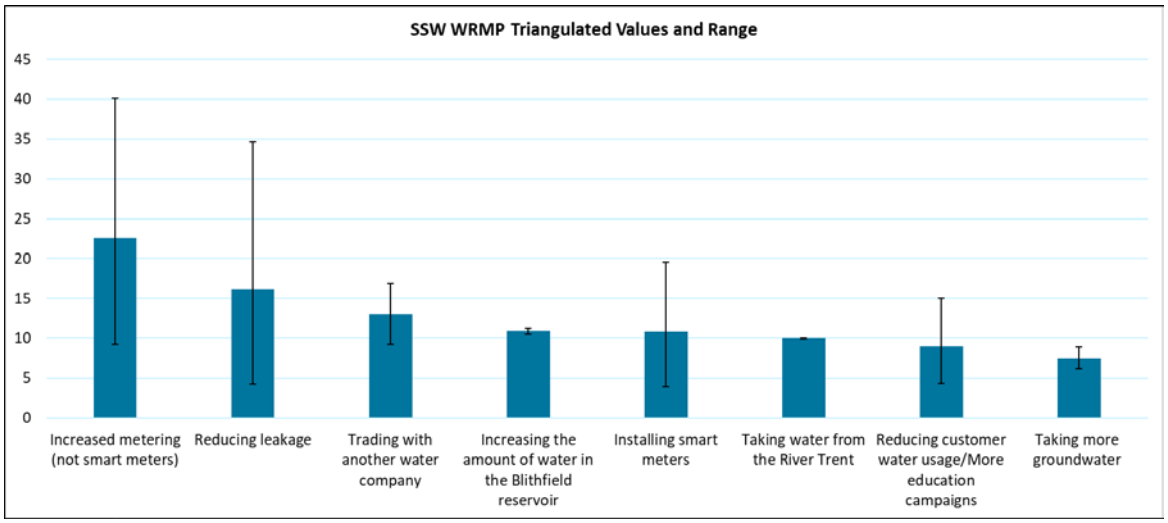
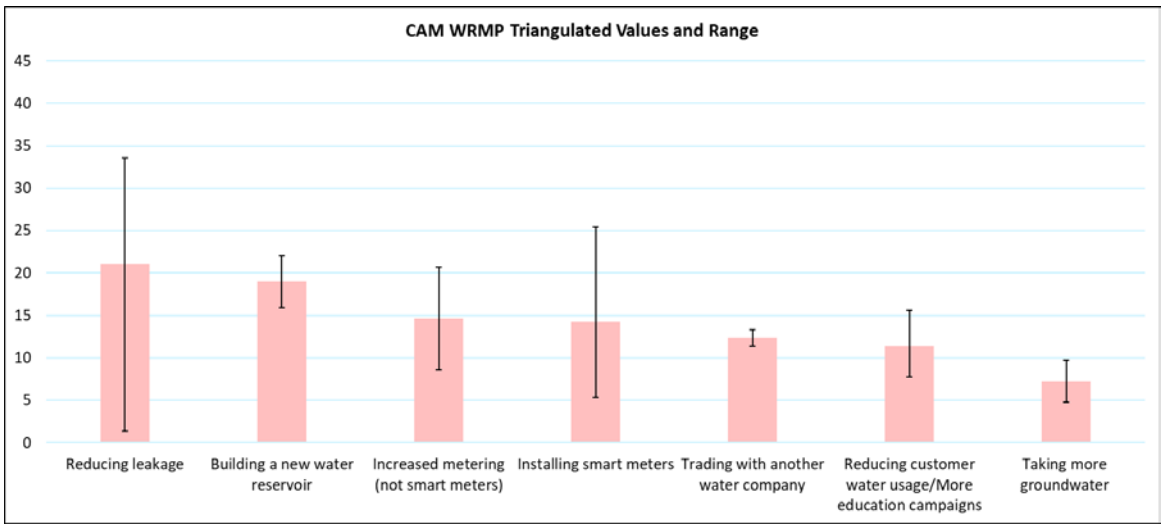


Figure 15:CAM WRMP Triangulated Values and Range: Up-weighting Customer priorities and Down-weighting all else



We find that `Increased metering' is still the highest priority for SSW while `Reducing Leakage' is the highest priority for CAM. 'Taking more groundwater' is still the least desired option for both SSW and CAM areas.

The following two tables bring together all the results from the sensitivity tests described above. First, Table 23 presents the SSW main triangulated values in comparison to the triangulated values derived for the various sensitivity cases. It shows that `Increased metering' was the highest priority and 'Taking more groundwater' was the least desired option for SSW customers across all the sensitivity cases.

Table 23: Comparison of SSW WRMP Triangulated Values

Options	MAIN	CASE 1	CASE 2A	CASE 2B	CASE 3
Increased metering (not smart meters)	22.2	23.0	23.9	20.6	22.6
Reducing leakage	16.2	16.3	15.9	16.4	16.2
Trading with another water company	12.5	12.6	11.8	13.1	13.0
Installing smart meters	10.9	10.2	9.5	12.4	10.8
Reducing customer water usage/More education campaigns	11.2	10.8	10.5	11.9	9.0
Increasing the amount of water in the Blithfield reservoir	10.4	10.4	10.8	9.9	10.9
Taking water from the River Trent	9.5	9.6	9.8	9.2	10.0
Taking more groundwater	7.2	7.2	7.8	6.6	7.5

Note: MAIN refers to the WRMP triangulated values in Section 3.4; CASE 1 refers to the WRMP triangulated values derived for Sensitivity Case 1: Alternative sets of weights; CASE 2A refers to the WRMP triangulated values derived for Sensitivity Case 2: Down-weighting WRMP workshops; CASE 2B refers to the WRMP triangulated values derived for Sensitivity Case 2: Up-weighting WRMP workshops and CASE 3 refers to the WRMP triangulated values derived for Sensitivity Case 3: Up-weighting Customer priorities and Down-weighting all else.

Table 23 presents the CAM main triangulated values in comparison to the triangulated values derived for the various sensitivity cases. We find that `Building a new water reservoir' was the highest priority and 'Taking more groundwater' was the least desired option for CAM customers across all the sensitivity cases (except for Case 2B and Case 3 where `Reducing Leakage' became the highest option).

Table 24: Comparison of CAM WRMP Triangulated Values

Options	MAIN	CASE 1	CASE 2A	CASE 2B	CASE 3
Building a new water reservoir	18.5	18.6	19.3	17.7	19.0
Reducing leakage	18.2	18.4	18.3	18.1	21.1
Increased metering (not smart meters)	14.5	14.7	14.5	14.5	14.7
Trading with another water company	12.1	12.1	12.2	11.9	12.4
Reducing customer water usage/More education campaigns	13.2	12.9	12.9	13.6	11.4
Installing smart meters	16.5	16.1	16.6	16.4	14.3
Taking more groundwater	7.1	7.1	6.2	7.9	7.3

Note: MAIN refers to the WRMP triangulated values in Section 3.4; CASE 1 refers to the WRMP triangulated values derived for Sensitivity Case 1: Alternative sets of weights; CASE 2A refers to the WRMP triangulated values derived for Sensitivity Case 2: Down-weighting WRMP workshops; CASE 2B refers to the WRMP triangulated values derived for Sensitivity Case 2: Up-weighting WRMP workshops and CASE 3 refers to the WRMP triangulated values derived for Sensitivity Case 3: Up-weighting Customer priorities and Down-weighting all else.

There were, however, a few shifts in the triangulated values for the other options across the various sensitivity cases. For example, while `Installing smart meters' was the third most important option based on the MAIN results as well as the Case 1 and Case 2 results, it became the fourth most important option under Case 3. In such cases, decisions over which options to include in the plan may be sensitive to judgments made regarding the weight to give to different studies when triangulating.

4 WTP TRIANGULATION

In this section, we present the triangulated results with respect to WTP based on our triangulation methodology. Section 4.1 reviews the suitability of the supplementary data for triangulation; Section 4.2 describes how we have mapped the evidence to WTP core measures to enable comparison; Section 4.3 discusses the assessment and rating of the derived measures for each source; Section 4.4 presents our main triangulated results for the WTP values; and Section 4.5 contains sensitivity tests with respect to the WTP triangulated results.

4.1 Screen

The core data comes from the WTP research which includes results from the discrete choice experiments in both Wave 1 and Wave 2 as well as the Wave 1 MaxDiff exercise. The supplementary data sources that can be used to derive comparable measures include the following:

- WRMP research (online and workshops)
- Customer Priorities research
- Customer Contacts/complaints
- Customer Satisfaction
- Performance Commitments (PC) Slider research
- External WTP evidence (PR14, PR19, academic and grey literature)

The following two tables present the sources considered and the reasons (in brief) for screening them in/out for purposes of WTP triangulation.

Table 25: WTP Triangulation: Data Sources Screened In

Source	Reasons for screening in
WTP Core: DCE	Both Wave 1 and Wave 2 are well-designed and implemented WTP studies with large representative samples of SSW/CAM customers.
WTP Core: MaxDiff	Potential scale for triangulation with WTP core DCE is the index of priority for each service measure i.e. indicator of the % total 'importance' attached to all improvements. This priority index is not a direct measure of WTP, but closely related and, moreover, MaxDiff questions have been found to be easier for survey participants to answer than discrete choice experiment questions in some other contexts (Whitty, JA et.al (2014), Potoglou, D et.al (2011), Flynn, TN (2010))
Customer Priorities	Potential scales for triangulation with WTP include the proportion of times each measure is ranked top or ranked in the top 3. Customer priorities are not a direct measure of WTP, but closely related and, moreover, priorities questions are less complex for survey participants to answer than discrete choice experiment questions.
SSC Customer Contacts	Data on the number of unwanted contacts from customers pertaining to a number of service areas. A candidate measure for triangulation is the rate at which customers who experience a service issue of each kind contact SSC about it The principle being adopted in using this as a measure of WTP is that WTP for a service issue should be proportional to the relative propensity to contact the company in response to a service issue. This is a different kind of evidence, based on experienced utility, weighted by risk, rather than decision utility.
Customer Service tracker	Satisfaction measures relating to discoloured water, taste and smell, low water pressure and interruptions to water supply. Candidate measures for triangulation include the relative impact on satisfaction that occur when customers experience a service issue of

	each kind. The principle being adopted in using this as a measure of WTP is that a WTP index for one fewer service failure in future of each type of service failure should be proportional to the relative impact of each type of service failure on satisfaction. This is a different kind of evidence, based on experienced utility, weighted by risk, rather than decision utility.
WRMP	Potential scales for triangulation with WTP include measures of priority amongst the included measures. Mapping assumes that priorities index is the same as a WTP index for S0 to S2) (details in next section)
PC Slider research	Unit WTP values derived from the slider research for common attributes (details in next section)
External WTP evidence	PR14 and PR19 Unit WTP values for different service measures

Table 26: WTP Triangulation: Data Sources Screened Out

Source	Reasons for screening out
Foundation priorities	Customers priorities for service delivery both at present and over the longer term (prompted and spontaneous). Purely qualitative and discursive hence no useable measure
Metering study	Focussed on customers' reasons for not switching to a meter, hence not comparable.
Bright and SIM survey	Satisfaction measurement of key interaction points – billing and operational hence cannot be used directly as we will need to relate satisfaction to experience of service failure. Satisfaction is not itself a good measure of WTP since satisfaction with different service elements contributes differently to overall satisfaction depending on how important the service element is to the customer.
SSC Web survey	Satisfaction measures relating several service measures. No comparable measures.
CCWater studies	Qualitative research about attitudes to water use/saving, behaviours and messaging. No comparable measures
External WTP evidence	*VoLL*: This was screened out for two reasons: firstly, our approach requires at least two measures since we package scale everything; secondly, VoLL is insufficiently closely related to interruptions, particularly given that there are many direct valuations obtained for interruptions in the water sector. *Lanz and Provins*: Units aren't comparable, at least initially. For example, hardness is valued at £0.06 for a reduction of 1 mg CaCO3 per litre

4.2 Map

Core WTP Data

The final output from the WTP core DCE research included the following (for each of the 16 service measures detailed in Table 12):

- Attribute levels for the status quo situation (S0) and two possible levels of improvement from the current level (S0): 'some improvement' (S1) and 'significant improvement' (S2).
- WTP values for each of these levels, together with statistical confidence intervals around the average values
- Total pot values together with confidence intervals around the values
- Unit WTP values (for improvement from S0 to S2) together with confidence intervals around these values.

The definitions for the 16 service measures and their units are presented in Table 27 below. There were changes made to the definition for a few attributes in the WTP Wave 2 study. These changes have been included (indicated in blue font) in Table 27 below. Drought restrictions, Giving customers control of their water usage and Traffic disruption were not included in the Wave 2 study.

We focus on the unit WTP values (i.e. WTP for 'S0 to S2' improvement) rather than Mean WTP (S0 to S1) or Mean WTP (S1 to S2) values for our triangulation exercise. This is because the scope of services changes offered to participants varied considerably across service measures. Thus, for example, if WTP (S0 to S1) for property flooding for a company was £6 and WTP (S0 to S1) for discoloured water was £5, then it would not necessarily be the case that property flooding incidents were considered worse than discoloured water incidents. It may instead have been that the company was offering a greater reduction in the risk of property flooding in the S1 level than it was offering for discoloured water in that S1 level.

Note that we included WTP values based on both the pilot and main interviews, rather than those from the main stage only. This was done to maintain consistency with the report produced by Impact. Also, no 'package scaling' was applied to the results, despite a package exercise being included in the Wave 2 research, and analysis by Impact (who ran the study) showing that package effects were important. The reason for not scaling down the WTP results to be consistent with a large-scale package of improvements was because package scaling is only necessary when the overall business plan involves increases in customers' bills. Our understanding is that SSC's preferred plan will entail reduced bills in real terms rather than increased bills and so no package scaling was required. Further, we used the WTP `Wave 2' results based on the SP exercise in the context of the current bill as the main WTP values for purposes of triangulation. The WTP values resulting from the lower bill SP exercise were used as a sensitivity check that contributed to the range of values, but not to the central case.

Table 27: Core WTP service measure definitions

Attribute	Attribute Definition	Attribute units
Taste and smell of water	Your tap water tastes and smells different (e.g. of chlorine) for a period of 3 days. (You do not know whether it is safe to drink or not until you contact your water company)	Property affected
Discoloured water	The tap water at your property is discoloured for 24 hours. Running the tap for a few minutes will not remove this discolouration. (You do not know whether it is safe to drink or not until you contact your water company)	Property affected
Water not safe to drink	Due to contamination, you are unable to drink the water at your property for a period of 2 weeks. Wave 2: changed from 2 to 3 weeks	Property affected
Lead pipes	Approximately every 3rd property in your water company's area is served by a lead pipe, most of these are pipes are owned by the customer. (A harmless additive is added to the water supply to ensure the lead pipe poses no risk to health). Wave 2: altered from no health risk to almost none	Property affected
Water hardness	Hard water causes appliances, taps, tiles, etc to scale which can reduce their usable life. Softening the water is an option but this can alter the taste of your water. Wave 2: altered to say hard water good for health	Property affected
Unexpected temporary loss of water supply	There is an unexpected problem with the network, such as a burst main, that means your property is without water for up to 24 hours. Wave 2: duration changed to up to 1-5 hours and 6-11 hours.	Property affected
Temporary use ban	There is a hosepipe ban in your area for 5 months from May to September.	1% change in risk
Drought Restrictions (*Wave 1 only*)	HH: Because of a water drought, most of the region would have to get all their water from a standpipe located in your street for between 2 to 4 weeks/NHH: Because of a water drought, your company is only able to use water for essential operational use (e.g. no washing of machinery). Most of the companies in the region would have to get all their water for non-essential operations from a standpipe located in their street for between 2 to 4 weeks.	1% change in risk
Low water pressure	The water at your property loses pressure a number of times throughout the day and night which reduces the water flow to a slow trickle.	Property affected
Flooding from a burst pipe	A pipe owned by your water company that supplies water to your property bursts and floods the ground floor of your property	Property affected
Traffic disruption (*Wave 1 only*)	Over time pipes need to be repaired or replaced, therefore you encounter road works on your journeys to and from your home. This means you are delayed by 15 minutes each time you travel. Road works are typically in place for 3 days.	Roadwork incident
Leakage	Around 24% (SSW) / 20% (CAM) of the water supplied by your water company is lost through leaking pipes. The majority of this is from the water company's pipe network and the rest from the supply pipe that serve customers' properties (which is the responsibility of the property owner). As new leaks are always appearing they can't be reduced to 0.	ML/D
Water metering	The vast majority of business customers and 33% household customers (SSW)/70% (CW) have a water meter fitted in this region which means they pay just for the water they use. The remaining properties pay a fixed amount per year depending on the rateable value of their property.	Household
Giving customers control of their water usage (*Wave 1 only*)	To help you understand and manage your water consumption your water company is able to give you a water meter reading via a device in your home.	Household
Protecting wildlife habitats	All water companies have a legal duty to protect and improve areas for wildlife and plants in the places where they operate. They currently protect and improve 99 hectares - which is the same areas as 138 football pitches (SSW) / 17 hectares - which is the same areas as 24 football pitches (CAM). Wave 2: now mentions % of land managed in context of whole region	Hectare
Managing impacts on rivers & streams	In order to supply customers your water company has to take water from the environment. This can impact on rivers and streams and the land around them (e.g. floodplains) in your area. Your water company has a legal duty to restore the river and the wildlife around it in your area. Wave 2: now also in context of actively managing land with landowners	Hectare

Note: The text in blue font refers to the change in attribute definitions in the WTP Wave 2 study. Drought restrictions, Giving customers control of their water usage and Traffic disruption are not included in Wave 2.

Unit WTP is derived by dividing the WTP for S0 to S2 improvements by the number of units of service change between S0 and S2 service levels. Unit WTP values thus represent a comparable unit of change being valued across service measures. This is because they express customer's WTP for one avoided incident of each type of service measure in each case. Therefore, we use unit WTP values for our triangulation exercise since they are not sensitive to the scope of service change offered and are also likely to be more closely related to customer contacts and priorities (once scaled by number of households affected).

The final output of the WTP core DCE exercise is based on a revised methodology of taking the per customer (household (HH) and non-household (NHH)) WTP data from the WTP survey and converting it into the units of measure that will be utilised within the Investment Optimiser tool. The following steps were used to derive the final output of the WTP core DCE exercise:

- Per customer WTP data from the WTP survey is in the form £X per customer.
- There are three service levels, the starting point S0, the 'some improvement' level S1 and the 'significant improvement 'level S2. The WTP values provided by the survey are cumulative, so to get from S0 to S2 we add together the two WTP values. (i.e. if customers are willing to pay £X to get to S1, and then a further £Y to get to S2, then to go from S0 to S2 they would be willing to pay £X+£Y). This new approach ignores the 'some' improvement level.
- The service level improvements shown to respondents in Wave 2 were different to those shown in Wave 1. In order to combine the Wave 2 and Wave 1 values in a meaningful manner, we have taken the Wave 2 (S2) service level to be the correct range for the combined case and have used either the intermediate level or the best level from Wave 1 to be consistent with this assumption. For example, for discoloured water, the unit values in Wave 1 were recalculated based on service level improvements from base to the Wave 1 intermediate level (S1). However, for metering, we calculated the unit values based on service level improvements from base to the Wave 1 best level (S2).
- WTP per customer is converted into a total WTP for all customers in that group by multiplying by the number of customers in the group. There are four groups – SST HH, SST NHH, CAM HH and CAM NHH.
- The total WTP for all customers in the group ('the pot') is divided by the range of service improvement asked in the question for that group. For example, if S0 to S2 is 5,000 properties, we divide the total pot WTP by 5,000 to get a 'per property affected' value.
- Public values are taken for each group. Note that we use the Wave 1 WTP 'Private' value and the WTP values resulting from the lower bill Wave 2 DCE exercise as sensitivity checks in the triangulation so that they contribute to the range of values but not to the central estimate (details in Section 4.4).
- The household and business WTP are added together for each region. Note that due to small sample bases we only use the Wave 2 WTP 'CAM NHH' value as a sensitivity check in the triangulation so that they contribute to the range of values but not to the central estimate (details in Section 4.4).
- The regional WTP totals are weighted by the size of each region (using property counts) to get to a final, weighted, combined WTP.
- The 'Combined SSC' WTP triangulated values are calculated as a weighted average of the South Staffs and Cambridge area results.
- The above steps are repeated for the low and high confidence intervals, so we end up with a low, mean and high value for each measure, for each region and combined. Note that for sensitivity testing we define the low and high values such that the Low value is calculated as the minimum WTP value plus 20% of the difference between the minimum value and the central case value, and the High value is calculated as the maximum value minus 20% of the difference between the central case value and the maximum value.

The justification for redefining the confidence intervals in this manner is to avoid having extreme range of values for the Combined WTP.

The final output of the WTP MaxDiff choice exercise is an index for each service measure that summarises the relative priority given to each S0 to S2 improvement, with the sum of the indices equal to 100. There was no mention of cost in the exercise and it is hence ambiguous whether costs were, or were not, considered by customers when choosing their priorities amongst options. In light of this ambiguity we have made no adjustments to the measure, and hence implicitly assume that it is a measure of WTP.

WRMP Research

The WRMP core research (workshop and online) is used to triangulate for the core WTP service measures. The options in the WRMP research that are common to the WTP study are presented in the following table.

Table 28: Mapping WRMP options to WTP core service measures

WRMP workshop options	WRMP online options	WTP service measure name
Reducing leakage	Reducing leakage	Leakage
Installing smart meters	Installing smart meters	Giving customers control of their water usage
Increased metering (not smart meters)		Water metering

To convert the WRMP priorities scales to a comparable measure for the WTP service measures we use the derived WRMP priority indices (see Table 8) as a measure of relative WTP for 'S0 to S2'. These relative WTP values are scaled to equate package WTP to the WTP Wave 2 DCE results for leakage and water metering and to the WTP Wave 1 DCE results for smart metering. The resultant measures are then translated to the same units as reported for each of the common service measures in the core WTP research. These values are also adjusted for by the bill impact per customer for moving from S0 to S2 as in the case of Table 14. Table 29 below presents the Unit values derived from the WRMP workshop and online research for the common service measures.

Table 29: Unit WTP values based on WRMP data

		WRMP workshop		WRMP online	
WTP service measure name	Unit	SSW Derived Unit Value	CAM Derived Unit Value	SSW Derived Unit Value	CAM Derived Unit Value
Leakage	ML/D	£44,629	£179,978	£29,046	£150,393
Giving customers control of their water usage	Household	£0.88	£0.65	£0.42	£0.33
Water metering	Household	£5.56	£1.66		

Customer Priorities

The Customer priorities survey asked customers to choose their top three priorities from a wide range of options. To obtain a comparable measure for the core WTP values, we focus on the following survey question:

Q16. Which do you think are the most important areas that SSW/CAM should be concentrating on in the next 5-10 years. Please rank your top 3 areas

The options in the Customer priorities research that are common to the WTP service measures are presented in the following table.

Table 30: Mapping Customer priorities options to WTP core service measures

Customer priorities options	WTP service measure name
Providing a high-quality water supply that is always safe to drink	Water not safe to drink
Making sure water always comes out of the tap - ie no supply interruptions	Unexpected temporary loss of water supply
Reducing the amount of water that leaks from our pipes	Leakage
Protecting and improving the natural environment for wildlife and plants	Protecting wildlife habitats
Ensuring the water always tastes and smells good	Taste and smell of water
Making sure the water is never discoloured / cloudy / has particles in it	Discoloured water
Making sure the water does not cause appliances, taps, tiles, etc to scale - which can reduce their usable life	Water Hardness
Ensuring your water pressure is not too high or low (e.g. a slow dripping tap)	Low water pressure
Ensuring we minimise traffic disruption caused by repairing our network of pipes	Traffic disruption
Removing all lead pipes from the water network (a harmless additive is added to the water to ensure lead pipes pose no risk to health)	Lead pipes

Due to the absence of a preference scale that can be used to incorporate responses on all three most important areas, we estimated an econometric model (rank ordered logit) to analyse the customer priorities survey data in order to derive a better priorities scale (see Table 10).

In order to convert customer priorities data to a comparable measure for the WTP core service measures, we took the following steps:

- We used the Priority index derived from the rank-ordered logit model of top three choices (see Table 10) as a measure of relative WTP for 'S0 to S2'.
- These relative WTP values were scaled to equate package WTP to the WTP Wave 2 DCE results for all included measures with the exception of Traffic disruption. Since Traffic disruption was not included in the Wave 2 study, we scaled it to WTP Wave 1 DCE results.
- Finally, we derived the Unit WTP values (S0 to S2) by dividing the WTP values obtained in Step 2 by the service level change (S0 to S2) and then translating them to the same units as reported for each of the common service measures in the core WTP research.

Table 31 below presents the Unit values derived from the Customer priorities data for the common service measures.

Table 31: Unit WTP values based on Customer Priorities data

WTP service measure name	Unit	SSW Derived Unit Value	CAM Derived Unit Value
Water not safe to drink	Property affected	£1,775.97	£1,846.89
Unexpected temporary loss of water supply	Property affected	£366.78	£310.05
Leakage	ML/D	£26,705.37	£50,383.60
Protecting wildlife habitats	Hectare	£8,962.45	£14,171.07
Taste and smell of water	Property affected	£299.14	£287.15
Discoloured water	Property affected	£40.15	£111.95
Water Hardness	Property affected	£84.88	£60.76
Low water pressure	Property affected	£8.77	£9.39
Traffic disruption	Roadworks incident	£386.99	£40.37
Lead pipes	Property affected	£5.24	£5.48

Customer Contacts

Unwanted customer contacts are potentially a valid source for WTP triangulation on the basis that it seems reasonable to suppose that customers are more likely to contact the company, having experienced a service issue of some kind, if the service issue affected them substantially than if it had only a very minor impact on them. Generalising this intuition leads us to consider as a candidate measure for triangulation the number of unwanted contacts about each type of service issue as a proportion of the number of customers affected that service issue.

Since WTP is proportional to utility, and since 'impact' can be considered to be proportional to disutility, the use of this measure can be thought of as imposing the principle of 'expected utility' onto valuations. Whereas a DCE exercise derives WTP by asking participants to choose between potential future service packages with different risks for each type of service issue, the approach taken to use of customer contacts is to treat value as being proportional to the expected impact (ie probability multiplied by the size of the impact). By so doing, the approach provides a measure based on an alternative theoretical perspective to the DCE-derived measure of WTP. Both measures have strengths and weaknesses, and these are appraised in Section 4.3.

Table 32 below presents the customer contacts data and the number of affected properties for the three common service measures that we use for triangulation.

Table 32: Customer Contacts data

	SSW				CAM			
Service issue	Unwanted contacts (3 years)	Properties affected per year (WTP Core DCE)	Properties affected (3 years)	Unwanted contacts / 1,000 properties affected (3 years)	Unwanted contacts (2 years)	Properties affected per year (WTP Core DCE)	Properties affected (2 years)	Unwanted contacts / 1,000 properties affected (2 years)
Taste and smell of water	1176	8800	26400	44.5	180	2336	4671	38.5
Discoloured water	5559	35700	107100	51.9	355	2856	5711	62.2
Unexpected temporary loss of water supply	13254	7943	23829	556.2	2768	3288	6575	421.0

Source: "Triangulation approach with BAU - SY data incl Unw Feb18 (for Accent)". Note: We assume that the number of affected properties reported in the WTP Core DCE research is based on a 3-year average for SSW and a 2-year average for CAM. The 3-year period considered here are YTD (April 2017-Feb 2018), Feb YTD 2016/17 and Feb YTD 2015/16. The number of unwanted contacts Feb YTD 2015/16 is not available for CAM households. We haven't included NHH contacts data since NHH data was available for only operational contacts and not billing contacts. We include repeat contacts, on the basis that additional contacts are an indicator of additional impact.

Note that the service measures in the Contacts data that are common to the WTP core options are:

- Taste and smell of water
- Discoloured water
- Lead pipes
- Water hardness
- Unexpected temporary loss of water supply
- Low water pressure
- Traffic disruption
- Flooding from a burst pipe
- Leakage levels (Company pipes)

However, we focus on only four of the above service measures since the remaining service measures cannot be translated to meaningful comparable measures. Table 33 presents the mapping of the customer contacts options to the WTP core service measures.

Table 33: Mapping Customer contacts options to WTP core service measures

Service measure (Contacts)	Service measure definition (WTP Core)
Taste and smell of water	Your tap water tastes and smells different (e.g. of chlorine) for a period of 3 days. (You do not know whether it is safe to drink or not until you contact your water company)
Discoloured water	The tap water at your property is discoloured for 24 hours. Running the tap for a few minutes will not remove this discolouration. (You do not know whether it is safe to drink or not until you contact your water company)
Unexpected temporary loss of water supply	There is an unexpected problem with the network, such as a burst main, that means your property is without water for up to 24 hours.
Water not safe to drink	Due to contamination, you are unable to drink the water at your property for a period of 3 weeks.

The customer contact types have been tallied up with the WTP service measures as closely as possible. However, where there is a timeframe in the WTP service measure, this isn't always logged in the customer contacts data. For example, taste and smell of water service measure in the WTP research is about having taste and smell issues with tap water for a period of 3 days. However, the customer contacts data for taste and smell doesn't provide us with any information on the duration of the taste and smell incident that prompted the customers to contact the water company.

In order to convert customer contacts data to a comparable measure for the WTP core service measures, we took the following steps:

- In the first step, we used the Unit impact index i.e. Unwanted contacts/1,000 properties affected and rescaled it by Wave 2 DCE service level change (S0 to S2 level) for each of the common service measures shown in Table 32 to derive the Impact index (S0 to S2).

- To ensure that that the WTP estimates for the comparable service measures were consistent with the WTP for an overall package of service change, we scaled the Impact index derived in the first step to equal the package WTP value from the WTP Wave 2 DCE results for the included measures. This was done by multiplying the Impact index by the sum of the WTP values from impact (S0 to S2) for all the service measures and dividing the resulting measure by the sum of the Impact indices for the common service measures.

- Finally, we derived the Unit WTP values (S0 to S2) by dividing the WTP values obtained in Step 2 by the WTP Wave 2 service level change (S0 to S2) and then translating them to the same units as reported for each of the common service measures in the core WTP research.

Table 34 below presents the Unit values derived from the customer contacts data for the common service measures.

Table 34: Unit WTP values based on Customer contacts data

WTP service measure name	Unit	SSW Derived Unit Value	CAM Derived Unit Value
Taste and smell of water	Property affected	£62.24	£47.72
Discoloured water	Property affected	£71.42	£94.11
Unexpected temporary loss of water supply	Property affected	£736.49	£622.58
Water not safe to drink	Property affected	£22.16	£15.86

Customer Satisfaction

The main sources of customer satisfaction data available to us for triangulation were the Customer tracker data (SSW and CCW) and SIM and Bright surveys. We focussed on the customer tracker data for triangulation. This is because the information contained in the SIM and Bright survey was not sufficient to translate these into measures comparable to WTP.

The service measures in the Customer satisfaction data common to the WTP core options are the following:

- Discoloured, cloudy or milky water
- Unusual taste or smell of water
- Interruption to your supply
- Persistent low pressure
- Water leak in local area

However, we focus on four service measures i.e. taste and smell, discoloured water, interruption to water supply and low water pressure for purposes of triangulation since the other service measures cannot be translated into meaningful comparable measures. For example, we do not consider 'Water leak in local area' because the unit (ML/D) is not mappable to household experience. We also do not consider 'Poor customer service' because this was not one of the core WTP service measures.

The common service measures are presented in the following table.

Table 35: Mapping Customer satisfaction options to WTP core service measures

Attributes (CST)	Attributes (WTP Core)
Taste and smell of water	Your tap water tastes and smells different (e.g. of chlorine) for a period of 3 days. (You do not know whether it is safe to drink or not until you contact your water company)
Discoloured water	The tap water at your property is discoloured for 24 hours. Running the tap for a few minutes will not remove this discolouration. (You do not know whether it is safe to drink or not until you contact your water company)
Interruption to your supply	There is an unexpected problem with the network, such as a burst main, that means your property is without water for up to 24 hours.
Persistent low pressure	The water at your property loses pressure a number of times throughout the day and night which reduces the water flow to a slow trickle.

Satisfaction scores do not themselves necessarily correlate with WTP for improvement since WTP is a measure associated with a change rather than a static state. Instead, we translate the satisfaction scores to a comparable unit by using the results of a regression analysis conducted by Accent which examined how the impact of a service failure affected overall satisfaction. Thus, the principle being adopted in using this as a measure of WTP is that a WTP index for one fewer service failure in the future of each type of service failure should be proportional to the relative impact of each type of service failure on satisfaction.

This measure is similar in nature to the measure based on customer contacts. In that case, welfare impacts were taken to be proportional to the relative propensity to contact the company in response to a service issue; in the present case, welfare impacts are taken to be proportional to the relative impact on overall satisfaction. In both cases, the measures rely on the equivalence between the value of a package of risk reductions and the expected utility

impact of those risk reductions. Both measures have strengths and weaknesses, and these are appraised in Section 4.3.

The results from the regression analysis are presented below.

Table 36: Customer Satisfaction regression results

	Overall Satisfaction	
MODEL 3 results: Impact of service failures on overall satisfaction	SSW Coefficient	CAM Coefficient
Taste and smell of water	-0.13	-0.38
Discoloured water	-0.32	-0.07
Interruption to your supply	0.10	-0.27
Persistent low pressure	-0.28	-0.22

Source: SS HH tracker (2017-2018): Annual summary Findings (Model 3 results); Note: The coefficients are the predicted increase in overall satisfaction (scale: 1-5) moving from the reference category to the comparison category. The reference category for all the service measures in both the regressions is "No/don't know/can't remember"

The rows of the above table present the coefficients of the regression analysis of the impact of service failures on overall satisfaction. To convert customer satisfaction data to a comparable measure for the WTP core service measures, we took the following steps:

- In the first step, we used the Unit impact index i.e. coefficients of the regression analysis of the impact of service failures on overall satisfaction and rescaled it by the Wave 2 service level change (S0 to S2 level) for each of the common service measures to derive the Impact index (S0 to S2). Note that we set the Unit impact index for 'Interruption to water supply' (SSW) equal to zero due to its apparent slight positive impact on satisfaction.

- To ensure that that the WTP estimates for the comparable service measures were consistent with the WTP for an overall package of service change, we scaled the Impact index derived in the first step to equate the package WTP to the WTP Wave 2 DCE results for the included measures. This was done by multiplying the Impact index by the sum of the WTP values from impact (S0 to S2) for all the service measures and dividing the resulting measure by the sum of the Impact indices for the common service measures.

- Finally, we derived the Unit WTP values (S0 to S2) by dividing the WTP values obtained in Step 2 by the WTP Wave 2 DCE service level change (S0 to S2) and then translating them to the same units as reported for each of the common service measures in the core WTP research.

Table 37 below presents the Unit values derived from the customer satisfaction data for the three service measures.

Table 37: Unit WTP values based on Customer satisfaction data

WTP service measure name	Unit	SSW Derived unit value	CAM Derived unit value
Discoloured water	Property affected	£44.40	£200.72
Unusual taste or smell	Property affected	£109.30	£36.98
Interruption to your supply	Property affected	£0	£142.62
Persistent low pressure	Property affected	£95.64	£116.21

Performance Commitment Service Sliders

In order to support SSC in its 2019 price review for Ofwat, a PC slider study was conducted by Explain Research in 2018. This research was based on an online questionnaire that was developed for the Performance Commitment engagement project of SSC. The questionnaire asked customers (HH and NHH) to move the sliders up and down for 11 attributes in order to see the dynamic impact on a typical bill. The customers could see the levels for each PC which drove the sliders, for example, they could see the bill impact if they wanted, say, an additional 50 hectares of land to be managed by SSC in order to protect and improve areas for wildlife and plants in the places where they operate. This task was designed to help SSC evaluate the extent of improvements that customers wanted them to achieve for these 11 PCs and help them understand how much customers would like SSC to spend for each of these PCs to deliver the service that they want.

Note that there were 4 common attributes i.e. Protecting wildlife habitats, Leakage, Taste and smell of water and Unexpected temporary loss of water supply between the data sources.

However, there were some issues with the Taste, Smell and appearance attribute due to which we were unable to use it for mapping to WTP. The principal issue with Taste, Smell and appearance attribute was that the service levels were rounded to either 0 or 1 in the online survey. Given this, we would expect that the customers would choose the cheapest bill amount corresponding to service levels 0 and 1. However there was no such evidence in the slider survey results. We did consider using the underlying unrounded service levels, but this would not be consistent with what the customers were shown in the survey. We also considered using a smoothed marginal cost curve on the basis that perhaps customers had inferred that they would be experiencing some level of service improvement for the bill amount that they chose. However, this assumption seemed a bit ad hoc. In addition to the above issue, there were two further issues with the Taste, Smell and appearance attribute. First, this attribute couldn't be directly mapped to WTP since the WTP survey included Taste and Smell and Discoloured water as separate attributes. Second, while the service levels for this attribute in the WTP survey were described in terms of number of properties affected, the slider survey described the service levels in terms of contacts per 1000 people. Since it was a challenge to translate the data into similar units i.e. convert contacts to number of affected properties, we decided to exclude this attribute from our mapping exercise.

The common service measures are presented in the following table.

Table 38: Mapping PC Slider options to WTP core service measures

Attributes (PC Slider)	Attributes (WTP Core)
Protecting wildlife	Protecting wildlife habitats
Leakage levels	Leakage
Interruptions to water supply	Unexpected temporary loss of water supply

The raw slider research data contained information on the service levels chosen for each of the attributes as well as the associated bill amounts. We derived the individual WTP values as follows:

$$\text{Derived WTP for attribute} = \frac{\text{Bill amount chosen-Lowest bill amount}}{\text{Highest service level-Lowest service level}}$$

In obtaining this measure, we assumed a minimum bound for the individual WTP i.e. we assumed that an individual's WTP was equal to the bill amount at the service level that they chose in the survey and equal to zero for all service levels above the chosen service level.
The sample average of the individual derived WTP values was taken to be the Unit WTP index for each of the attributes[5]. These unit indices were then rescaled so as to equate their package WTP to the Wave 2 DCE results.

Table 39 below presents the Unit values derived from the customer satisfaction data for the three service measures.

Table 39: Unit WTP values based on PC Slider data

WTP service measure name	Unit	SSW Derived unit value	CAM Derived unit value
Protecting wildlife habitats	Hectare	£1,395.41	£1,349.80
Leakage	ML/day	£15,829	£59,174.81
Unexpected temporary loss of water supply	Property affected	£366.75	£329.97

SSW PR14 and External WTP Evidence

The main sources of WTP evidence that we used for triangulation against the core PR19 WTP values were the following:

- SSW PR14 WTP values
- External WTP evidence which includes PR14 and PR19 WTP values reported by various water companies that is available in the public domain.

SSW PR14 research contained WTP values for the following service measures:

- Taste and smell of tap water
- Discoloured tap water
- Water hardness (very hard)
- Water hardness (moderately hard)
- Unexpected supply interruption lasting 0 to 3 hours
- Unexpected supply interruption lasting 3 to 6 hours
- Unexpected supply interruption lasting 6 to 12 hours
- Unexpected supply interruption lasting 12 to 24 hours
- Unexpected supply interruption lasting 24 to 48 hours
- Hosepipe /Temporary use ban
- Non-essential use ban
- Low water pressure
- Internal sewer flooding
- Leakage
- Pollution incidents
- River Flows

However, we focus on only five of the above service measures since the remaining service measures cannot be translated to meaningful comparable measures. Table 40 presents the mapping of the customer contacts options to the WTP core service measures.

[5] Note that 240 SSW and 86 CAM respondents who chose the baseline levels for all the attributes were dropped from our analysis.

Table 40: Mapping SSC PR14 service measures to Core WTP core service measures

SSW PR14 service measure names	WTP service measure names
Taste and smell of tap water	Taste and smell of water
Discoloured tap water	Discoloured water
Unexpected supply interruption lasting 12 to 24 hours	Unexpected temporary loss of water supply
Water hardness (moderately hard)	Water hardness
Hosepipe /Temporary use ban	Temporary use ban

We convert the SSW PR14 values for both HH and NHH to a comparable measure for the core WTP service measures as follows:

- Rescale the Unit impact index i.e. the reported unit values by the Wave 2 WTP service level change (S0 to S2 level) for each of the common service measures shown in Table 40 to derive the Impact index (SO to S2).
- Scale the Impact index to equate the package WTP to the WTP Wave 2 DCE results for the included measures.
- Derive the Unit WTP values (S0 to S2) by dividing the WTP values obtained in Step 2 by the service level change (S0 to S2) and then translating them to the same units as reported for each of the common service measures in the core WTP research.

Table 41 below presents the Unit values derived from the SSW PR14 research for the 5 service measures.

Table 41: Unit WTP values based on SSC PR14 WTP values

Service measure	Unit	SSW Derived unit value-HH	SSW Derived unit value-NHH
Taste and smell of water	Property affected	£171	£130
Discoloured water	Property affected	£167	£119
Unexpected temporary loss of water supply	Property affected	£323	£405
Water hardness	Property affected	£0.82	£39
Temporary use ban	1% change in risk	£76,389	£11,460

External WTP evidence included PR14 and PR19 WTP values reported by other water companies. PR14 and PR19 WTP values were reported by over 14 water companies that is available in the public domain. We converted all the PR14 and PR19 WTP values to a comparable measure for the core WTP service measures by following the exact same steps as in the case of the supplementary data sources and the SSW PR14 study.

Table 42 and Table 43 below presents the original as well as the derived unit values for Household and Non-household customers based on the external WTP 14 evidence.

Table 42: External PR14 WTP values and Derived Unit values for HH customers

Company/ Attribute	EXTERNAL WTP DATA		DERIVED UNIT VALUES		
A	**Unit value**	**Unit**	**SSW**	**CAM**	**Unit**
Taste and smell of water	£28,537	Property affected	£272	£184	Property affected
Unexpected Supply interruptions - 6-12 hours	£459	Property affected	£4	£3	Property affected
B					
Unexpected Supply interruptions - 6-12 hours	£671	Property affected	£276	£359	Property affected
Hosepipe /Temporary use bans	£9	Property affected	£20,618	£6,414	1% change in risk
C					
Discoloured water	£2,855	Property affected	£78	£162	Property affected
Taste and smell of water	£10,640	Property affected	£292	£602	Property affected
Unexpected Supply interruptions- 3-6 hours	£511	Property affected	£14	£29	Property affected
D					
Discoloured water	£15,061	Property affected	£112	£308	Property affected
Taste and smell of water	£18,310	Property affected	£136	£374	Property affected
Unexpected Supply interruptions- 3-6 hours	£1,313	Property affected	£10	£27	Property affected
E					
Discoloured water	£126	Property affected	£71	£127	Property affected
Unexpected Supply interruptions - Less than 3 hours	£416	Property affected	£235	£420	Property affected
Temporary use bans	£108	Property affected	£359,205	£153,617	1% change in risk
G					
Discoloured water	£830	Property affected	£130	£531	Property affected
Taste and smell of water	£885	Property affected	£138	£566	Property affected
Unexpected Supply interruptions - Less than 3 hours	£102	Property affected	£16	£65	Property affected
Temporary use bans	£9	Property affected	£8,274	£8,122	1% change in risk
H					
Unexpected Supply interruptions- 3-6 hours	£50	Property affected	£119	£156	Property affected
Temporary use bans	£34	Property affected	£478,323	£149,576	1% change in risk
I					
Unexpected Supply interruptions- 3-6 hours	£320	Property affected	£74	£174	Property affected
Temporary use bans	£24	Property affected	£32,891	£18,361	1% change in risk
Occasional low water pressure	£229	Property affected	£53	£124	Property affected
J					
Discoloured water	£6,510	Property affected	£159	£784	Property affected
Unexpected Supply interruptions - 6-12 hours	£790	Property affected	£19	£95	Property affected
Temporary use bans	£0	Property affected	£0	£0	1% change in risk
Occasional low water pressure	£560	Property affected	£14	£67	Property affected
K					
Unexpected Supply interruptions- 3-6 hours	£1,670	Property affected	£407	£561	Property affected
Temporary use bans	£123	Property affected	£176,708	£58,261	1% change in risk
Hardness of water	£7	Property affected	£2	£2.5	Property affected
Leakage	£247500	ML/day	£60,368	£83,143	ML/day
L					
Discoloured water	£1,430	Property affected	£124	£383	Property affected
Taste and smell of water	£2,445	Property affected	£212	£655	Property affected
Unexpected Supply interruptions- 3-6 hours	£206	Property affected	£18	£55	Property affected
Temporary use bans	£107	Property affected	£54,700	£40,427	1% change in risk
Occasional low water pressure	£299	Property affected	£26	£19	Property affected
M					
Discoloured water	£109	Property affected	£53	£132	
Taste and smell of water	£196	Property affected	£95	£238	Property affected
Unexpected Supply interruptions- 12-24 hours	£234	Property affected	£113	£284	Property affected
Temporary use bans	£5	Property affected	£14,235	£8,566	1% change in risk
Leakage	£ 122335	ML/day	£59,131	£148,644	ML/day
N					
Unexpected Supply interruptions - 6-12 hours	£1,000	Property affected	£784	£850	Property affected
Temporary use bans	£58	Property affected	£267,852	£69,488	1% change in risk
Hardness of water	£2	Property affected	£2	£1.8	Property affected
Leakage	£ 35614	ML/day	£27,924	£30,261	ML/day
O					
Discoloured water	£1,326	Property affected	£178	£433	Property affected
Taste and smell of water	£1,233	Property affected	£166	£402	Property affected
Unexpected Supply interruptions - 6-12 hours	£1,396	Property affected	£188	£456	Property affected
Temporary use bans	£35	Property affected	£27,733	£16,107	1% change in risk
Hardness of water	£41	Property affected	£6	£14	Property affected
Leakage	£267960	ML/day	£36,048	£87,457	ML/day

Note: Company F excluded since it contained values for only one service measure

Table 43: External PR14 WTP values and Derived Unit values for NHH customers

Company/ Attribute	EXTERNAL WTP DATA		DERIVED UNIT VALUES		
A	**Unit value**	**Unit**	**SSW**	**CAM**	**Unit**
Taste and smell of water	106972	Property affected	£256	£2,354	Property affected
Unexpected Supply interruptions - 6-12 hours	2455	Property affected	£6	£54	Property affected
B					
Unexpected Supply interruptions - 6-12 hours	2990	Property affected	£257	£414	Property affected
Hosepipe /Temporary use bans	49.5	Property affected	£25,069	£9,657	1% change in risk
C					
Discoloured water	14290	Property affected	£101	£907	Property affected
Taste and smell of water	51990	Property affected	£366	£3,299	Property affected
Unexpected Supply interruptions- 3-6 hours	2771	Property affected	£20	£176	Property affected
D					
Discoloured water	27960	Property affected	£143	£1,852	Property affected
Taste and smell of water	27760	Property affected	£142	£1,839	Property affected
Unexpected Supply interruptions- 3-6 hours	2276	Property affected	£12	£151	Property affected
E					
Discoloured water	133	Property affected	£76	£229	Property affected
Unexpected Supply interruptions - Less than 3 hours	850	Property affected	£485	£1,462	Property affected
Temporary use bans	88	Property affected	£295,513	£213,402	1% change in risk
G					
Discoloured water	2170	Property affected	£149	£1,751	Property affected
Taste and smell of water	2796	Property affected	£192	£2,257	Property affected
Unexpected Supply interruptions - Less than 3 hours	466	Property affected	£32	£376	Property affected
Temporary use bans	16	Property affected	£6,455	£18,207	1% change in risk
H					
Unexpected Supply interruptions- 3-6 hours	149	Property affected	£174	£347	Property affected
Temporary use bans	39	Property affected	£268,778	£127,913	1% change in risk
I					
Unexpected Supply interruptions- 3-6 hours	339	Property affected	£87	£91	Property affected
Occasional low water pressure	127	Property affected	£32	£34	Property affected
J					
Discoloured water	2550	Property affected	£164	£1,507	Property affected
Unexpected Supply interruptions - 6-12 hours	410	Property affected	£26	£242	Property affected
Temporary use bans	0	Property affected	£0	£0	1% change in risk
Occasional low water pressure	250	Property affected	£16	£148	Property affected
K					
Unexpected Supply interruptions- 3-6 hours	770	Property affected	£212	£0.03	Property affected
Temporary use bans	1352	Property affected	£2,189,857	£81	1% change in risk
Hardness of water	1	Property affected	£4	£0.00004	Property affected
Leakage	118800	ML/day	£32,669	£710,436	ML/day
L					
Discoloured water	1373	Property affected	£113	£869	Property affected
Taste and smell of water	2965	Property affected	£245	£1,877	Property affected
Unexpected Supply interruptions- 3-6 hours	1026	Property affected	£85	£649	Property affected
Temporary use bans	674	Property affected	£327,746	£601,548	1% change in risk
Occasional low water pressure	246	Property affected	£20	£37	Property affected
M					
Discoloured water	720	Property affected	£123	£816	Property affected
Taste and smell of water	450	Property affected	£77	£510	Property affected
Unexpected Supply interruptions- 12-24 hours	1635	Property affected	£279	£1,854	Property affected
Temporary use bans	218	Property affected	£218,851	£348,533	1% change in risk
N					
Unexpected Supply interruptions - 6-12 hours	4409	Property affected	£682	£0.4	Property affected
Temporary use bans	1690	Property affected	£1,540,555	£195	1% change in risk
Hardness of water	25	Property affected	£62	£0.002	Property affected
Leakage	56612	ML/day	£8,762	£653,818	ML/day
O					
Discoloured water	320	Property affected	£212	£0.06	Property affected
Taste and smell of water	216	Property affected	£143	£0.04	Property affected
Unexpected Supply interruptions - 6-12 hours	249	Property affected	£165	£0.05	Property affected
Temporary use bans	112	Property affected	£436,324	£31	1% change in risk
Hardness of water	10	Property affected	£105	£0.002	Property affected
Leakage	39706	ML/day	£26,262	£1,102,544	ML/day

Note: Company F excluded since it contained values for only one service measure

Table 44 and Table 43 below presents the original as well as the derived unit values for Household and Non-household customers based on the external WTP 19 evidence.

Table 44: External PR19 WTP values and Derived Unit values for HH customers

Company/ Attribute	EXTERNAL WTP DATA		DERIVED UNIT VALUES (in £)		
A	**Unit value**	**Unit**	**SSW**	**CAM**	**Unit**
Discoloured water	314	Property affected	71	179	Property affected
Unexpected Supply interruptions - 6-12 hours	943	Property affected	214	538	Property affected
Leakage	133624	Ml/d	30320	76272	Ml/d
Rota cuts and/or standpipes	112	Property affected	149685	90140	1% change in risk
B					
Unexpected Supply interruptions -4-8 hours	3822	Property affected	223	499	Property affected
Hosepipe /Temporary use bans	105	Property affected	36011	19314	1% change in risk
Leakage	559984	Ml/d	32607	73055	Ml/d
C					
Discoloured water	75	Property affected	64	106	Property affected
Taste and smell of water	231	Property affected	196	326	Property affected
Unexpected Supply interruptions- 12-24 hours	295	Property affected	251	417	Property affected
Temporary use bans	108	Property affected	540759	215015	1% change in risk
Rota cuts and/or standpipes	43	Property affected	215302	85608	1% change in risk
Occasional low water pressure	70	Property affected	60	99	Property affected
Leakage	44447	Ml/d	37784	62758	Ml/d
Protecting wildlife	11584	Hectare	9847	16356	Hectare
Traffic disruption	839	Property affected	713	1185	Roadworks incident
Water not safe to drink	548	Property affected	466	185	Property affected
Water metering	2	Household	2	3	Household
D					
Discoloured water	231	Property affected	138	269	Property affected
Taste and smell of water	255	Property affected	153	297	Property affected
Unexpected Supply interruptions- 12-24 hours	90	Property affected	54	105	Property affected
Temporary use bans	155	Property affected	547167	254867	1% change in risk
Rota cuts and/or standpipes	155	Property affected	547167	254867	1% change in risk
Occasional low water pressure	21	Property affected	13	24	Property affected
Leakage	104096	Ml/d	62389	121394	Ml/d
Protecting wildlife	11703	Hectare	7014	13648	Hectare
Traffic disruption	417	Property affected	250	486	Roadworks incident
Water not safe to drink	431	Property affected	258	503	Property affected
Water metering	7	Property fitted	4	8	Household
E					
Unexpected Supply interruptions - 3-6 hours	310	Property affected	60	118	Property affected
Unexpected Supply interruptions - 6-12 hours	174	Property affected	33	66	Property affected
Rota cuts and/or standpipes	172	Property affected	194513	92660	1% change in risk
Leakage	291633	Ml/d	55994	111425	Ml/d
Protecting wildlife	9092	Hectare	1746	3474	Hectare
G					
Taste and smell of water	38235	Property affected	577	1743	Property affected
Unexpected Supply interruptions - Less than 3 hours	132	Property affected	2	6	Property affected
Temporary use bans	32	Property affected	2844	2057	1% change in risk
Leakage	390688	Ml/d	5894	17814	Ml/d
I					
Unexpected Supply interruptions - Less than 3 hours	1312	Property affected	738	217	Property affected
Temporary use bans	0	Property affected	0	0	1% change in risk
Leakage	753888	Ml/d	424238	124965	Ml/d
Protecting wildlife	61013	Hectare	34334	10114	Hectare
J					
Taste and smell of water	1455	Property affected	237	272	Property affected
Unexpected Supply interruptions -3-6 hours	515	Property affected	84	96	Property affected
Unexpected Supply interruptions -6-12 hours	579	Property affected	94	108	Property affected
Temporary use bans	325	Property affected	311491	85670	1% change in risk
L					
Discoloured water	60	Property affected	50	59	Property affected
Taste and smell of water	147	Property affected	123	145	Property affected
Unexpected Supply interruptions- 3-6 hours	136	Property affected	114	134	Property affected
Unexpected Supply interruptions- 6-12 hours	287	Property affected	240	283	Property affected
Unexpected Supply interruptions-12-24 hours	293	Property affected	245	289	Property affected
Temporary use bans	38	Property affected	186835	52889	1% change in risk
Occasional low water pressure	80	Property affected	67	79	Property affected
Traffic disruption	67	Property affected	56	66	Roadworks incident
M					
Discoloured water	139	Property affected	69	58	Property affected
Taste and smell of water	266	Property affected	132	112	Property affected
Unexpected Supply interruptions- 3-6 hours	282	Property affected	140	118	Property affected
Unexpected Supply interruptions- 6-12 hours	515	Property affected	255	216	Property affected
Temporary use bans	97	Property affected	282943	57460	1% change in risk
P					
Temporary use bans	38	Property affected	19800	10466	1% change in risk
Leakage	655153	Ml/d	57956	127974	Ml/d
Water metering	53	Property fitted	5	10	Household
Q					
Discoloured water	90	Property affected	27	50	Property affected
Taste and smell of water	2132	Property affected	644	1173	Property affected
Unexpected Supply interruptions - Less than 3 hours	632	Property affected	191	348	Property affected
Temporary use bans	54	Property affected	96095	41878	1% change in risk
Leakage	24293	Ml/d	7340	13361	Ml/d
T					
Unexpected Supply interruptions- 3-6 hours	319	Property affected	3	3	Property affected
Water not safe to drink	63964	Property affected	694	587	Property affected
U					
Unexpected Supply interruptions - 6-12 hours	2495	Property affected	131	255	Property affected
Leakage	611894	Ml/d	32054	62421	Ml/d

Table 45: External PR19 WTP values and Derived Unit values for NHH customers

Company/ Attribute	EXTERNAL WTP DATA		DERIVED UNIT VALUES (in £)		
A	**Unit value**	**Unit**	**SSW**	**CAM**	**Unit**
Discoloured water	873	Property affected	126	659	Property affected
Unexpected Supply interruptions - 6-12 hours	2182	Property affected	315	1648	Property affected
Leakage	416722	Ml/d	60080	314749	Ml/d
Rota cuts and/or standpipes	467	Property affected	396568	497340	1% change in risk
B					
Unexpected Supply interruptions -4-8 hours	65629	Property affected	280	1142	Property affected
Hosepipe /Temporary use bans	30486	Property affected	767455	748173	1% change in risk
Leakage	11838937	Ml/d	50600	206061	Ml/d
C					
Discoloured water	963	Property affected	40	171	Property affected
Taste and smell of water	2812	Property affected	117	501	Property affected
Unexpected Supply interruptions- 12-24 hours	12997	Property affected	543	2315	Property affected
Temporary use bans	3097	Property affected	761907	777641	1% change in risk
Rota cuts and/or standpipes	1770	Property affected	435446	444438	1% change in risk
Occasional low water pressure	1792	Property affected	75	319	Property affected
Leakage	1379870	Ml/d	57635	245729	Ml/d
Protecting wildlife	117258	Hectare	4898	20881	Hectare
Traffic disruption	14278	Property affected	596	2543	Roadworks incident
Water not safe to drink	6724	Property affected	281	287	Property affected
D					
Discoloured water	9635	Property affected	185	1158	Property affected
Taste and smell of water	14953	Property affected	287	1797	Property affected
Unexpected Supply interruptions- 12-24 hours	3686	Property affected	71	443	Property affected
Temporary use bans	4506	Property affected	510211	763572	1% change in risk
Rota cuts and/or standpipes	4005	Property affected	453483	678674	1% change in risk
Occasional low water pressure	683	Property affected	13	82	Property affected
Leakage	1996421	Ml/d	38379	239934	Ml/d
Protecting wildlife	162432	Hectare	3123	19521	Hectare
Traffic disruption	23734	Property affected	456	2852	Roadworks incident
Water not safe to drink	26419	Property affected	508	3175	Property affected
E					
Unexpected Supply interruptions - 3-6 hours	701	Property affected	143	621	Property affected
Unexpected Supply interruptions - 6-12 hours	371	Property affected	76	329	Property affected
Rota cuts and/or standpipes	782	Property affected	941288	976935	1% change in risk
Leakage	339374	Ml/d	69355	300689	Ml/d
Protecting wildlife	45874	Hectare	9375	40645	Hectare
G					
Taste and smell of water	234737	Property affected	962	7052	Property affected
Unexpected Supply interruptions - Less than 3 hours	961	Property affected	4	29	Property affected
Temporary use bans	346	Property affected	8351	14657	1% change in risk
Leakage	1969650	Ml/d	8071	59175	Ml/d
I					
Unexpected Supply interruptions - Less than 3 hours	5161	Property affected	1379	423	Property affected
Temporary use bans	0	Property affected	0	0	1% change in risk
Leakage	5694943	Ml/d	85523	466597	Ml/d
Protecting wildlife	239385	Hectare	63969	19613	Hectare
J					
Taste and smell of water	3325	Property affected	181	769	Property affected
Unexpected Supply interruptions -3-6 hours	2524	Property affected	138	584	Property affected
Unexpected Supply interruptions -6-12 hours	2620	Property affected	143	606	Property affected
Temporary use bans	531	Property affected	170429	173208	1% change in risk
L					
Discoloured water	353	Property affected	52	154	Property affected
Taste and smell of water	804	Property affected	118	351	Property affected
Unexpected Supply interruptions- 3-6 hours	1565	Property affected	229	684	Property affected
Unexpected Supply interruptions- 6-12 hours	1941	Property affected	284	849	Property affected
Unexpected Supply interruptions-12-24 hours	2661	Property affected	390	1163	Property affected
Temporary use bans	211	Property affected	181950	130061	1% change in risk
Occasional low water pressure	338	Property affected	49	148	Property affected
Traffic disruption	735	Property affected	108	321	Roadworks incident
M					
Discoloured water	953	Property affected	74	267	Property affected
Taste and smell of water	1643	Property affected	127	461	Property affected
Unexpected Supply interruptions- 3-6 hours	4224	Property affected	327	1185	Property affected
Unexpected Supply interruptions- 6-12 hours	4699	Property affected	363	1318	Property affected
Temporary use bans	342	Property affected	155822	135236	1% change in risk
P					
Temporary use bans	211	Property affected	127870	198145	1% change in risk
Leakage	686587	Ml/d	70643	457275	Ml/d
T					
Unexpected Supply interruptions- 3-6 hours	10840	Property affected	1	2	Property affected
Water not safe to drink	7981466	Property affected	605	1530	Property affected
U					
Unexpected Supply interruptions - 6-12 hours	1663	Property affected	82	395	Property affected
Leakage	1553101	Ml/d	76393	368849	Ml/d

We then averaged the derived unit WTP values for each of the attributes based on the External PR14 and External PR19 evidence. Table 46 presents these values for household and non-household customers in both the SSW and CAM regions.

Table 46: Average Derived Unit Values from External PR14 and PR19 studies

Attributes	SSW HH		SSW NHH		CAM HH		CAM NHH	
	External PR14	External PR19	External PR14	External PR19	External PR14	External PR19	External PR14	External PR19
Water not safe to drink		£473		£464		£425		£1,664
Discoloured water	£113	£78	£135	£95	£358	£134	£991	£482
Taste and smell of water	£187	£236	£203	£299	£432	£483	£1,734	£1,822
Water hardness	£3		£57		£6		£0.001	
Unexpected temporary loss of water supply	£163	£168	£180	£184	£252	£209	£415	£789
Low water pressure	£31	£46	£23	£46	£70	£67	£73	£183
Temporary use ban	£130,958	£214,205	£530,915	£298,222	£48,085	£77,527	£131,957	£326,744
Drought restrictions		£276,667		£556,696		£130,819		£649,347
Leakage	£45,868	£82,137	£22,564	£57,409	£87,376	£86,453	£822,266	£295,451
Water metering		£4				£7		
Protecting wildlife habitats		£13,235		£5,248		£8,718		£25,165
Traffic disruption		£340		£387		£579		£1,905

Note that the derived unit WTP values for each of the attributes based on the External evidence was averaged and then weighted in order to ensure that we didn't place too much weight on the external evidence in comparison to the SSW evidence. The next step involved weighting the average Unit WTP values derived from External PR14 and PR19 with respect to theoretical and statistical measures of validity and combining them to derive a central estimate and a judicious range for the core WTP service measures. This step is discussed in the next section.

4.3 Assess and Rate

In this section we compare the strengths and weaknesses of the various data sources based on theoretical and statistical considerations and then assign each measure a RAG rating against the appraisal criteria.

Overall RAG ratings are assigned for each source and weights are then used based on these ratings to combine measures across sources. Table 15 in the previous section showed the set of weights corresponding to each of the RAG ratings. These weights are based on our judgement as to the relative validity of measures in the different categories. We explore sensitivity testing using alternative set of weights post WTP triangulation in Section 4.5.

WTP Core Research

Table 47 presents the key considerations in the assessment of the WTP core measures (DCE and MaxDiff) and the associated RAG ratings

Table 47: WTP Triangulation: Assessment and rating of WTP core data

Validity measures	Key considerations	RAG rating
Theoretical validity	i. WTP surveys involved customers in the design of survey and service measures for inclusion in the main survey hence the core measures are based on more informed choices	GREEN
	ii. Well-designed and implemented WTP studies	GREEN
	iii. Relative values in the WTP core DCE are affected by differences in scope of change offered, but this study is the benchmark	GREEN

	iv. WTP core MaxDiff measures are however weaker on validity since there is no scope sensitivity and no explicit controlling for bill impacts	AMBER
Statistical validity	i. Robust sample frame to ensure representation of all customer types (including hard to reach) ii. WTP measures based on large sample sizes iii. Results based on recent survey (2017 and 2018) iv. Due to the very small sample sizes obtained for non-households in the Cambridge area in the Wave 2 research, we down-weight this segment of results in the triangulation analysis.	GREEN GREEN GREEN RED
Overall validity	**WTP Wave 1 DCE**: Well-designed and implemented study with large representative samples of SSW/CAM customers **WTP Wave 2 DCE**: All segments except CAM NHH **WTP Wave 2 DCE**: CAM NHH **WTP core Maxdiff**: Same statistical properties as WTP Core: DCE, but somewhat weaker on validity	GREEN GREEN RED GREEN/ AMBER

WRMP Research

Table 48 presents the key considerations in the assessment of the WRMP core measures (Workshop and Online) and the associated RAG ratings

Table 48: WTP Triangulation: Assessment and rating of WRMP core data

Validity measures	Key considerations	RAG rating
Theoretical validity	i. WRMP measures based on survey in which the demand management and supply side options included were far fewer than what the companies really faces. They were simplified hybrid options, taken from the real process the company is going through as part of WRMP and PR19. ii. The criteria and the information shared about each of the demand management and supply side options were necessarily at a high level. Some key elements were not covered at all (e.g. timescale / phasing of delivery.) iii. Each option had a short description and gave respondents a feel for its service measures in terms volume, cost and environmental impact, using verbal scales iv. Workshop measures based on an informed dialogue process involving quiz, handouts and animations-This enabled the participants to make informed choices of the various priorities v. Fewer options and fewer details about each option could be shared in the online survey than in the workshop hence online measures based on less informed choices. vi. Both WRMP workshop and online measures are reasonable measures of priority amongst the included measures. However, these measures are not as strong as WTP since no WTP measured and mapping assumes that priorities index is the same as a WTP index for S0 to S2	AMBER AMBER GREEN GREEN AMBER AMBER
Statistical validity	--Online measures not based on a random sample of the wider customer base but based on data representative (after weighting) of each of the two regions --Online measures based on fairly small sample sizes: 300 (SSW) and 200 (CAM). -- Workshop measures based on representative sample -- Workshop measures based on very small sample sizes: 31 (SSW) and 27 (CAM). --Results based on recent surveys (2017)	GREEN /AMBER AMBER GREEN RED GREEN
Overall validity	**WRMP Online**: Reasonable measure of priority amongst the included measures, but not as strong as WTP. Mid-size representative samples of SSW/CAM customers **WRMP Workshop**: More info given and room for debate than online survey. However, sample is small	AMBER AMBER

Customer Priorities

Table 49 presents the key considerations in the assessment of the Customer priorities measures and the associated RAG ratings

Table 49: WTP Triangulation: Assessment and rating of Customer Priorities

Validity measures	Key considerations	RAG rating
Theoretical validity	i. Definition of service measures in the WTP study match reasonably closely to the definition of Customer priorities options being assessed. ii. Customer priorities options do not however contain any information on the scope of service change or the durations of incident iii. To mirror earlier qualitative Foundation Research, customer priorities measures based on survey in which the participants were uninformed; they viewed the options presented to them with no context setting (e.g. how much each option might cost).	AMBER RED RED
Statistical validity	i. Survey respondents recruited via a pop-up link to the online survey on the SSW/CAM websites and hence not based on a random sample of the wider customer base. However, data made representative (after weighting) of each of the two regions ii. Results based on recent survey (2017/2018) iii. Fairly large sample sizes: 291 SSW customers and 166 CAM customers iv. Customer priorities scale derived via rigorous statistical analysis of responses v. Derived WTP values based on customer priorities calibrated to equate package WTP to the WTP Wave 1 and Wave 2 DCE results for included measures.	AMBER GREEN GREEN GREEN AMBER
Overall validity	Good statistical properties, but less theoretically robust than focussed WTP study.	AMBER

Customer Contacts

Table 50 presents the key considerations in the assessment of the Customer contacts measures and the associated RAG ratings

Table 50: WTP Triangulation: Assessment and rating of Customer Contacts

Validity measures	Key considerations	RAG rating
Theoretical validity	i. Some concerns regarding the comparability of the definitions of the services between the core WTP study and the Customer contacts data ii. Contact types have been tallied up with the WTP service measures as best as possible. However, where there is a timeframe in the WTP service measure, this isn't logged in the contact type. iii. There is likely to be a small % logging error where the contact centre agent has logged the contact type incorrectly. iv. Contacts data has not been validated (e.g. by listening to a recorded call, read full complaint comments) so we assume that all contact data is logged correctly. v. Unwanted contacts as a proportion of properties affected are a good measure of impact. This is because unwanted contacts are made if customer experiences service failure which implies that the measure based on actual behaviour. However, there are some concerns that the approach might favour those who complain more frequently. For e.g. Older people are more likely to complain, hence values could be biased towards their preferences. (discolouration appears to be more highly valued by older people, hence this source could contain a bias towards discolouration.) vi. Derived WTP values based on customer contacts data calibrated to equate package WTP to the WTP Wave 2 DCE results for included measures.	AMBER AMBER AMBER AMBER AMBER GREEN
Statistical validity	i. Representative sample since contacts data based on full population of customers. ii. Contacts data based on SSC customer base hence the demographic structure consistent with core study iii. Contacts data based on 3-year average for SSW (YTD Apr17-Feb18, Feb YTD 2016/17 and Feb YTD 2015/16) and 2-year average for CAM (YTD Apr17-Feb18, Feb YTD 2016/17).	GREEN GREEN GREEN
Overall validity	Good statistical properties, but less theoretically robust than focussed WTP study.	AMBER

Customer Satisfaction

Table 51 presents the key considerations in the assessment of the Customer satisfaction measures and the associated RAG ratings.

Table 51: WTP Triangulation: Assessment and rating of Customer Satisfaction

Validity measures	Key considerations	RAG rating
Theoretical validity	i. Some concerns regarding the comparability of the definitions of the services between the core WTP study and the Customer satisfaction data e.g. differences in durations of incident ii. Satisfaction Index derived from regression analysis of the impact on satisfaction and NPS of experiencing a service failure hence it is a good measure of relative impact. However, there are some concerns over model findings that interruptions increase satisfaction slightly. iii. Derived WTP values based on customer satisfaction data calibrated to equate package WTP to the WTP Wave 2 DCE results for included measures	AMBER AMBER GREEN
Statistical validity	i. Sample sizes are fairly small: SSW=303, CAM=103. ii. Satisfaction data representative of SSC HH customer base iii. Results based on recent survey (2017/2018).	AMBER GREEN GREEN
Overall validity	Potentially a good measure of relative impact, but some concerns over model findings and potential discrepancies between self-reported experience and SSW's service levels.	AMBER

PC Service Sliders

Table 52 presents the key considerations in the assessment of the PC Slider measures and the associated RAG ratings.

Table 52: WTP Triangulation: Assessment and rating of PC Slider

Validity measures	Key considerations	RAG rating
Theoretical validity	i. Some concerns regarding the comparability of the definitions of the services between the core WTP study and the PC Slider data e.g. differences in durations of incident ii. In deriving WTP values, we assume a minimum bound for the individual WTP i.e. we assume that an individual's WTP is equal to the bill amount at the service level chosen in the survey and zero beyond. iii. Derived WTP values based on PC slider data calibrated to equate package WTP to the WTP core DCE results for included measures	AMBER AMBER GREEN
Statistical validity	i. Sample sizes are reasonable: SSW=319, CAM=139 ii. PC Slider data representative of SSC HH customer base iii. Results based on recent survey (2018).	AMBER GREEN GREEN
Overall validity	Potentially a good measure of WTP, but less theoretically robust than focussed WTP study.	GREEN /AMBER

PR14 And External WTP Evidence

Table 53 presents the key considerations in the assessment of the SSW PR14 measures and External PR14/PR19 measures and the associated RAG ratings

Table 53: WTP Triangulation: Assessment and rating of SSW PR14 and External PR14 data

Validity measures	Key considerations	RAG rating
Theoretical validity	***SSC PR14:***	
	i. Well-designed and implemented WTP study	GREEN
	ii. Measures do not always directly match to those in the PR19 research.	AMBER
	iii. Different degrees of change valued for each service measure.	AMBER
	iv. Derived WTP values based on SSC PR14 study calibrated to equate package WTP to the WTP core DCE results for included measures	AMBER
	External PR14 and PR19:	
	i. Well-designed and implemented WTP studies	GREEN
	ii. Measures do not always directly match to those in the SSC PR19 research	AMBER
	iii. Different degrees of change valued for each service measure.	AMBER
	iv. Derived WTP values calibrated to equate package WTP to the WTP Wave 2 DCE results for included measures	AMBER
Statistical validity	***SSC PR14:***	
	i. Robust sample frame to ensure representation of all customer types	GREEN
	ii. Large sample of SSW customers	GREEN
	iii. Results based on survey that is 5 years old	AMBER
	External PR14 and PR19:	
	i. Large samples of customers	GREEN
	ii. WTP studies based on surveys conducted among customers of non-SSC companies.	AMBER
	iii. **PR14** results based on surveys that are 5 years old	RED
	iii. **PR19** results based on recently completed surveys.	GREEN
Overall validity	**SSW PR14**: WTP focus; large representative sample of SSC customers, but 5 years old. Measures do not always directly match to those in the PR19 research.	AMBER
	External PR14: WTP focus; large samples, but not of SSC customers, and 5 years old. Also, measures do not always directly match those in the SSC PR19 research	AMBER / RED
	External PR19: WTP focus; large samples, but not of SSC customers, and recent data. Measures do not always directly match those in the SSC PR19 research	AMBER

The next step to triangulation involves applying the relevant weights to each of the sources (based on the RAG ratings discussed above) and combining them to derive central values and ranges for the core WTP service measures. This step is discussed in the next section.

4.4 Triangulate

This section presents our main WTP triangulation results derived from applying weights to each of the data sources based on their overall RAG ratings and combining the measures to derive central values and ranges for the core WTP service measures.

The various measures are combined for each of the WTP core service measures by taking a weighted average of the Unit values derived from each of the data sources. As indicated before, the household and business WTP are added together for each region and the regional WTP totals are weighted by the size of each region (using property counts) to get to a final, weighted, combined WTP. The 'Combined SSC' WTP triangulated values are calculated as a weighted average of the South Staffs and Cambridge area results. The lower bound for the Unit values for each of the WTP service measures is defined as the minimum WTP value plus 20% of the difference between the minimum value and the central case value, while the Higher bound is defined as the maximum value minus 20% of the difference between the central case value and the maximum value.

The triangulated WTP values (blue bar labelled 'COMBINED' in the figures below) reflect customers' willingness to pay for each of the WTP options and will be used within CBA as part of the process of setting SSC PC levels, and for setting ODI rates.

Figures 16 to 18 present the final WTP triangulated values for 'Services at Property' and their associated ranges for SSW Combined (HH and NHH), SSW HH and SSW NHH respectively. Figure 16 shows that the triangulated Combined Unit WTP values are highest for Water not safe to drink and lowest for Lead pipes for SSW customers (households and non-households). Figure 17 shows that triangulated Unit WTP values for Water not safe to drink, Low water pressure and Flooding from burst pipes and Taste and Smell are closer to their WTP DCE1 than their WTP DCE2 values for SSW households. Figure 18 shows that the triangulated Unit WTP values for Water not safe to drink, Flooding from burst pipes, Unexpected temporary loss of water supply, Low water pressure and Lead pipes are closer to their WTP DCE1 than their WTP DCE2 values for SSW non-households.

Figure 16: SSW Combined WTP Unit Values and Range - Services at Property

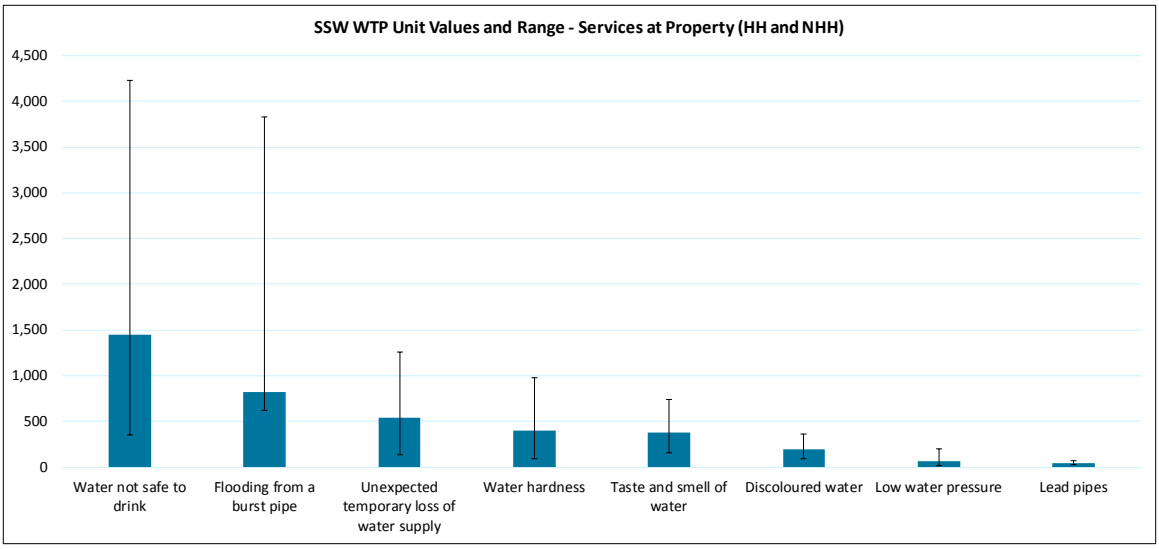
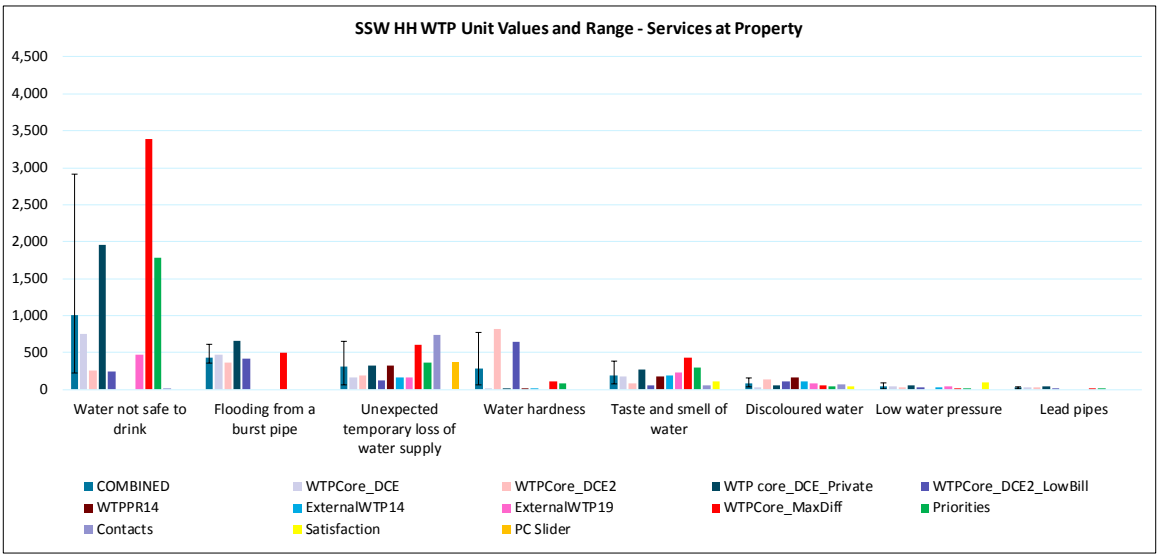
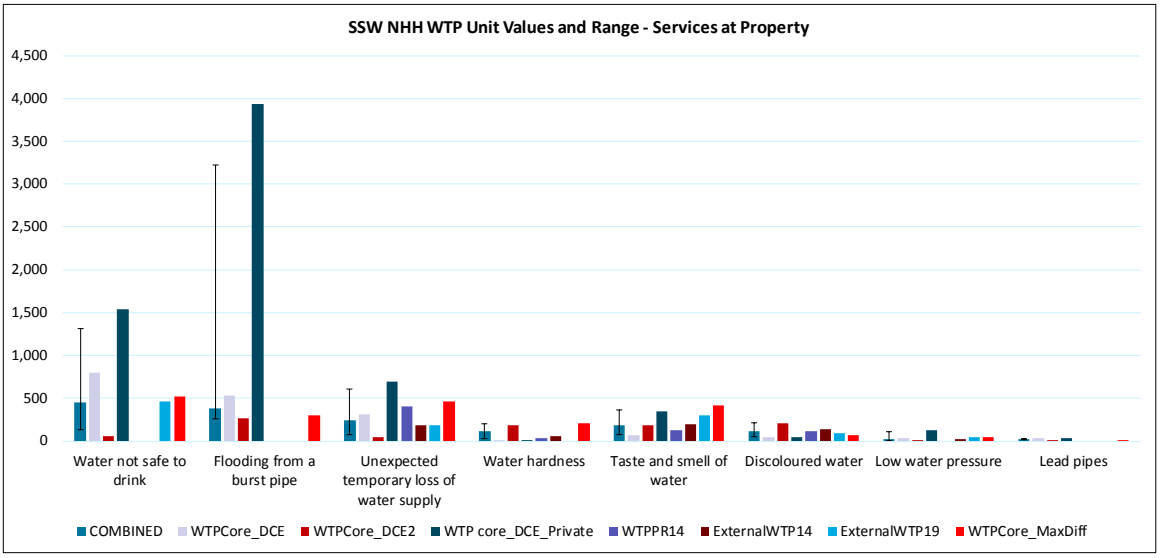


Figure 17: SSW HH WTP Unit Values and Range - Services at Property



Note: Wave 1 WTP Private values and Wave 2 WTP values resulting from the lower bill SP exercise are used as sensitivity checks so that they contribute to the range of values, but not to the central case i.e. Combined value.

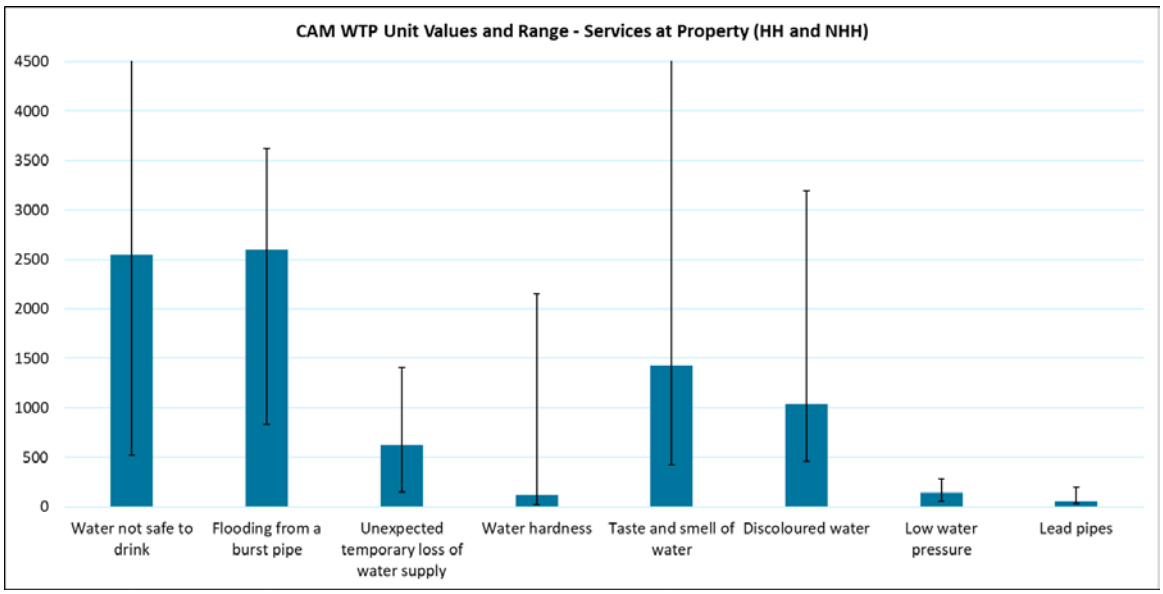
Figure 18: SSW NHH WTP Unit Values and Range - Services at Property



Note: Wave 1 WTP Private values are used as sensitivity checks so that they contribute to the range of values, but not to the central case i.e. Combined value.

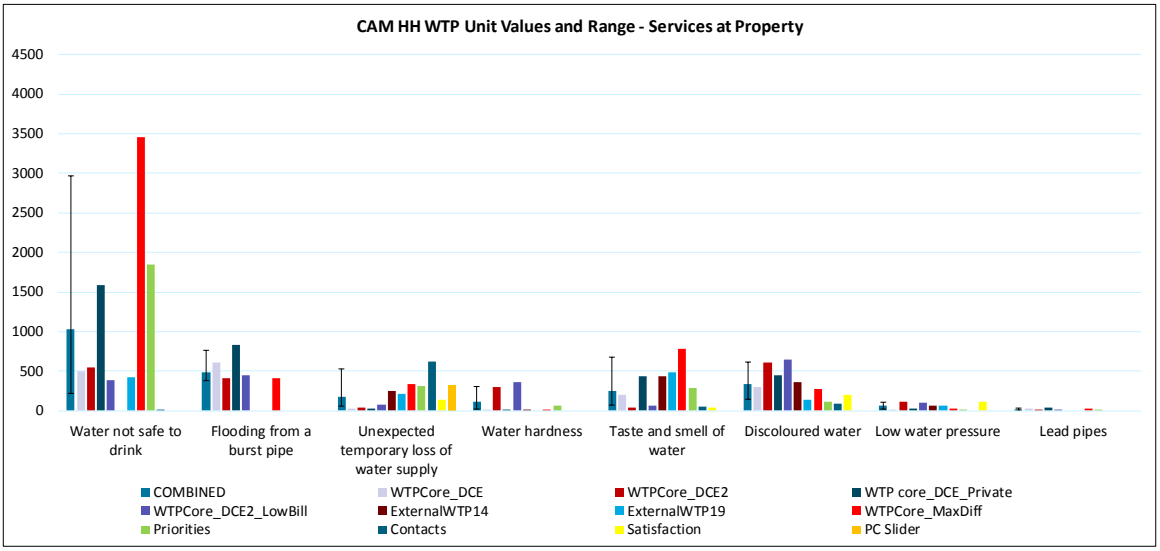
Figure 19, Figure 20 and Figure 21 presents the final WTP triangulated values for 'Services at Property' and their associated ranges for CAM Combined (HH and NHH), CAM HH and CAM NHH respectively. Figure 19 shows that the triangulated Combined Unit WTP values are highest for Flooding from burst pipes and lowest for Lead pipes for CAM customers (households and non-households).Figure 20 shows that triangulated Unit WTP values for Flooding from burst pipes, Lead Pipes and Taste and Smell are closer to their WTP DCE1 than their WTP DCE2 values for CAM households. Figure 21 shows that the triangulated Unit WTP values for Water not safe to drink, Flooding from burst pipes, Unexpected temporary loss of water supply, Water Hardness and Lead pipes are closer to their WTP DCE1 than their WTP DCE2 values for CAM non-households.

Figure 19: CAM Combined WTP Unit Values and Range - Services at Property



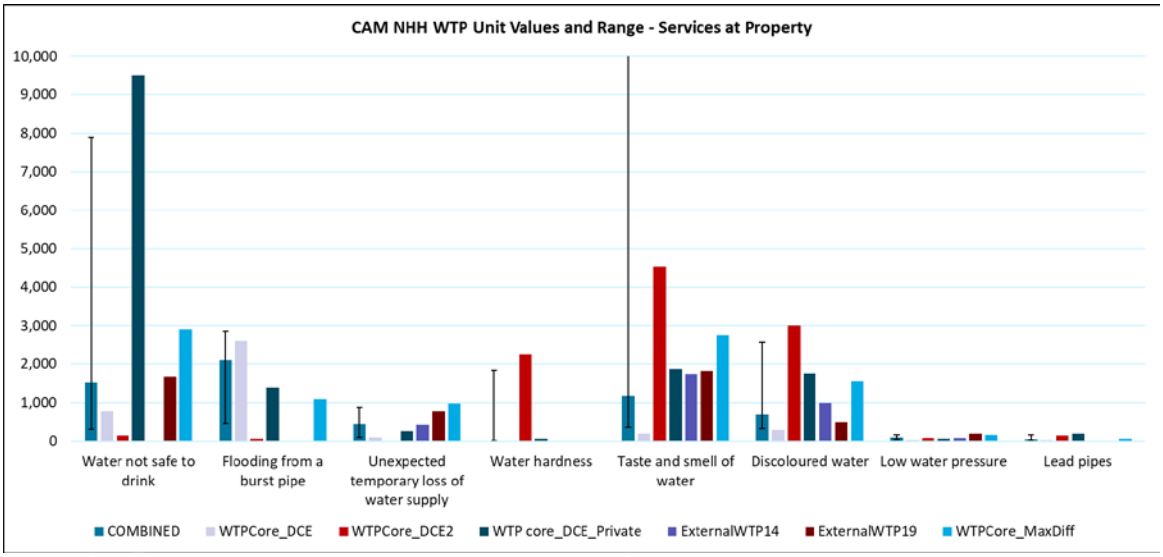
Note: Range curtailed to aid legibility. Upper bound of 'Water not safe to drink'=£10,872; Upper bound of 'Taste and smell of water'=£100,572.

Figure 20: CAM HH WTP Unit Values and Range - Services at Property



Note: Wave 1 WTP Private values and Wave 2 WTP values resulting from the lower bill SP exercise are used as sensitivity checks so that they contribute to the range of values, but not to the central case i.e. Combined value.

Figure 21: CAM NHH WTP Unit Values and Range - Services at Property

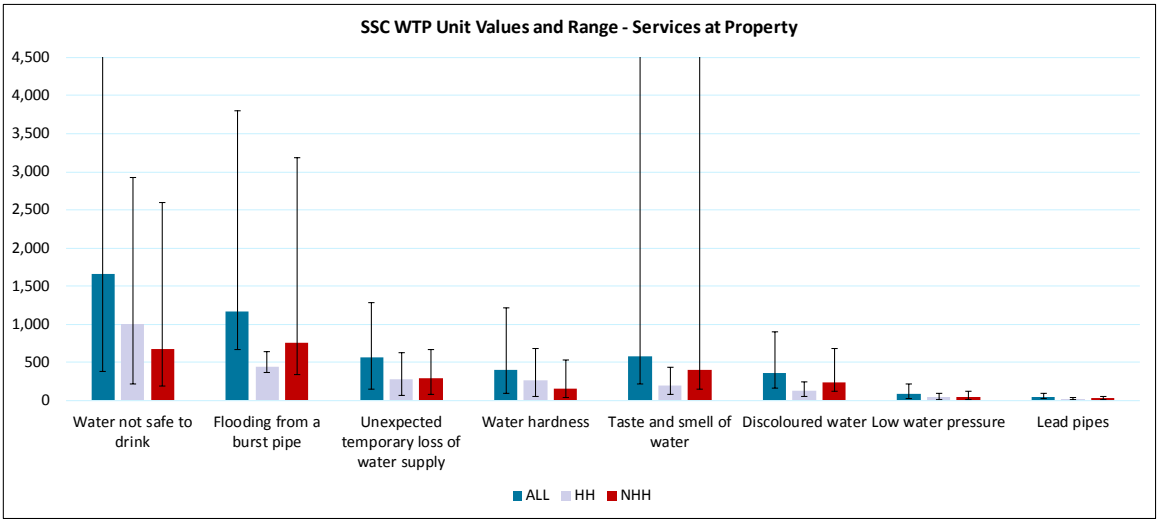


Note: Wave 1 WTP Private values are used as sensitivity checks so that they contribute to the range of values, but not to the central case i.e. Combined value. The above chart is based on a different scale in comparison to the corresponding chart for SSW i.e. Figure 18 due to a large value for 'Water not safe to drink'. Range curtailed to aid legibility: upper bound of 'Taste and smell of water'=£99,899.

Figure 22 presents the final WTP triangulated values for 'Services at Property' and their associated ranges for SSC (SSW and CAM combined).

The `Combined Unit WTP HH' is the weighted average of the triangulated WTP values for SSW HH and CAM HH, weighted by their respective HH property counts. The `Combined Unit WTP NHH' is the weighted average of the triangulated WTP values for SSW NHH and CAM NHH, weighted by their respective NHH property counts. Finally, the `Combined All' is the weighted average of the triangulated WTP values for SSW (HH and NHH combined) and CAM (HH and NHH combined), weighted by their respective total (HH and NHH) property counts. Overall, we find that the `COMBINED All' Unit values seem to have a very significant range due to the significant ranges associated with the `Combined NHH' values, especially with the CAM NHH values.

Figure 22: SSC WTP Unit Values and Range - Services at Property



Note: The triangulated WTP values (blue bar labelled 'ALL') will be used within the SSC CBA for setting PC levels and ODI rates. Range curtailed to aid legibility. Upper bound of 'Water not safe to drink'(ALL)=£5,504; Upper bound of 'Taste and smell of water'(ALL)=£19,894. Upper bound of 'Taste and smell of water'(NHH)=£19,479.

Figure 23, Figure 24 and Figure 25 presents the final WTP triangulated values for 'Drought Restrictions' and their associated ranges for SSW Combined (HH and NHH), SSW HH and SSW NHH respectively. Figure 23 shows that the triangulated Combined Unit WTP values is higher for Drought restrictions than Temporary Use Ban for SSW customers (households and non-households).Figure 24 shows that triangulated Unit WTP values for Drought restrictions are higher than their WTP DCE1 value for SSW households. Note that Drought restrictions was not included in the WTP Wave 2 study. The triangulated Unit WTP values for Temporary Use ban are closer to their WTP DCE1 values than their WTP DCE2 values for SSW households. Figure 25 shows that the triangulated Unit WTP values for Drought restrictions are higher than their WTP DCE1 values for SSW non-households. The triangulated Unit WTP values for Temporary Use ban are closer to their WTP DCE2 values than their WTP DCE1 values for SSW non-households.

Figure 23: SSW Combined WTP Unit Values and Range-Drought Restrictions

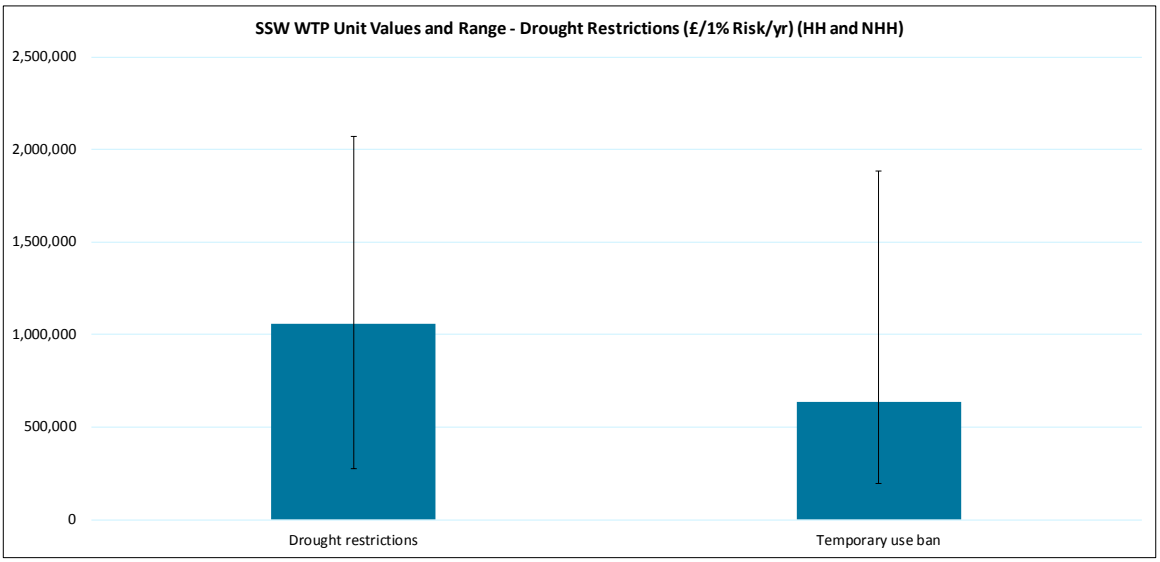
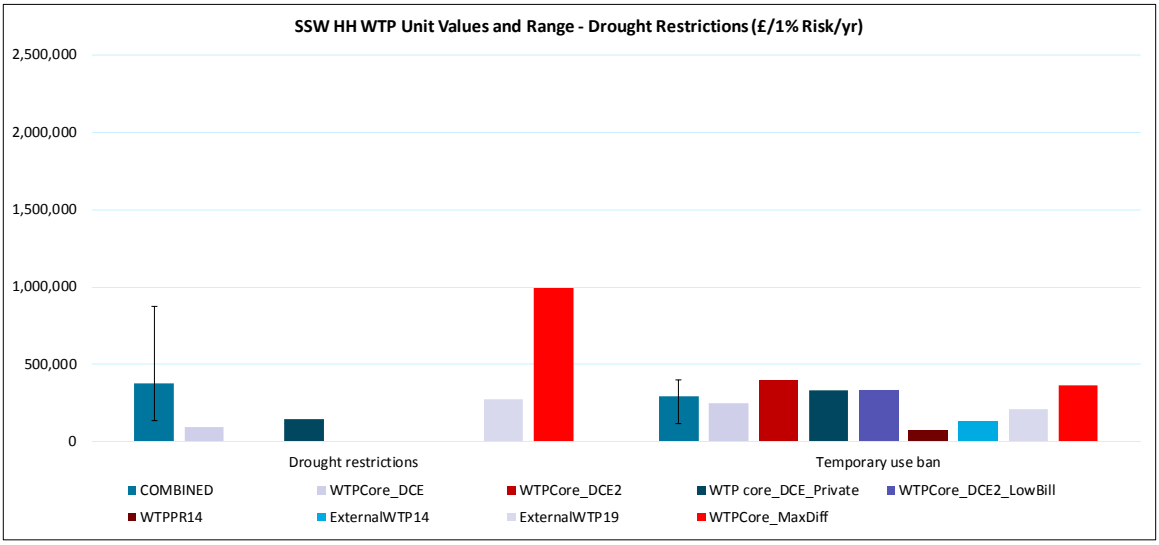
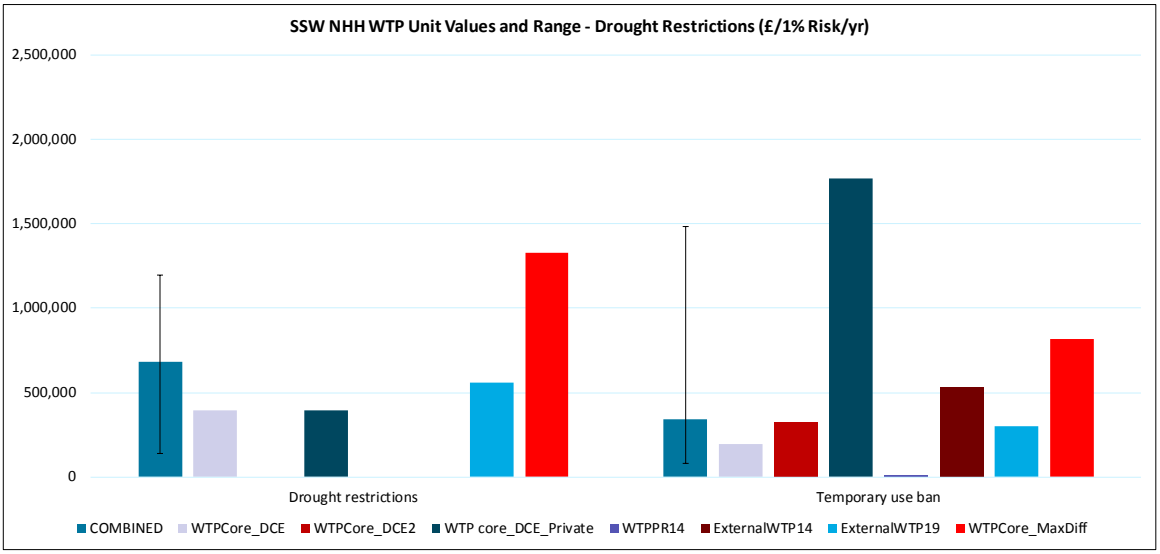


Figure 24: SSW HH WTP Unit Values and Range - Drought Restrictions



Note: Wave 1 WTP Private values and Wave 2 WTP values resulting from the lower bill SP exercise are used as sensitivity checks so that they contribute to the range of values, but not to the central case i.e. Combined value.

Figure 25: SSW NHH WTP Unit Values and Range - Drought Restrictions



Note: Wave 1 WTP Private values are used as sensitivity checks so that they contribute to the range of values, but not to the central case i.e. Combined value.

Figure 26, Figure 27 and Figure 28 presents the final WTP triangulated values for 'Drought Restrictions' and their associated ranges for CAM Combined (HH and NHH), CAM HH and CAM NHH respectively. Figure 26 shows that the triangulated Combined Unit WTP values is higher for Drought restrictions than Temporary Use Ban for CAM customers (households and non-households).Figure 27 shows that triangulated Unit WTP values for Drought restrictions are lower than their WTP DCE1 values for CAM households. Note that Drought restrictions was not included in the WTP Wave 2 study. The triangulated Unit WTP values for Temporary Use ban are closer to their WTP DCE1 values than their WTP DCE2 values for CAM households. Figure 28 shows that the triangulated Unit WTP values for Drought restrictions are higher than their WTP DCE1 values for CAM non-households. The triangulated Unit WTP values for Temporary Use ban are closer to their WTP DCE1 values than their WTP DCE2 values for CAM non-households.

Figure 26: CAM Combined WTP Unit Values and Range- Drought Restrictions

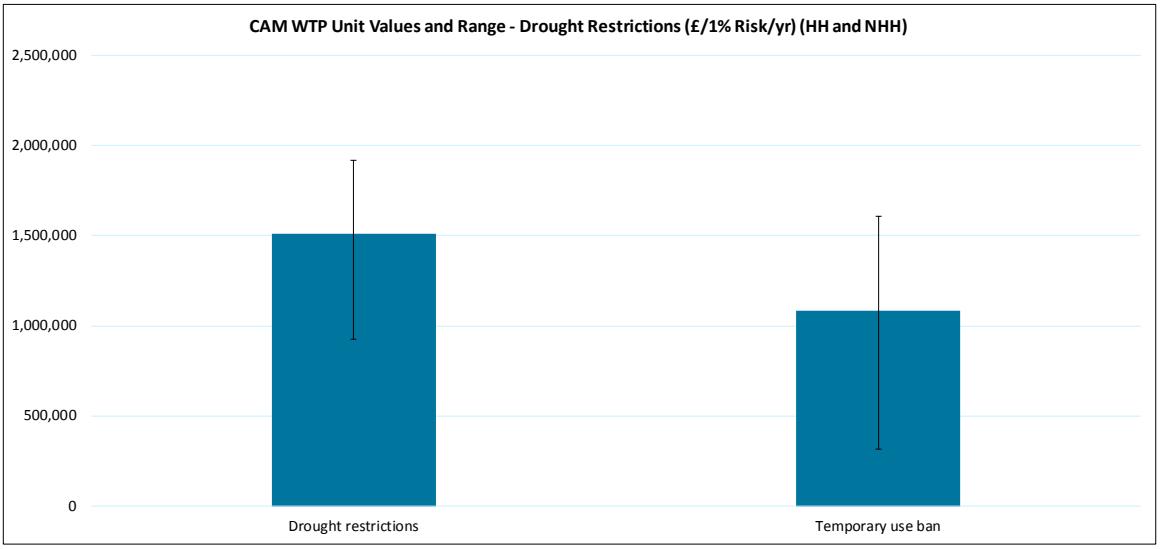
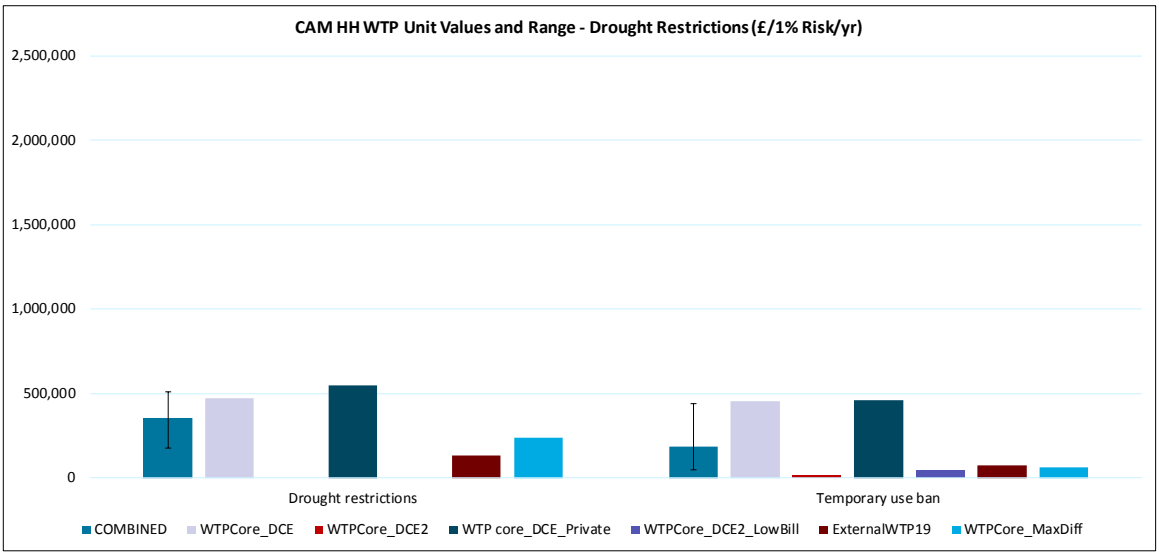


Figure 27: CAM HH WTP Unit Values and Range- Drought Restrictions



Note: Wave 1 WTP Private values and Wave 2 WTP values resulting from the lower bill SP exercise are used as sensitivity checks so that they contribute to the range of values, but not to the central case i.e. Combined value.

Figure 28: CAM NHH WTP Unit Values and Range - Drought Restrictions

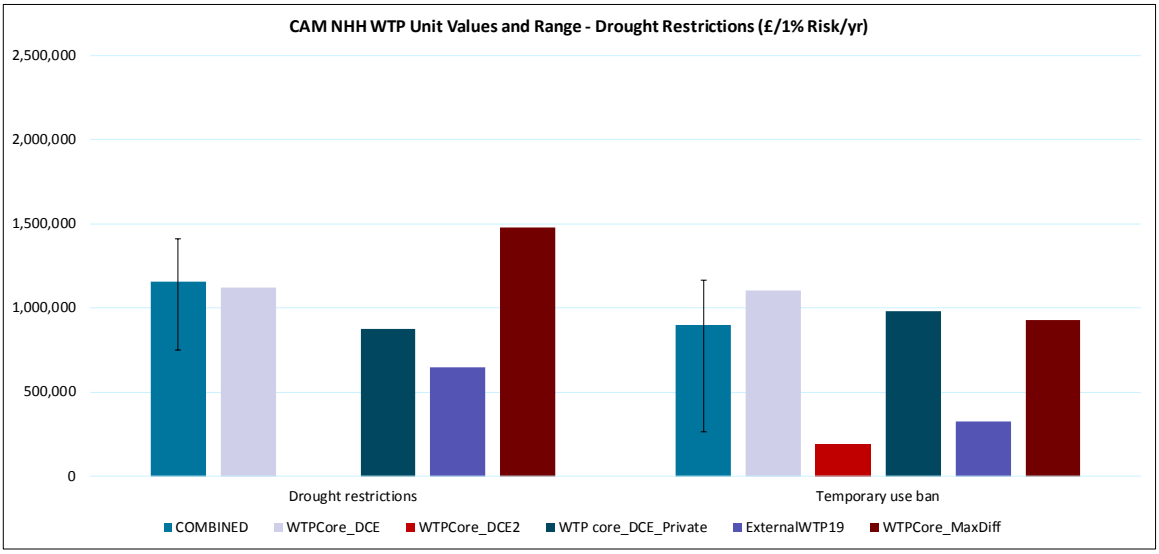
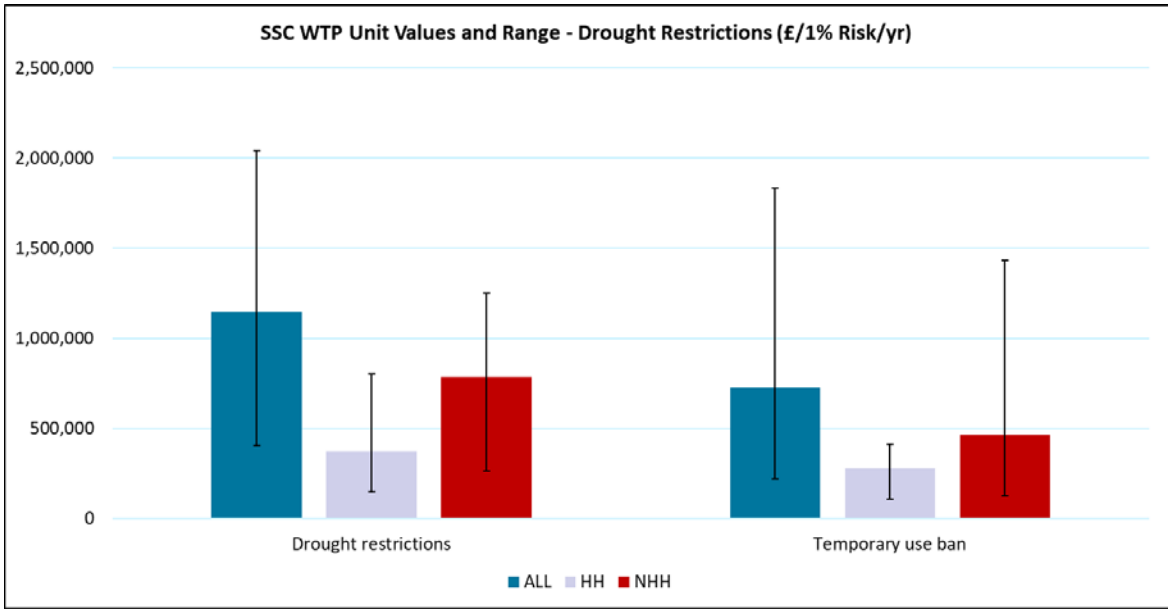


Figure 29 presents the final WTP triangulated values for 'Drought restrictions' and their associated ranges for SSC (SSW and CAM combined). Overall, we find that the `COMBINED All' Unit values seem to have a significant range due to the significant ranges associated with the `Combined NHH' values.

Figure 29: SSC WTP Unit Values and Range- Drought Restrictions



Note: No WTP data available on Drought restrictions from the SSW PR14 study and the Wave 2 WTP study. The triangulated WTP values (blue bar labelled 'COMBINED ALL') will be used within the SSC CBA for setting PC levels and ODI rates

Figure 30, Figure 31 and Figure 32 presents the final WTP triangulated values for 'Leakage' and their associated ranges for SSW Combined (HH and NHH), SSW HH and SSW NHH respectively. Figure 30 shows that the triangulated Combined Unit WTP value has a significant range for SSW customers (households and non-households).Figure 31 shows that triangulated Unit WTP values for Leakage are closer to their WTP DCE1 values than their WTP DCE2 values for SSW households. Figure 32 shows that the triangulated Unit WTP values for Leakage are closer to their WTP DCE2 values than their WTP DCE1 values for SSW non-households.

Figure 30: SSW Combined WTP Unit Values and Range-Leakage

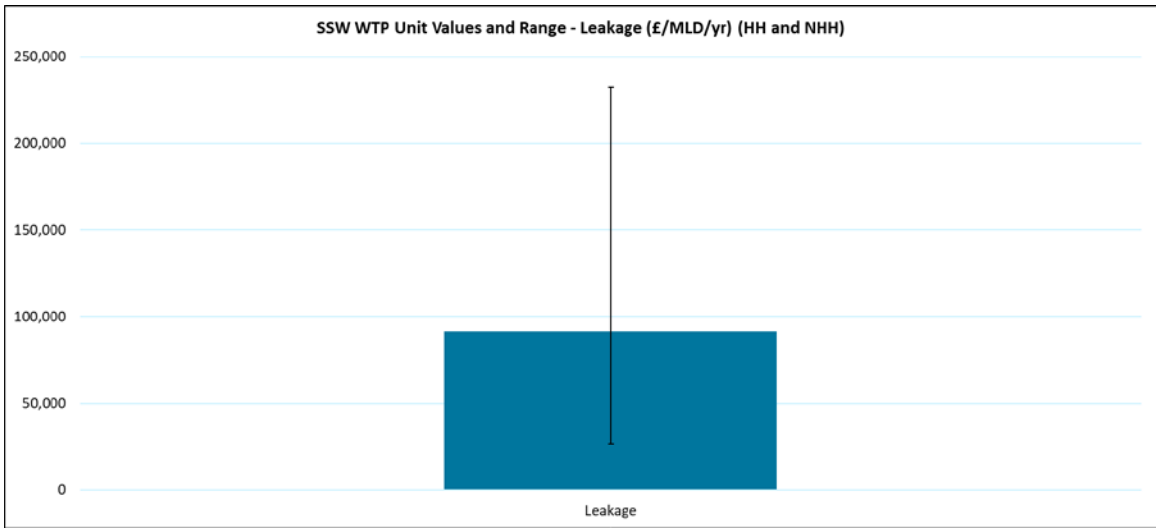
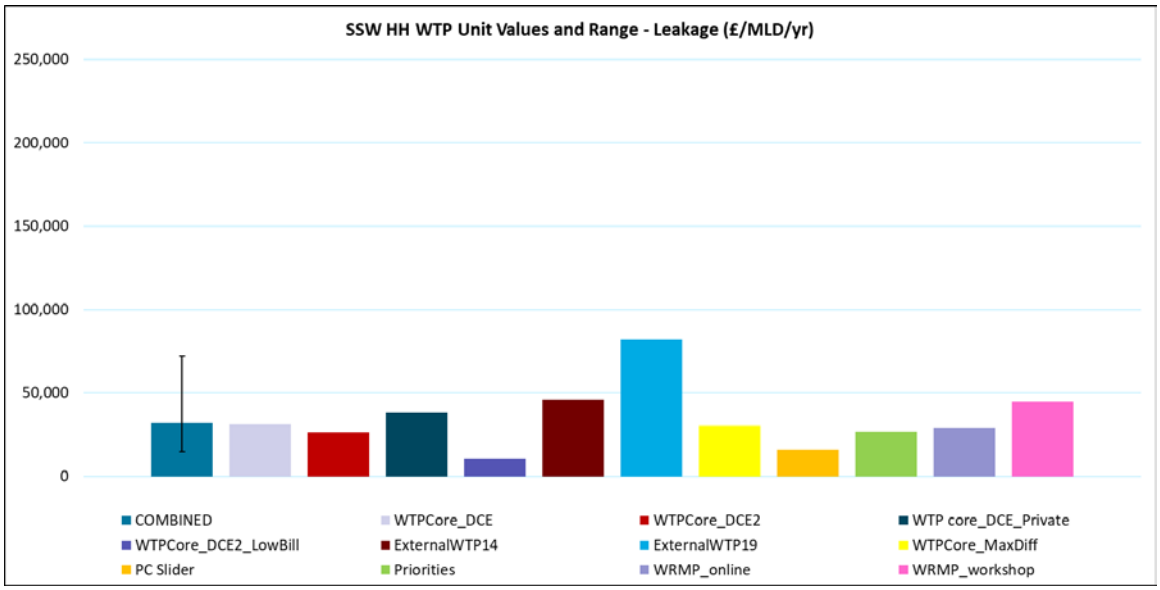
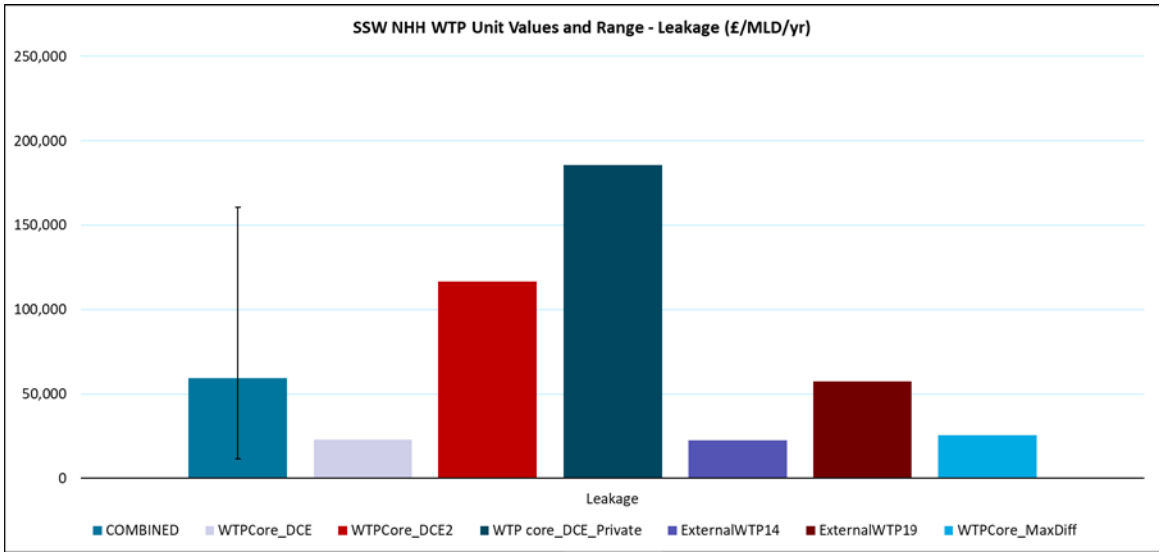


Figure 31: SSW HH WTP Unit Values and Range- Leakage



Note: Wave 1 WTP Private values and Wave 2 WTP values resulting from the lower bill SP exercise are used as sensitivity checks so that they contribute to the range of values, but not to the central case i.e. Combined value.

Figure 32: SSW NHH WTP Unit Values and Range - Leakage



Note: Wave 1 WTP Private values are used as sensitivity checks so that they contribute to the range of values, but not to the central case i.e. Combined value.

Figure 33, Figure 34 and Figure 35 presents the final WTP triangulated values for 'Leakage' and their associated ranges for CAM Combined (HH and NHH), CAM HH and CAM NHH respectively. Figure 33 shows that the triangulated Combined Unit WTP value has a significant range for CAM customers (households and non-households, mainly owing due to significant ranges for CAM NHH values. Figure 34 shows that triangulated Unit WTP values for Leakage are closer to their WTP DCE1 values than their WTP DCE2 values for CAM households. Figure 35 shows that the triangulated Unit WTP values for Leakage are closer to their WTP DCE2 values than their WTP DCE1 values for CAM non-households.

Figure 33: CAM Combined WTP Unit Values and Range- Leakage

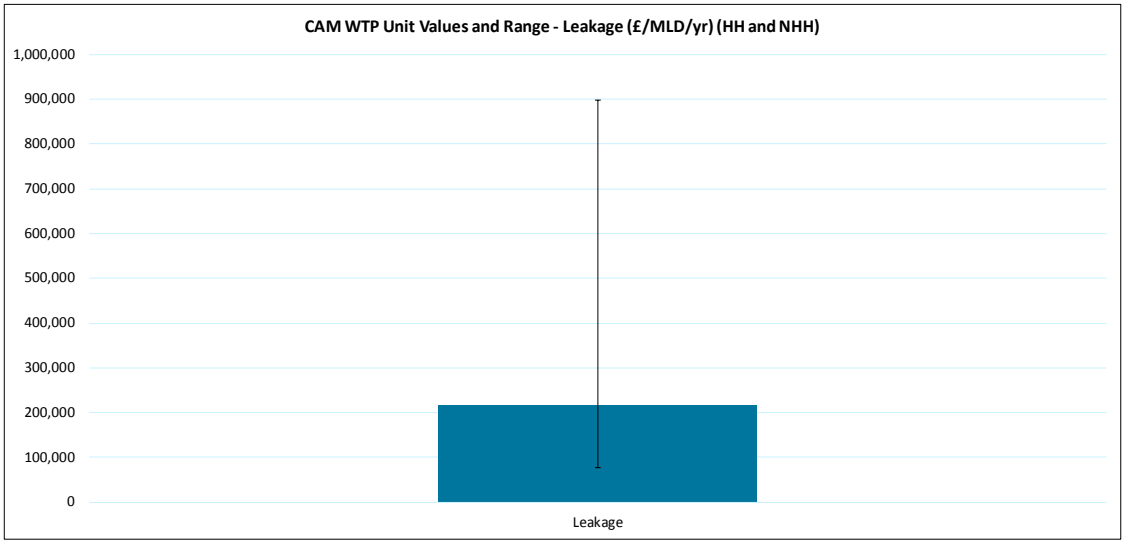
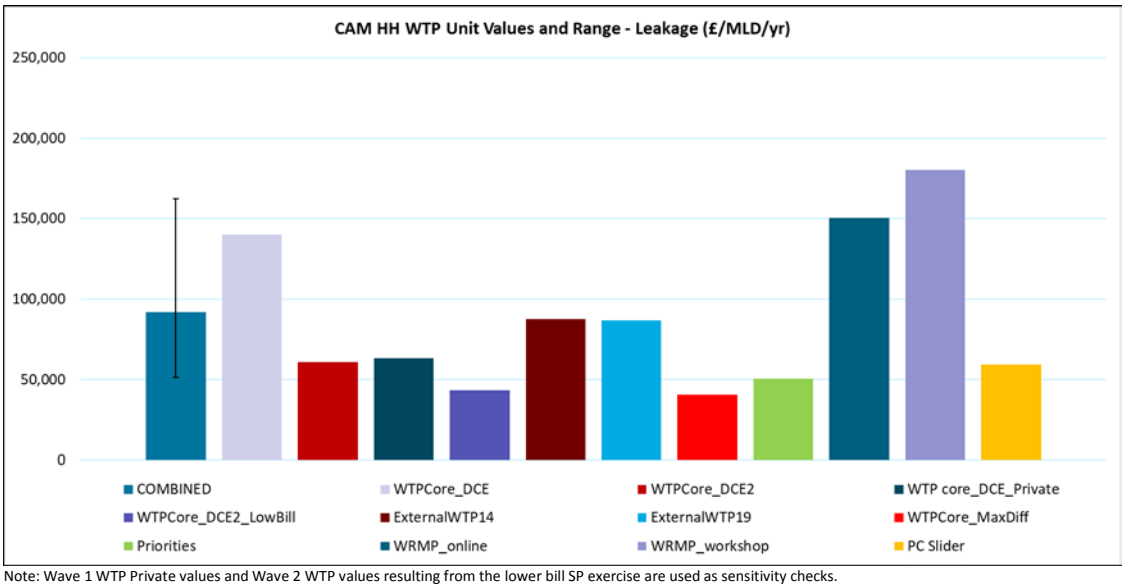


Figure 34: CAM HH WTP Unit Values and Range- Leakage



Note: Wave 1 WTP Private values and Wave 2 WTP values resulting from the lower bill SP exercise are used as sensitivity checks.

Figure 35: CAM NHH WTP Unit Values and Range- Leakage

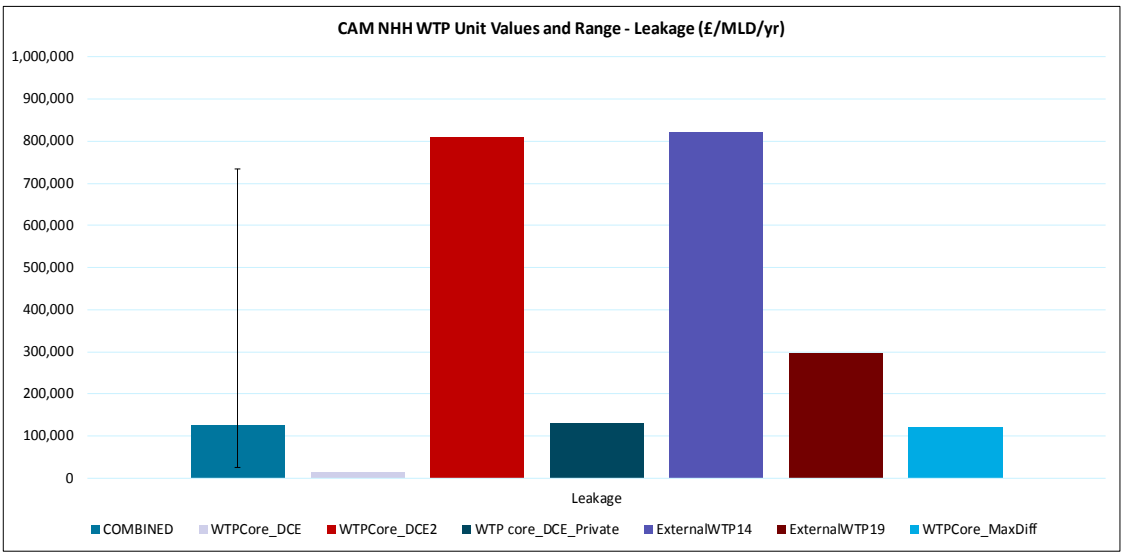
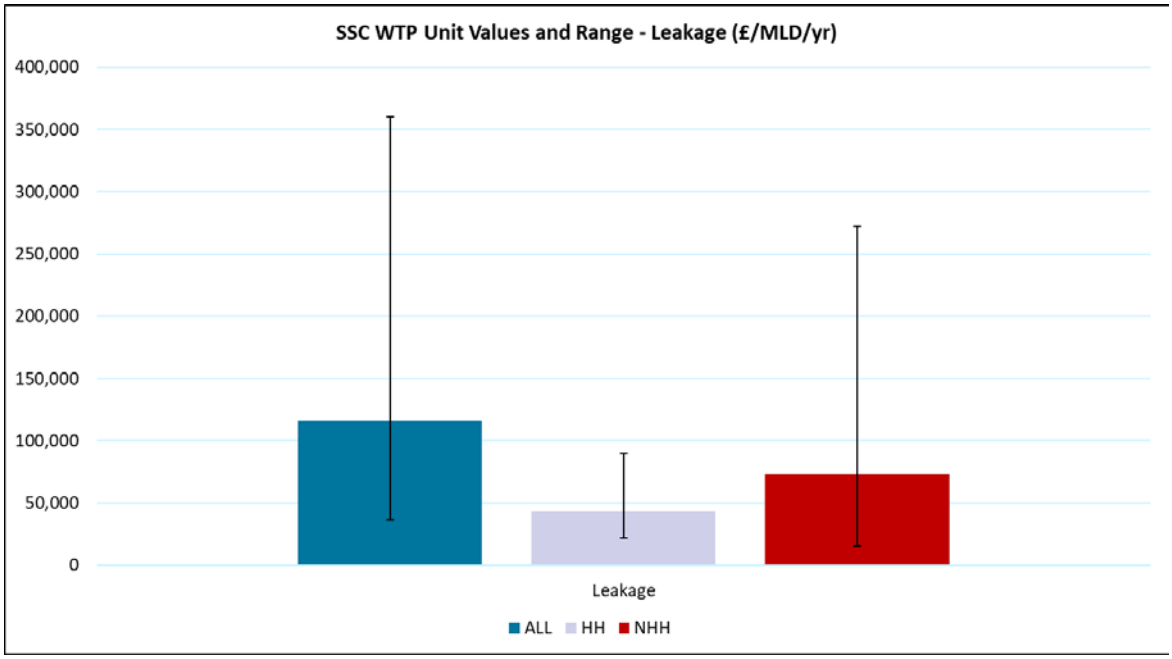


Figure 36 presents the final WTP triangulated values for 'Leakage' and their associated ranges for SSC (SSW and CAM combined). Overall, we find that the `COMBINED All' Unit values seem to have a significant range due to the significant ranges associated with the `Combined NHH' values and due to the high value assigned to NHH 'Leakage' in the WTP DCE2 and External PR14 studies.

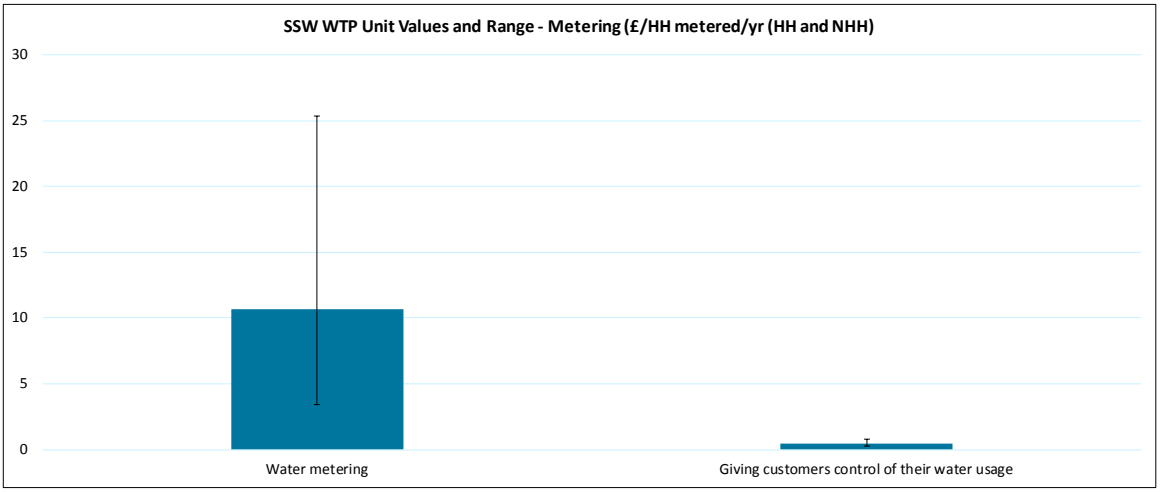
Figure 36: SSC WTP Unit Values and Range- Leakage



Note: SSW PR14 WTP value for Leakage not included since units are not comparable. The triangulated WTP values (blue bar labelled 'ALL') will be used within the SSC CBA for setting PC levels and ODI rates

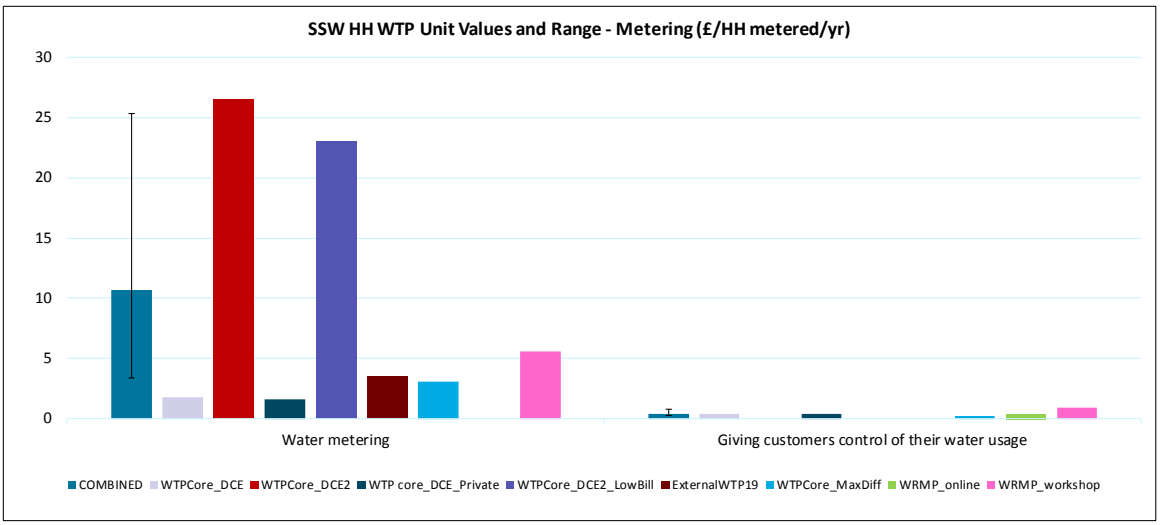
Figure 37 and Figure 38 presents the final WTP triangulated values for 'Metering' and their associated ranges for SSW Combined (HH and NHH) and SSW HH respectively. Note that there are no values available for NHH metering (water metering and smart metering) so in this case the SSW Combined values equal the SSW HH Combined values. Figure 37 shows that the triangulated Combined Unit WTP value for Water metering is higher than Smart metering and it has a significant range for SSW customers (households). Figure 38 shows that triangulated Unit WTP values for Water metering are closer to their WTP DCE2 values than their WTP DCE1 values for SSW households. Water metering has a significant range due to the high values assigned to this attribute in the Wave 2 WTP study. Note that smart metering was not included in the Wave 2 WTP study.

Figure 37: SSW Combined WTP Unit Values and Range-Metering



Note: No values available for NHH metering (water metering and smart metering) so in this case the SSW Combined values is equal to SSW HH Combined values.

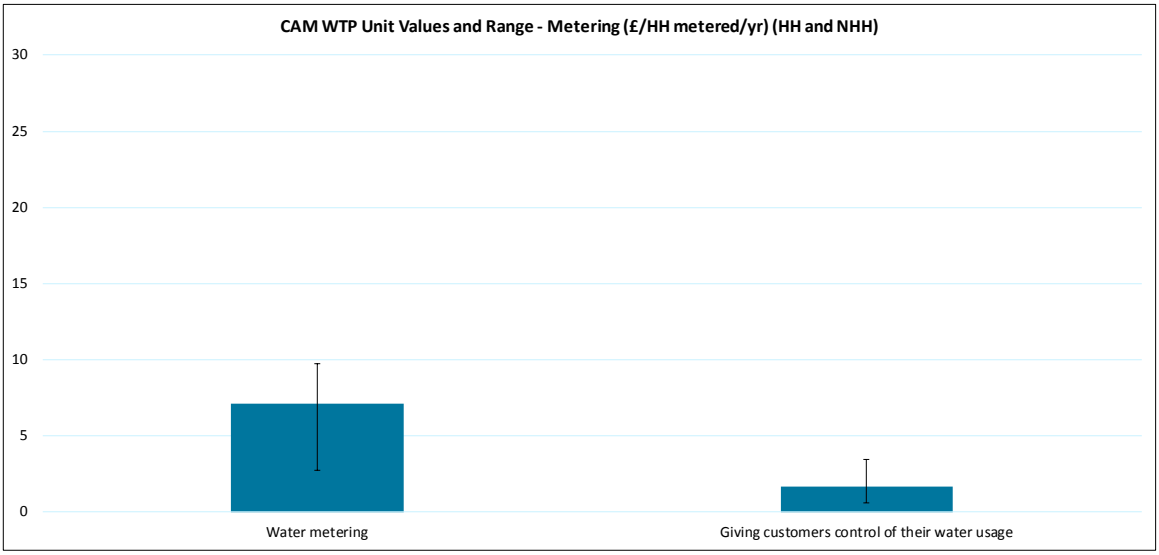
Figure 38: SSW HH WTP Unit Values and Range-Metering



Note: Wave 1 WTP Private values and Wave 2 WTP values resulting from the lower bill SP exercise are used as sensitivity checks so that they contribute to the range of values, but not to the central case i.e. Combined value. Smart metering was not included in the Wave 2 WTP study.

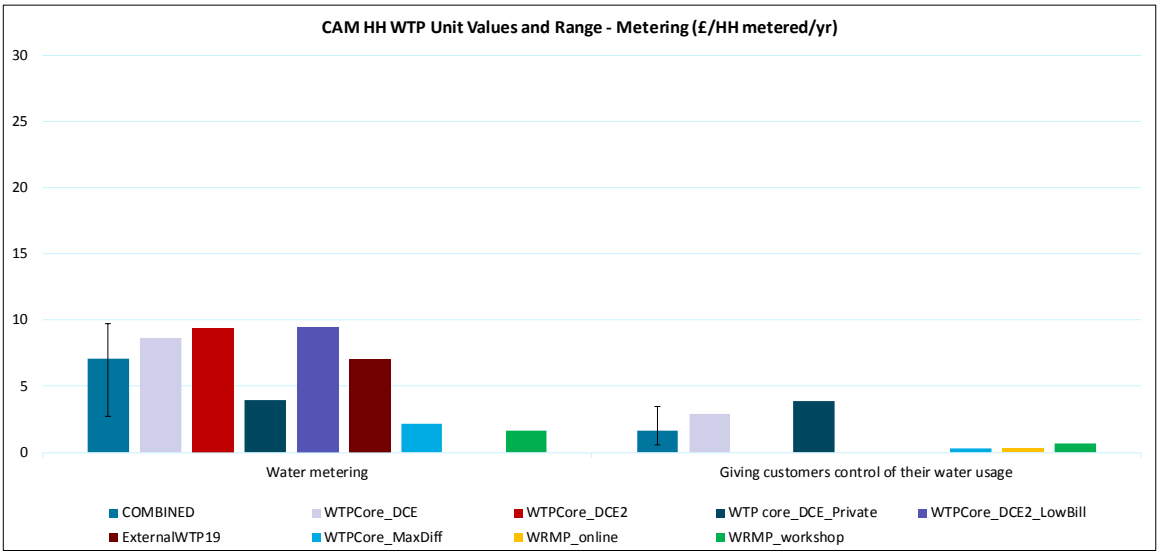
Figure 39 and Figure 40 presents the final WTP triangulated values for 'Metering' and their associated ranges for CAM Combined (HH and NHH) and CAM HH respectively. Note that there are no values available for NHH metering (water metering and smart metering) so in this case the CAM Combined values equal the CAM HH Combined values. Figure 39 shows that the triangulated Combined Unit WTP value for Water metering is higher than Smart metering for SSW customers (households). Figure 40 shows that triangulated Unit WTP values for Water metering are closer to their WTP DCE1 values than their WTP DCE2 values for CAM households.

Figure 39: CAM Combined WTP Unit Values and Range-Metering



Note: No values available for NHH metering (water metering and smart metering) so in this case the SSW Combined values is equal to SSW HH Combined values.

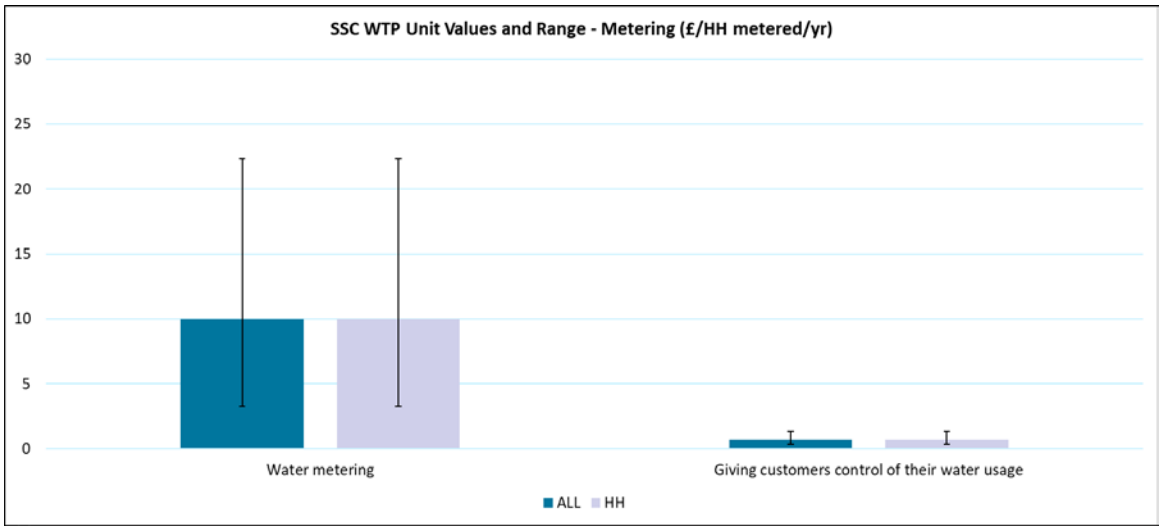
Figure 40: CAM HH WTP Unit Values and Range-Metering



Note: Wave 1 WTP Private values and Wave 2 WTP values resulting from the lower bill SP exercise are used as sensitivity checks so that they contribute to the range of values, but not to the central case i.e. Combined value. Smart metering was not included in the Wave 2 WTP study.

Figure 41 presents the final WTP triangulated values for 'Metering' and their associated ranges for SSC (SSW and CAM combined). Overall, we find that the `COMBINED All' Unit values for Water metering seem to have a significant range due to the significant ranges associated with the SSW `Combined HH' resulting from high values assigned to 'Water metering' in the Wave 2 WTP study.

Figure 41: SSC WTP Unit Values and Range-Metering



Note: No values available for NHH metering (water metering and smart metering). The triangulated WTP values (blue bar labelled 'ALL') will be used within the SSC CBA for setting PC levels and ODI rates

Figure 42, Figure 43 and Figure 44 presents the final WTP triangulated values for 'Environmental Protection' and their associated ranges for SSW Combined (HH and NHH), SSW HH and SSW NHH respectively. Figure 42 shows that the triangulated Combined Unit WTP value for Protecting wildlife is higher than Managing Impacts on rivers for SSW customers. Figure 43 shows that triangulated Unit WTP values for Protecting wildlife are closer to their WTP DCE1 values for SSW households. Figure 44 shows that the triangulated Unit WTP values for Protecting wildlife are closer to their WTP DCE1 values than their WTP DCE2 values for SSW non-households too. Opposite are the cases for Managing Impact on rivers for SSW HH and NHH customers.

Figure 42: SSW Combined WTP Unit Values and Range-Environmental Protection

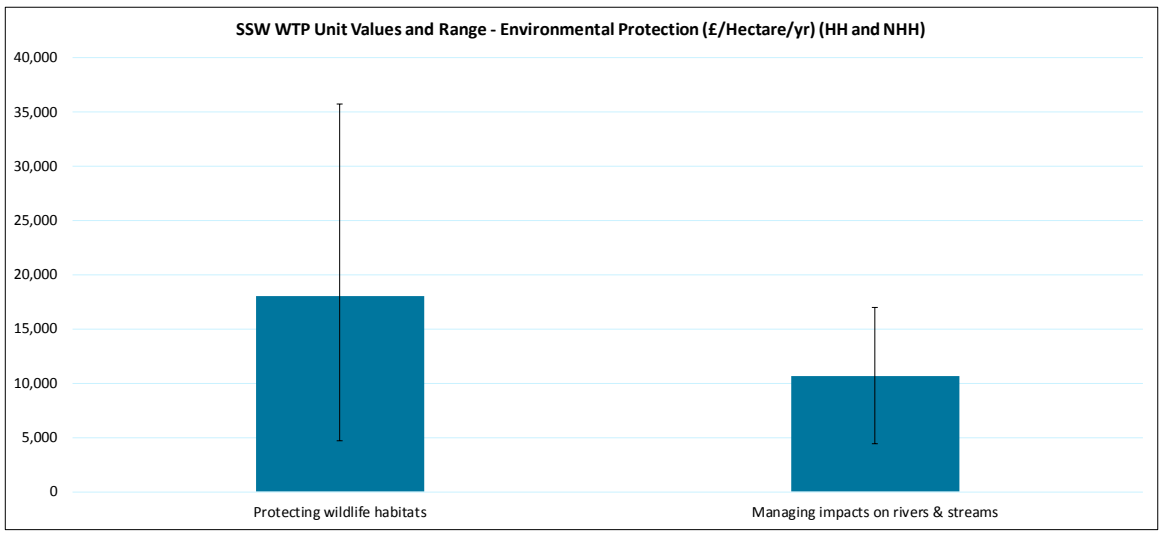
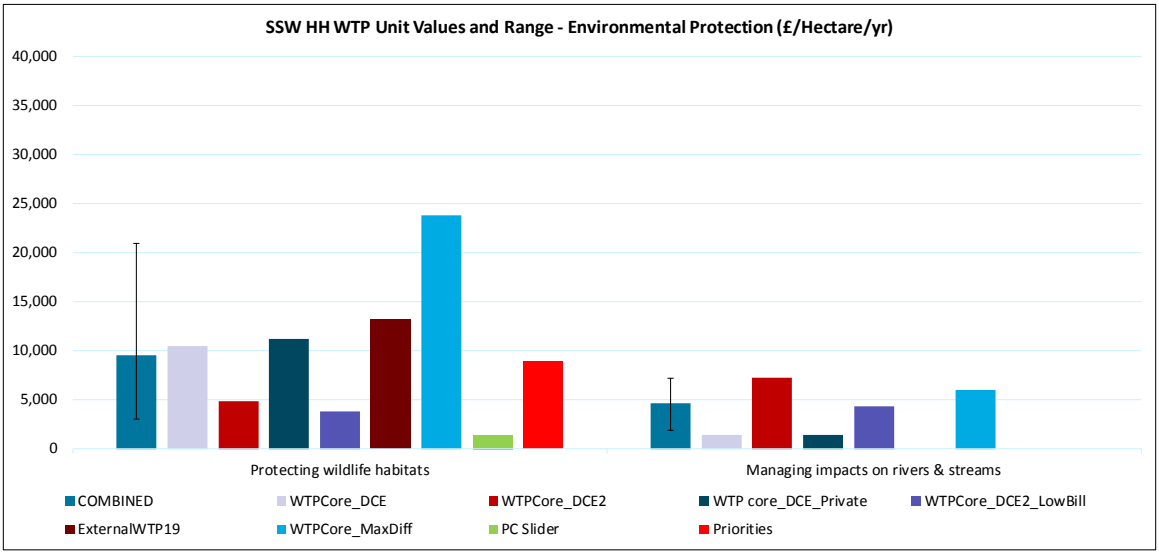
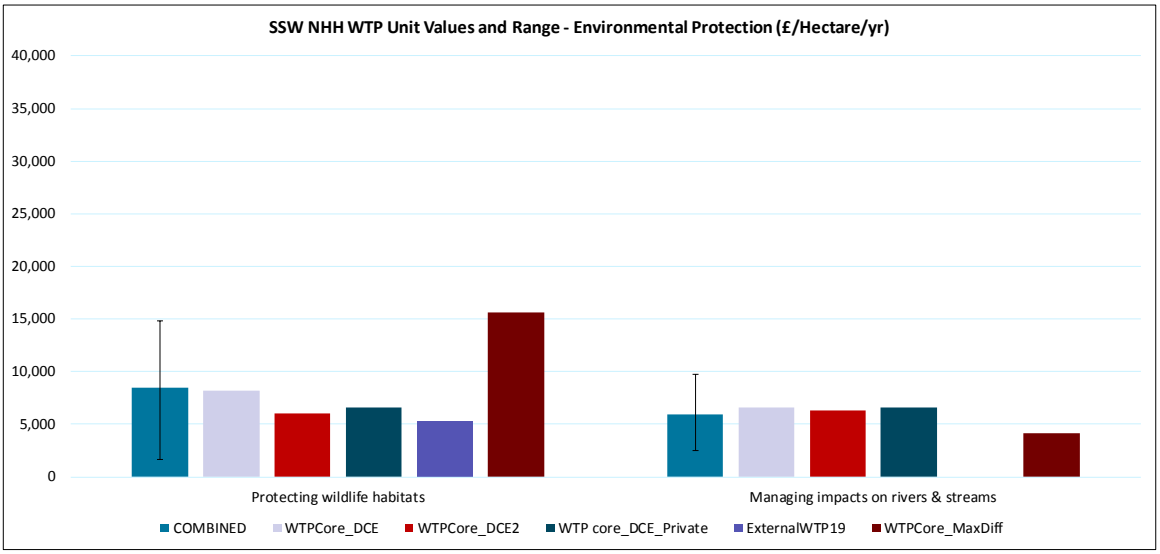


Figure 43: SSW HH WTP Unit Values and Range-Environmental Protection



Note: Wave 1 WTP Private values and Wave 2 WTP values resulting from the lower bill SP exercise are used as sensitivity checks.

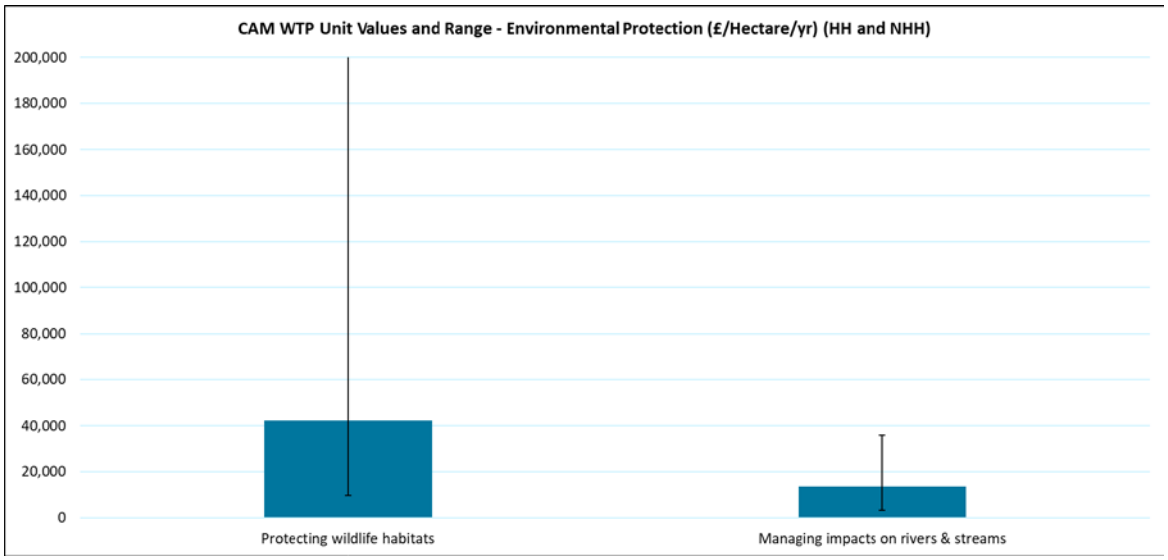
Figure 44: SSW NHH WTP Unit Values and Range-Environmental Protection



Note: Wave 1 WTP Private values used as sensitivity checks.

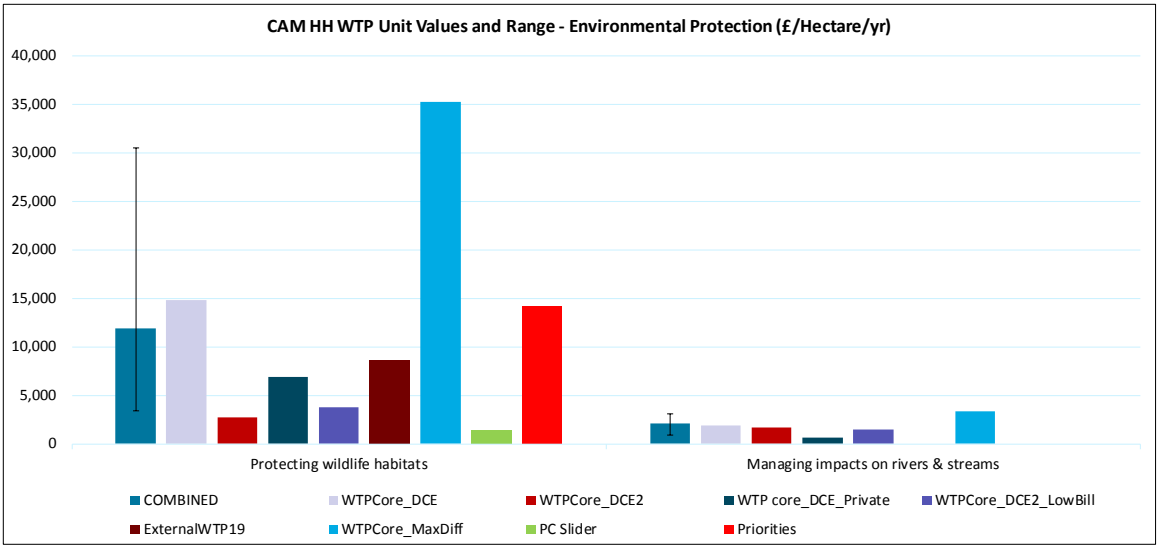
Figure 45, Figure 46 and Figure 47 presents the final WTP triangulated values for 'Environmental Protection' and their associated ranges for CAM Combined (HH and NHH), CAM HH and CAM NHH respectively. Figure 45 shows that the triangulated Combined Unit WTP value for Protecting wildlife is higher than Managing Impacts on rivers for CAM customers. Figure 46 shows that triangulated Unit WTP values for Protecting wildlife are closer to their WTP DCE1 values for CAM households but the range is significant due to high values assigned to it by Wave 1 MaxDiff and Wave 2 WTP studies. Figure 47 shows that the triangulated Unit WTP values for Protecting wildlife are closer to their WTP DCE2 values than their WTP DCE1 values for CAM non-households. Note that the range is significant due to very high ranges assigned to it by the Wave 2 WTP study.

Figure 45: CAM Combined WTP Unit Values and Range-Environmental Protection



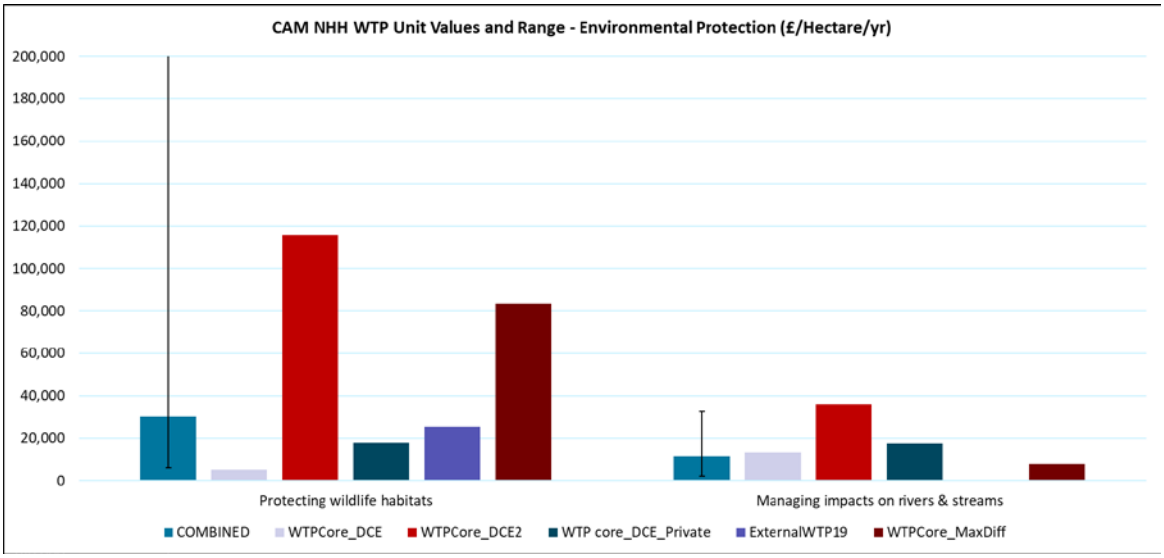
Note: range curtailed to aid legibility: upper bound for 'Protecting wildlife habitats'=£731,912

Figure 46: CAM HH WTP Unit Values and Range-Environmental Protection



Note: Wave 1 WTP Private values and Wave 2 WTP values resulting from the lower bill SP exercise are used as sensitivity checks.

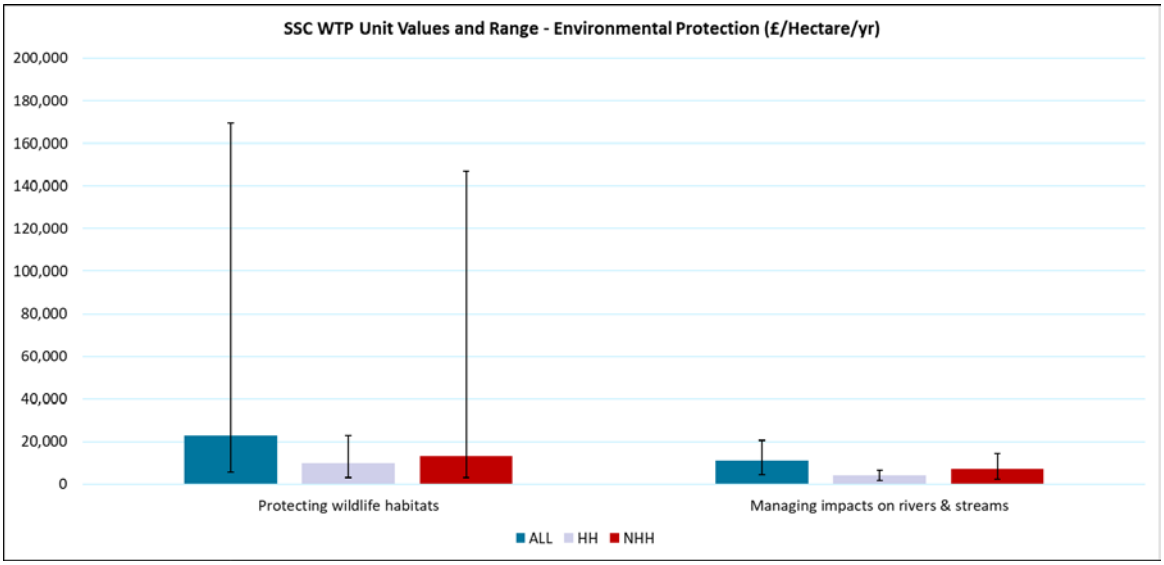
Figure 47: CAM NHH WTP Unit Values and Range-Environmental Protection



Note: Wave 1 WTP Private values used as sensitivity checks. Range curtailed to aid legibility: upper bound for 'Protecting wildlife habitats'=£701,353.

Figure 48 presents the final WTP triangulated values for 'Environmental Protection' and their associated ranges for SSC (SSW and CAM combined). Overall, we find that the `COMBINED All' Unit values for Protecting wildlife seem to have a significant range due to the significant ranges associated with the `Combined NHH' values resulting from high values assigned to it in the Wave 2 WTP study.

Figure 48: SSC WTP Unit Values and Range-Environmental Protection



Note: The triangulated WTP values (blue bar labelled 'ALL') will be used within the SSC CBA for setting PC levels and ODI rates

Figure 49, Figure 50 and Figure 51 presents the final WTP triangulated values for 'Traffic Disruption' and their associated ranges for SSW Combined (HH and NHH), SSW HH and SSW NHH respectively. Figure 50 shows that the triangulated Combined Unit WTP value is close to MaxDiff value but lower than the WTP Wave 1 DCE value for SSW Households. Figure 51 shows that the triangulated Combined Unit WTP value is higher than both WTP DCE1 and MaxDiff values for SSW non-households.

Figure 49: SSW Combined WTP Unit Values and Range-Traffic Disruption

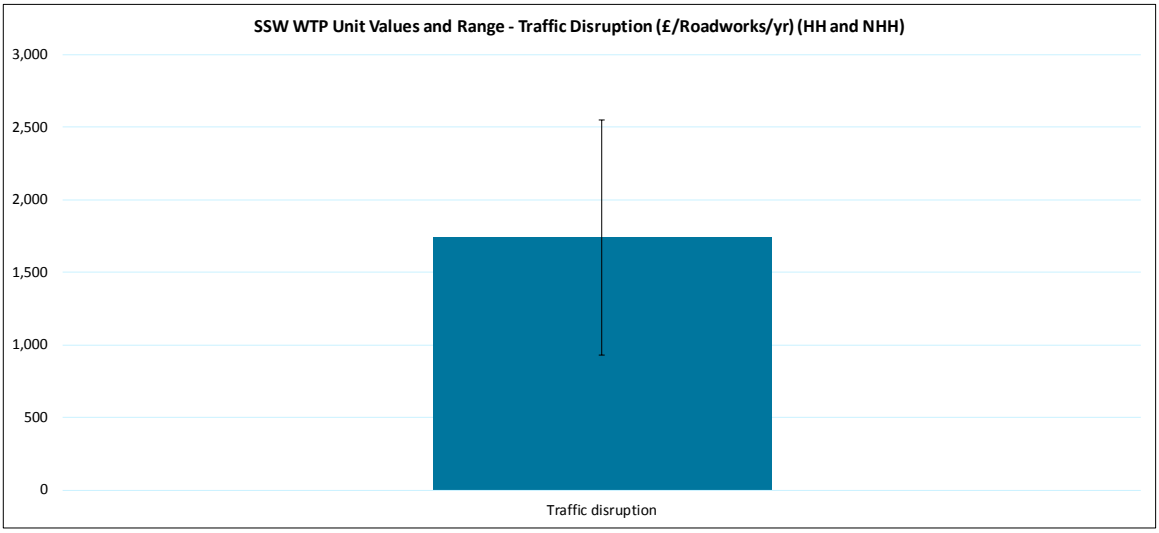
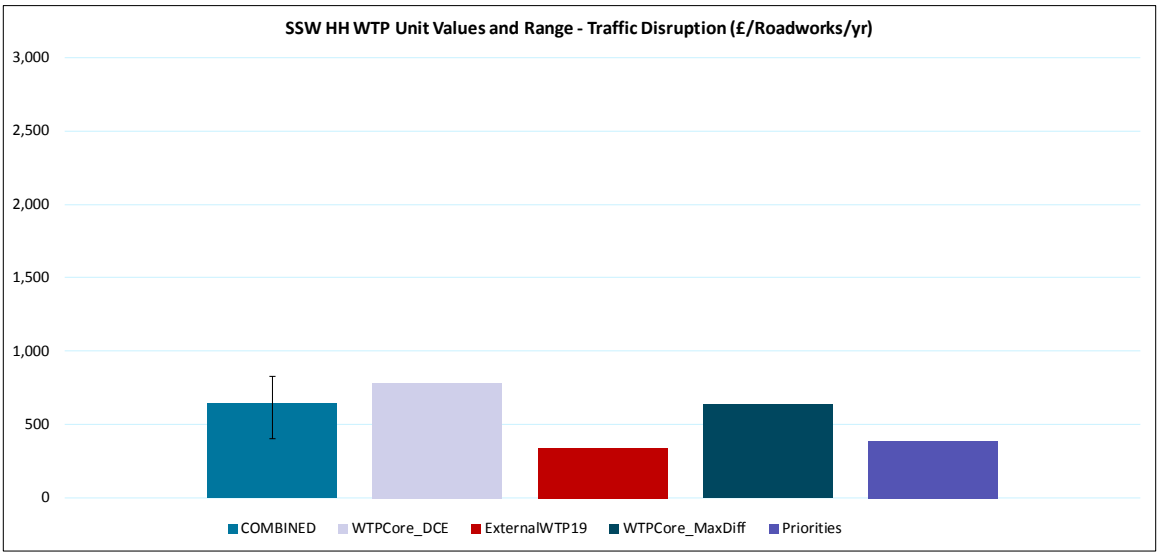
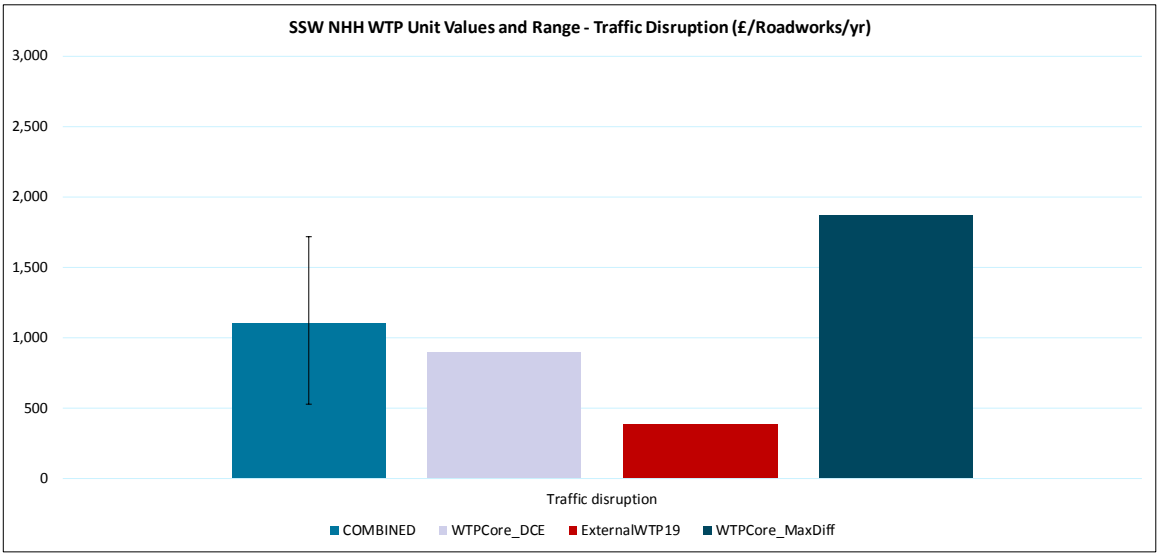


Figure 50: SSW HH WTP Unit Values and Range-Traffic Disruption



Note: Traffic Disruption not included in Wave 2 WTP study and no data available on Wave 1 WTP private values

Figure 51: SSW NHH WTP Unit Values and Range-Traffic Disruption



Note Traffic Disruption not included in Wave 2 WTP study and no data available on Wave 1 WTP private values

Figure 52, Figure 53 and Figure 54 presents the final WTP triangulated values for 'Traffic Disruption' and their associated ranges for CAM Combined (HH and NHH), CAM HH and CAM NHH respectively. Figure 53 shows that the triangulated Combined Unit WTP value is closer to WTP DCE1 than the MaxDiff value for SSW households. Figure 54 shows that the triangulated Combined Unit WTP value is closer to WTP DCE1 than the MaxDiff value for SSW non-households.

Figure 52: CAM Combined WTP Unit Values and Range-Traffic Disruption

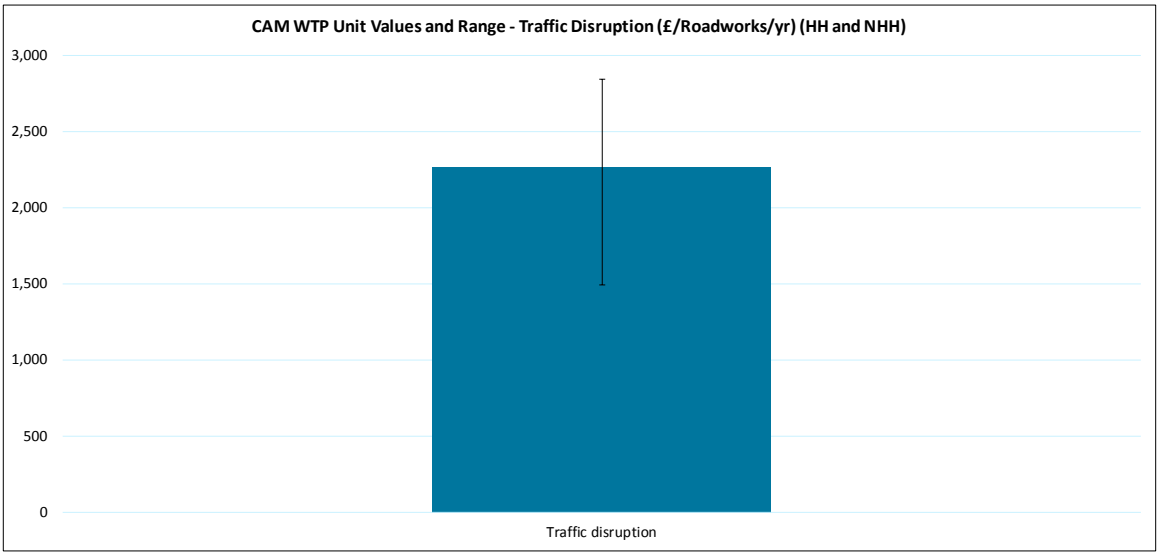
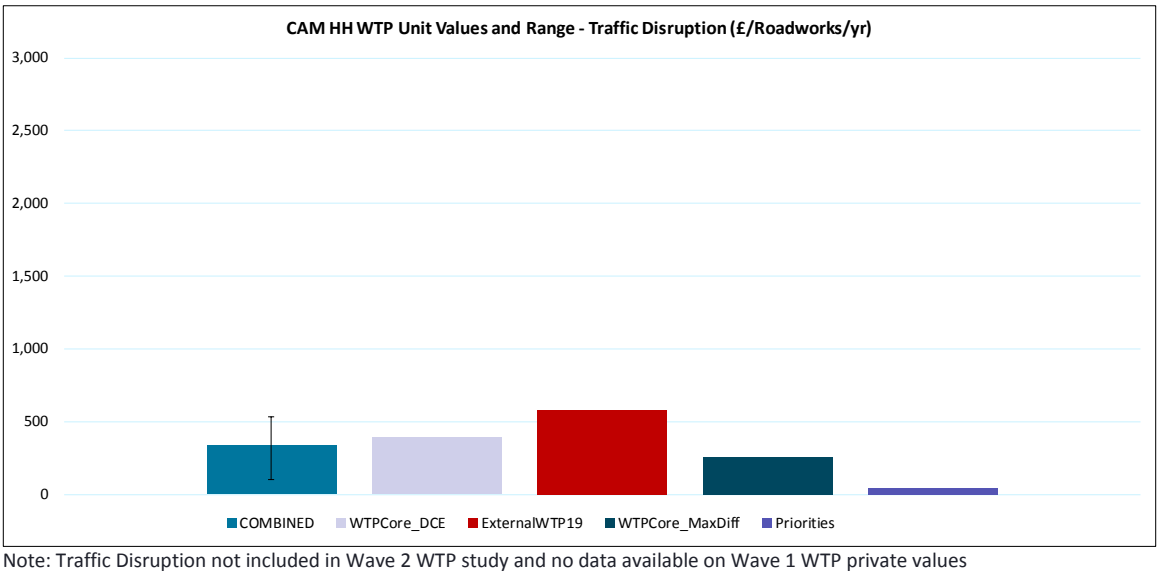
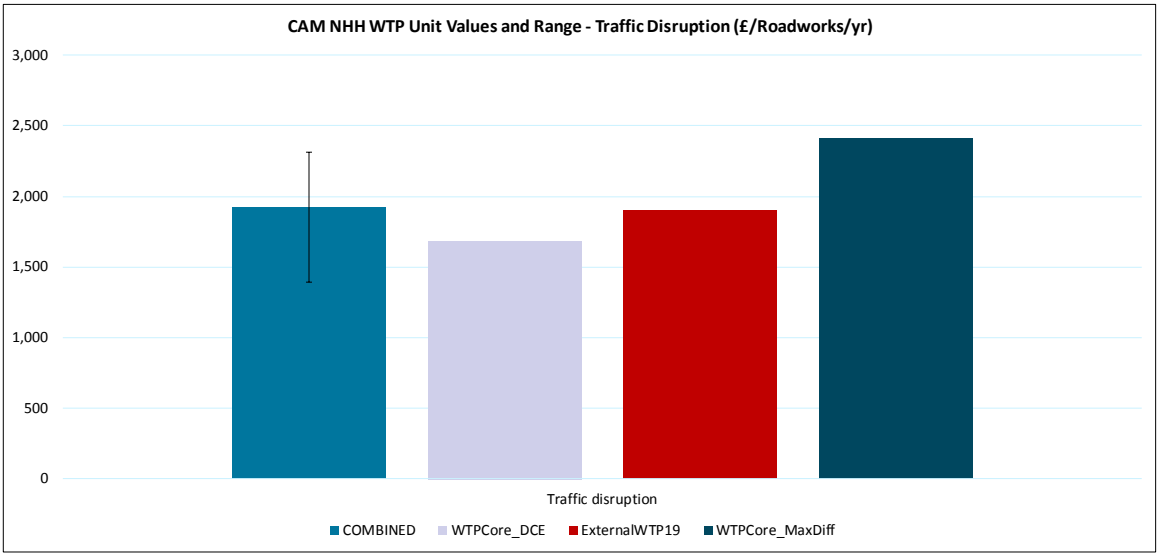


Figure 53: CAM HH WTP Unit Values and Range-Traffic Disruption



Note: Traffic Disruption not included in Wave 2 WTP study and no data available on Wave 1 WTP private values

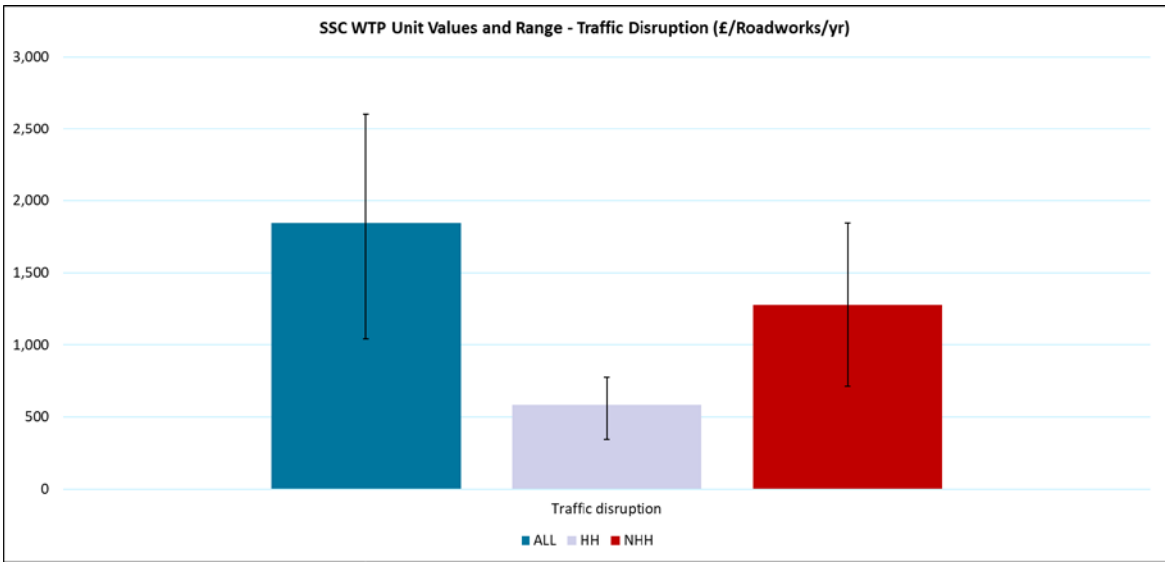
Figure 54: CAM NHH WTP Unit Values and Range-Traffic Disruption



Note Traffic Disruption not included in Wave 2 WTP study and no data available on Wave 1 WTP private values

Figure 55 presents the final WTP triangulated values for 'Traffic Disruption and their associated ranges for SSC (SSW and CAM combined). Overall, we find that the `All' Unit values seem to have a significant range due to the significant ranges associated with the ` NHH' values.

Figure 55: SSC WTP Unit Values and Range-Traffic Disruption



Note: The triangulated WTP values (blue bar labelled 'COMBINED ALL') will be used within the SSC CBA for setting PC levels and ODI rates

4.5 Sensitivity Test

We present the following case below to test the sensitivity of our results with respect to the weights for the RAG ratings. For alternative weights we reproduce Table 20 below.

Table 54: Alternative RAG weights

Overall RAG rating	Original weight	Alternative weight
Green	100%	100%
Green / Amber	50%	75%
Amber	25%	50%
Amber / Red	10%	25%
Red	0%	0%

Figure 56, Figure 57 and Figure 58 presents the final WTP triangulated values for 'Services at Property' and their associated ranges for SSW, CAM and SSC respectively, based on the alternative set of weights described in Table 20. Overall, we find that the Combined Unit WTP values for the core service measures under alternative weights in case of both the regions are close to their values in the Main case i.e. with the original weights. The only exceptions are Unexpected Temporary Loss of Water supply for CAM HH and Taste and Smell for CAM NHH which increases significantly (i.e. >20%) under the alternative set of weights.

Figure 56: SSW Combined WTP Unit Values and Range- Services at Property: Alternative set of weights

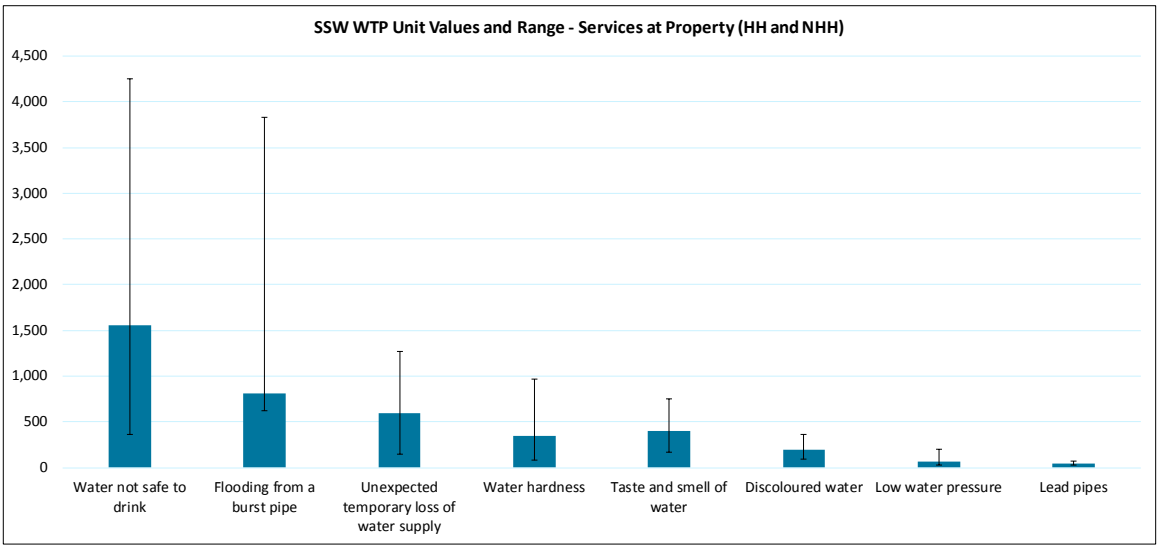
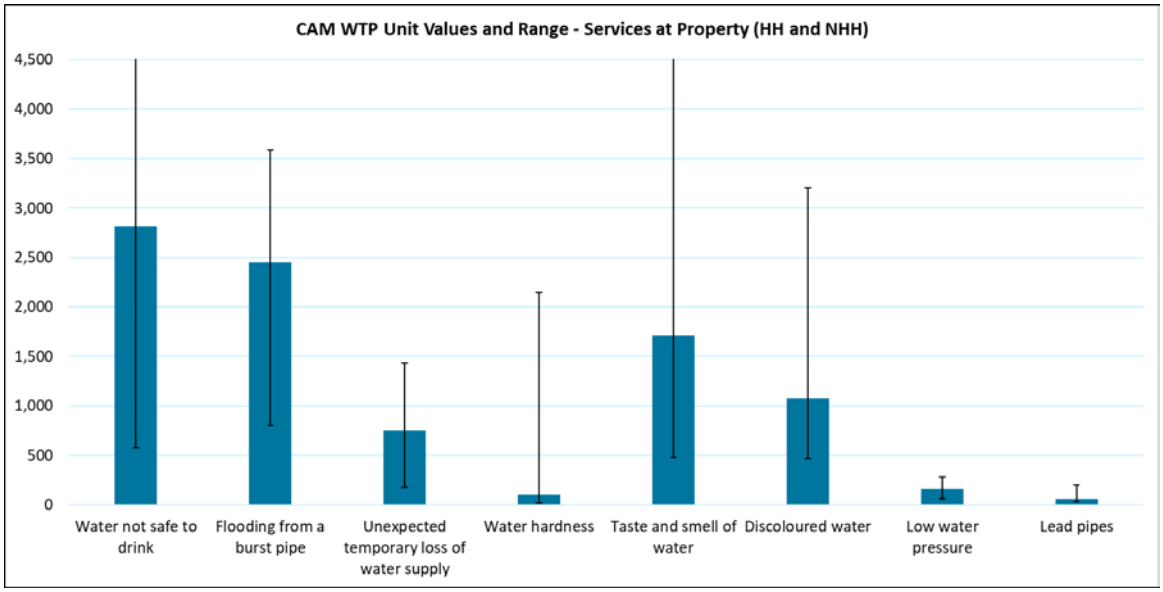
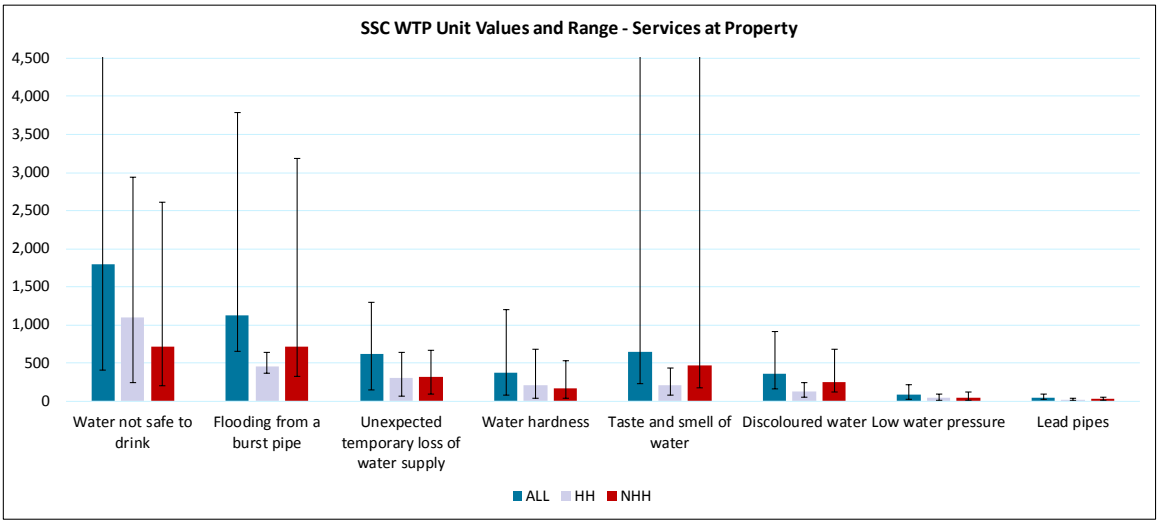


Figure 57: CAM Combined WTP Unit Values and Range- Services at Property: Alternative set of weights



Note: Range curtailed to aid legibility. Upper bound of 'Water not safe to drink'=£10,925; Upper bound of 'Taste and smell of water'=£100,628.

Figure 58: SSC Combined WTP Unit Values and Range- Services at Property: Alternative set of weights



Range curtailed to aid legibility. Upper bound of 'Water not safe to drink'(ALL)=£5,531; Upper bound of 'Taste and smell of water'(ALL)=£19,910. Upper bound of 'Taste and smell of water'(NHH)=£19,497.

Figure 59, Figure 60 and Figure 61 presents the final WTP triangulated values for 'Drought Restrictions' and their associated ranges for SSW, CAM and SSC respectively, based on the alternative set of weights described above. Overall, we find that the Combined Unit WTP values for the core service measures under alternative weights in case of both the regions are close to their values in the Main case i.e. with the original weights.

Figure 59: SSW Combined WTP Unit Values and Range- Drought Restrictions: Alternative set of weights

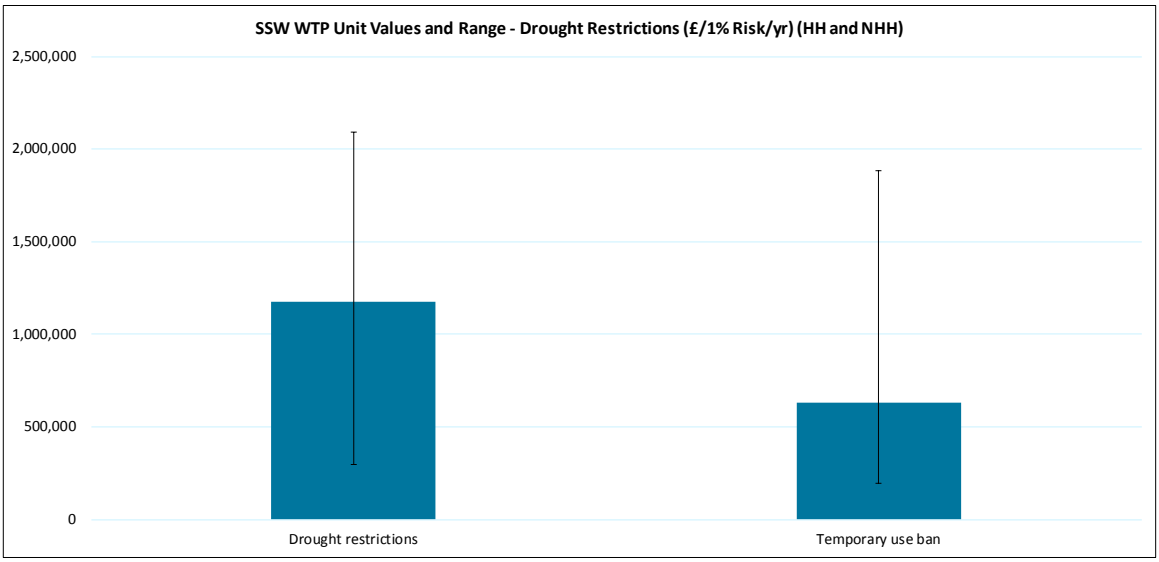


Figure 60: CAM Combined WTP Unit Values and Range- Drought Restrictions: Alternative set of weights

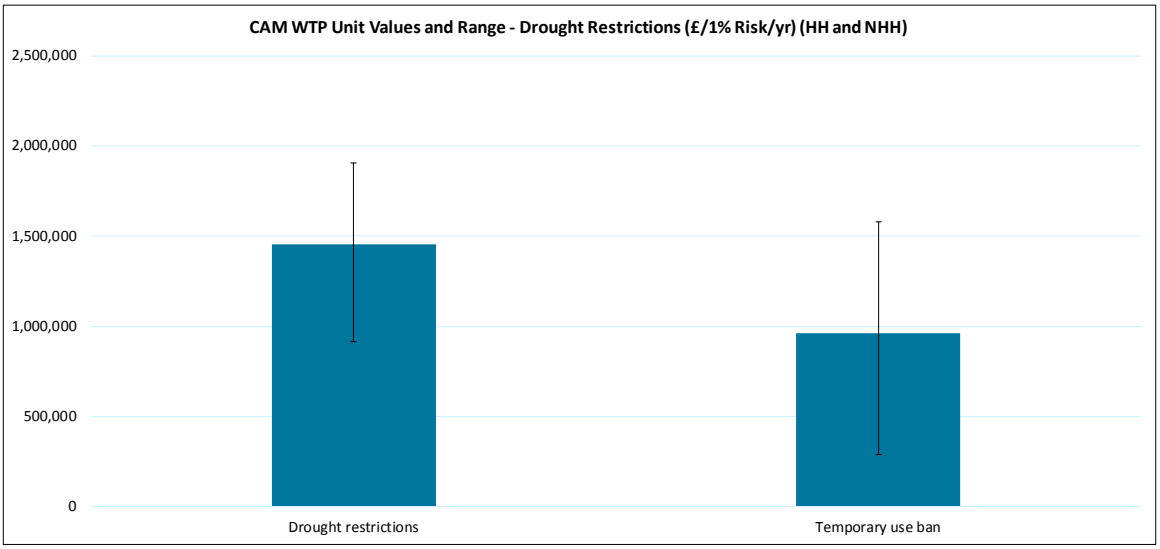


Figure 61: SSC Combined WTP Unit Values and Range- Drought Restrictions: Alternative set of weights

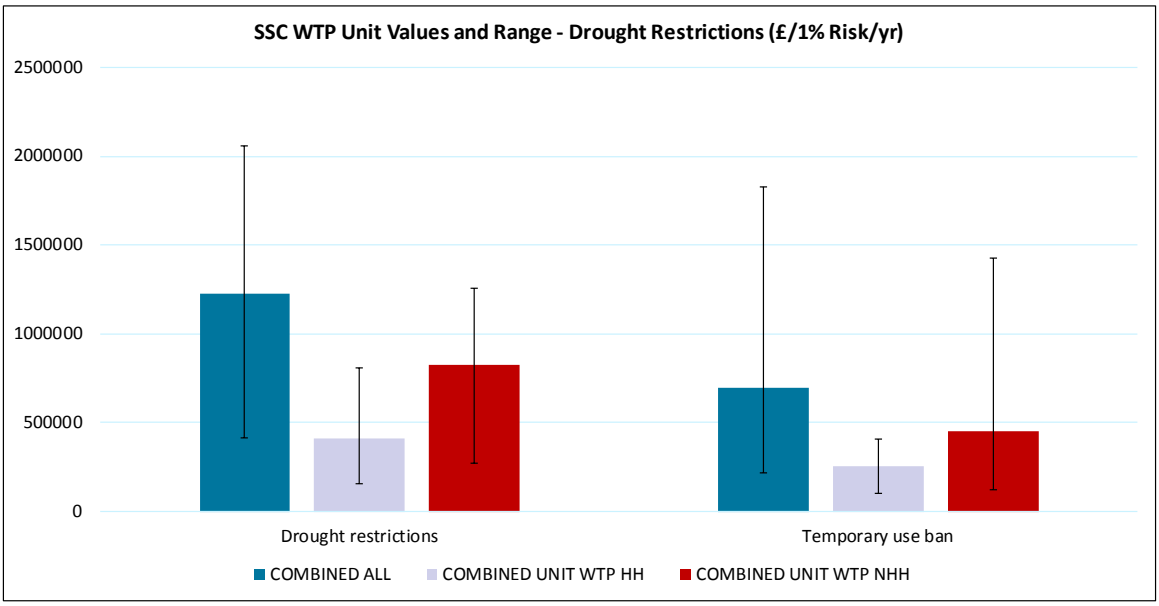


Figure 62, Figure 63 and Figure 64 presents the final WTP triangulated values for 'Leakage' and their associated ranges for SSW, CAM and SSC respectively, based on the alternative set of weights described above. Overall, we find that the Combined Unit WTP values for the core service measure under alternative weights in case of SSW and CAM HH are close to their values in the Main case i.e. with the original weights. The only exception is for CAM NHH which increases significantly (>40%) under the alternative set of weights.

Figure 62: SSW Combined WTP Unit Values and Range-- Leakage: Alternative set of weights

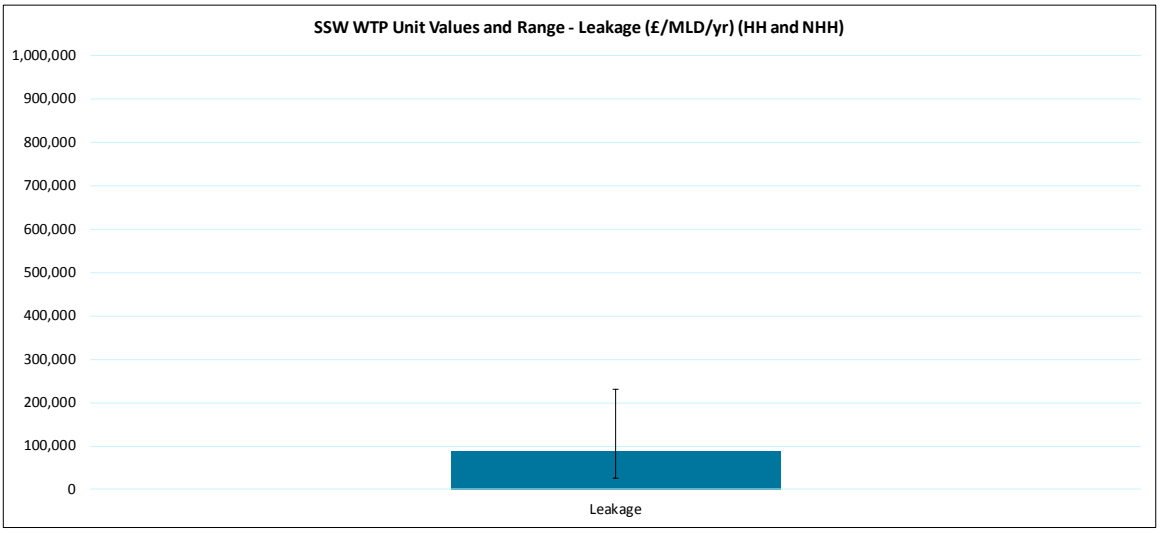


Figure 63: CAM Combined WTP Unit Values and Range-- Leakage: Alternative set of weights

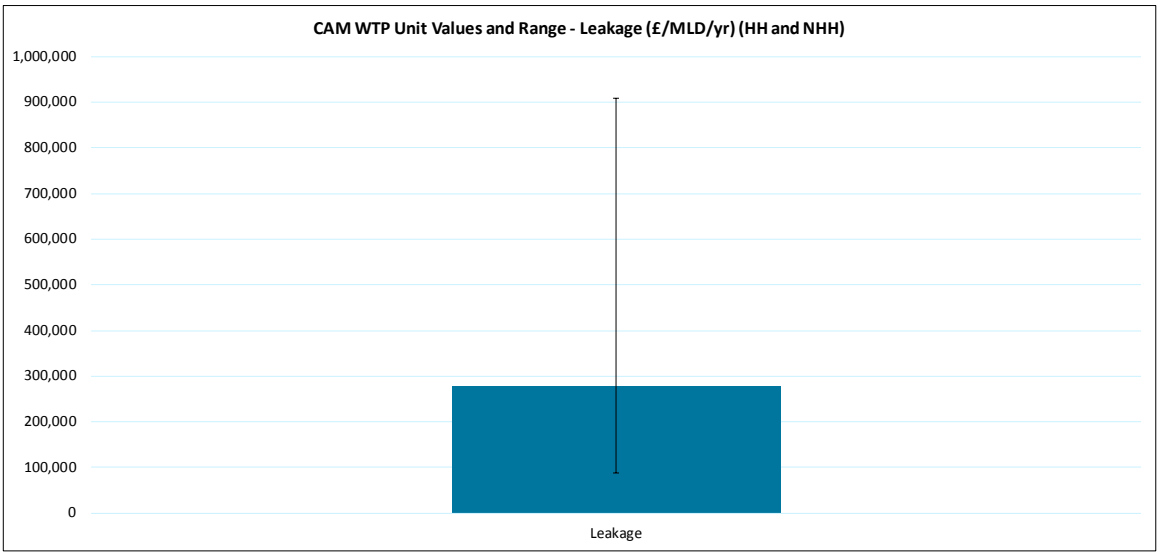


Figure 64: SSC Combined WTP Unit Values and Range-- Leakage: Alternative set of weights

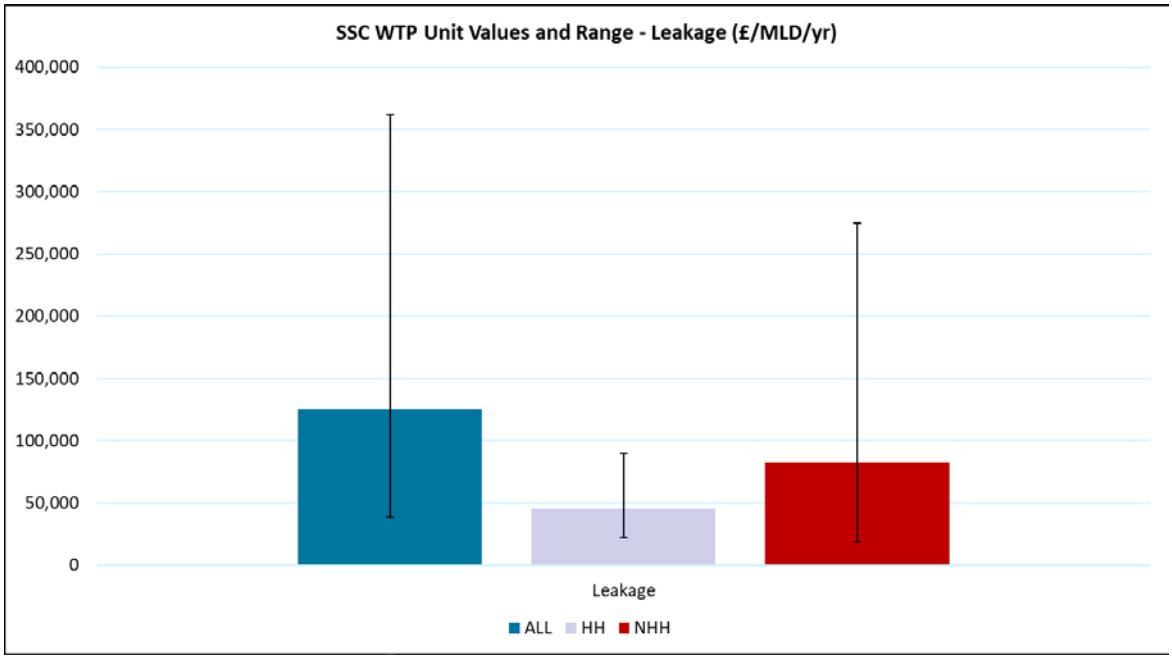


Figure 65, Figure 66 and Figure 67 presents the final WTP triangulated values for 'Metering' and their associated ranges for SSW, CAM and SSC respectively, based on the alternative set of weights described above. Overall, we find that the Combined Unit WTP values for the core service measures under alternative weights in case of both the regions are close to their values in the Main case i.e. with the original weights.

Figure 65: SSW Combined WTP Unit Values and Range- Metering: Alternative set of weights

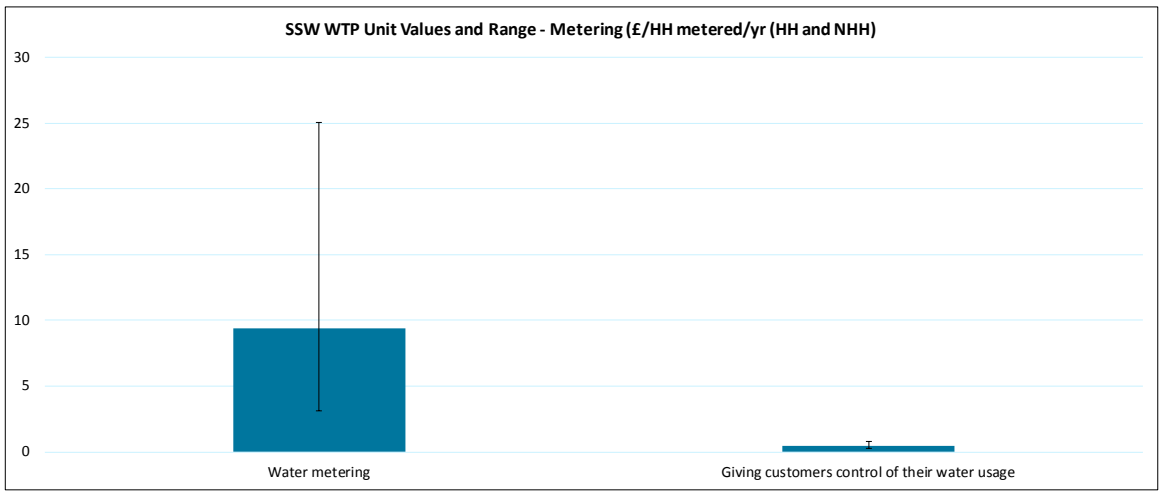


Figure 66: CAM Combined WTP Unit Values and Range- Metering: Alternative set of weights

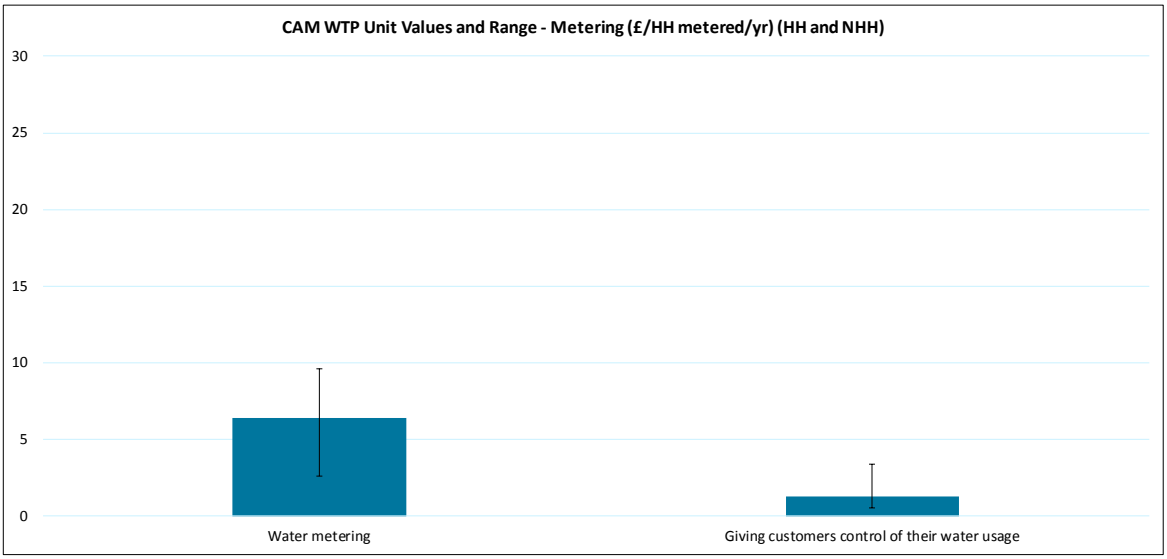


Figure 67: SSC Combined WTP Unit Values and Range- Metering: Alternative set of weights

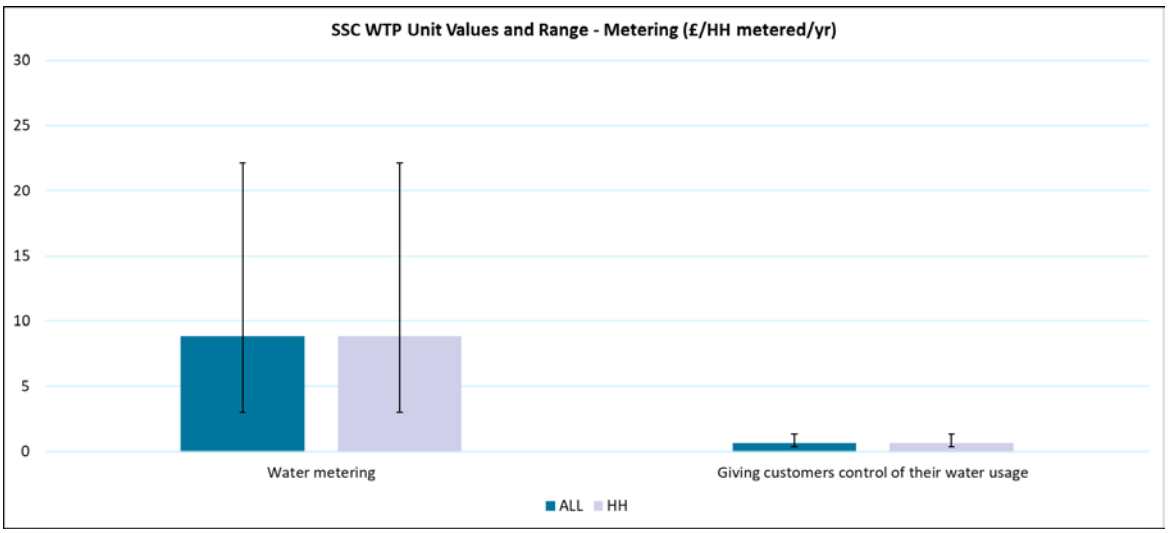


Figure 68, Figure 69 and Figure 70 presents the final WTP triangulated values for 'Environmental Protection' and their associated ranges for SSW, CAM and SSC respectively, based on the alternative set of weights described above. Overall, we find that the Combined Unit WTP values for the core service measures under alternative weights in case of both the regions are close to their values in the Main case i.e. with the original weights.

Figure 68: SSW Combined WTP Unit Values and Range- Environmental Protection: Alternative set of weights

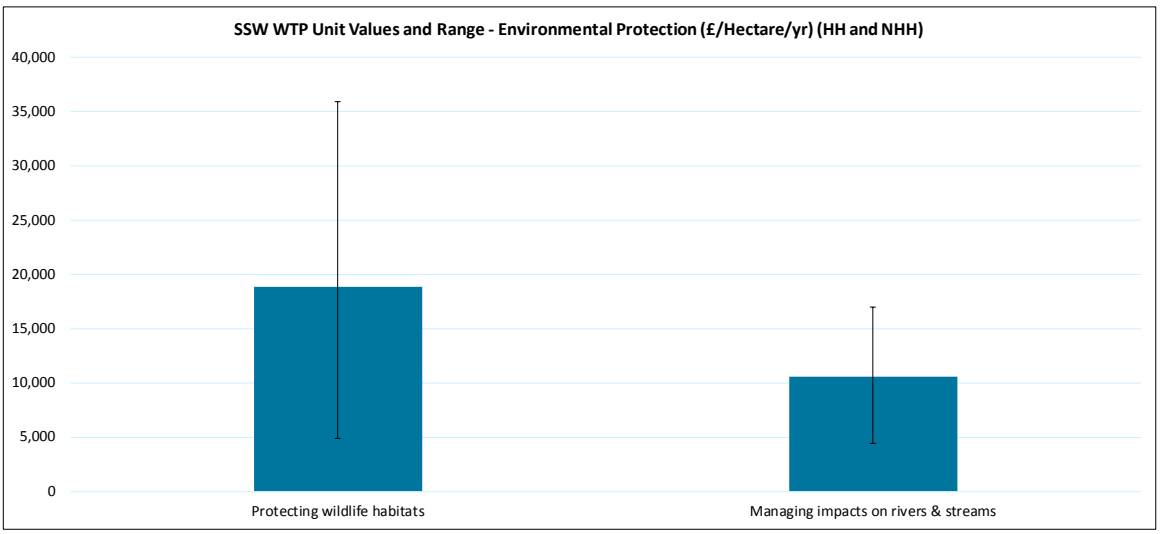
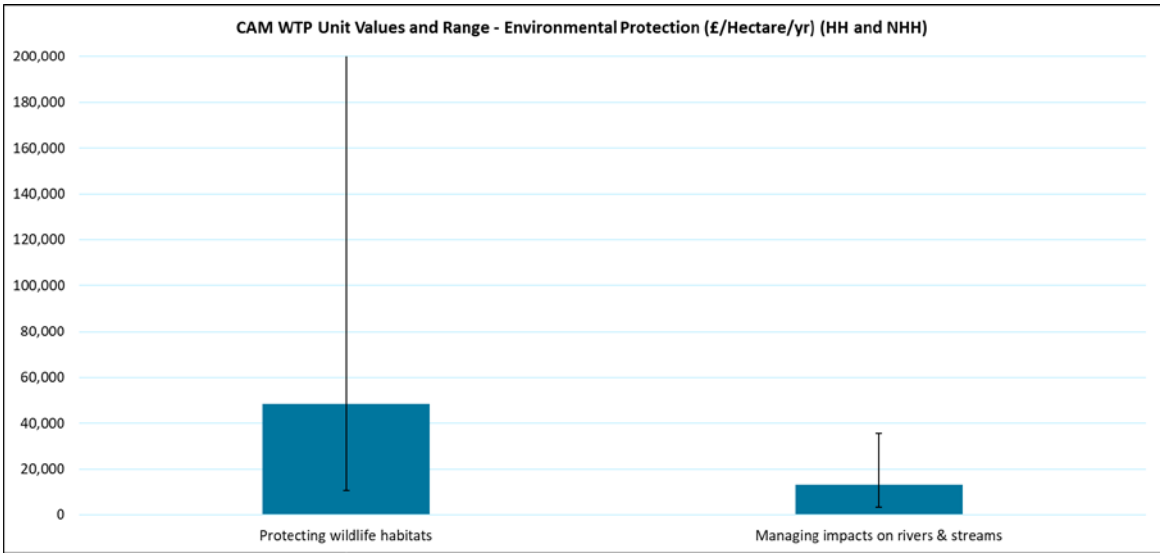


Figure 69: CAM Combined WTP Unit Values and Range- Environmental Protection: Alternative set of weights



Note: range curtailed to aid legibility: upper bound for 'Protecting wildlife habitats'=£733,110

Figure 70: SSC Combined WTP Unit Values and Range- Environmental Protection: Alternative set of weights

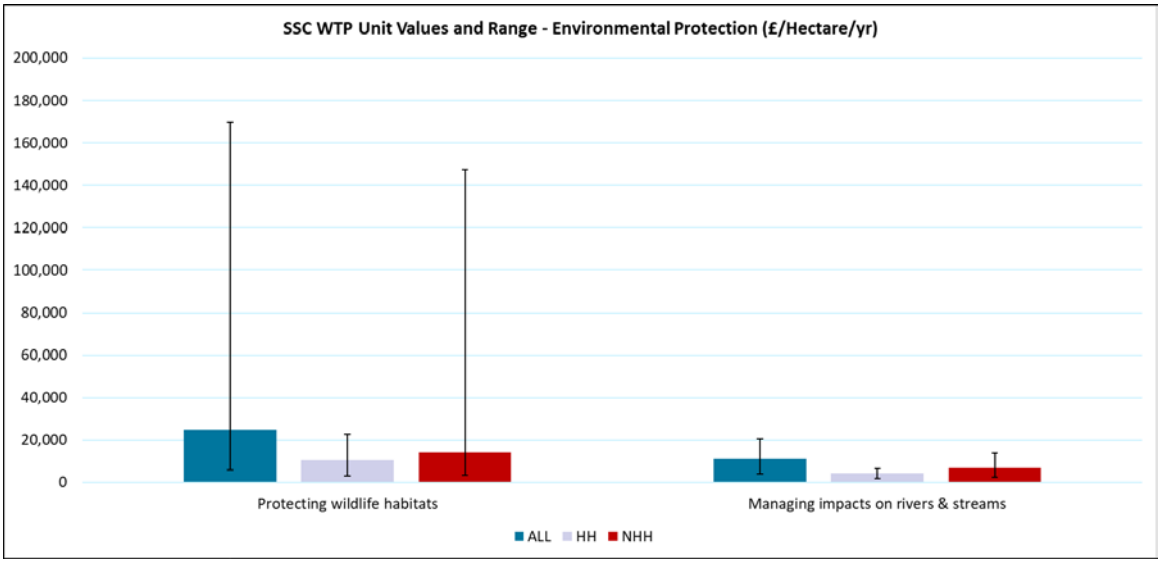


Figure 71, Figure 72 and Figure 73 presents the final WTP triangulated values for 'Traffic disruption' and their associated ranges for SSW, CAM and SSC respectively, based on the alternative set of weights described above. Overall, we find that the Combined Unit WTP values for the core service measures under alternative weights in case of both the regions are close to their values in the Main case i.e. with the original weights.

Figure 71: SSW Combined WTP Unit Values and Range- Traffic Disruption: Alternative set of weights

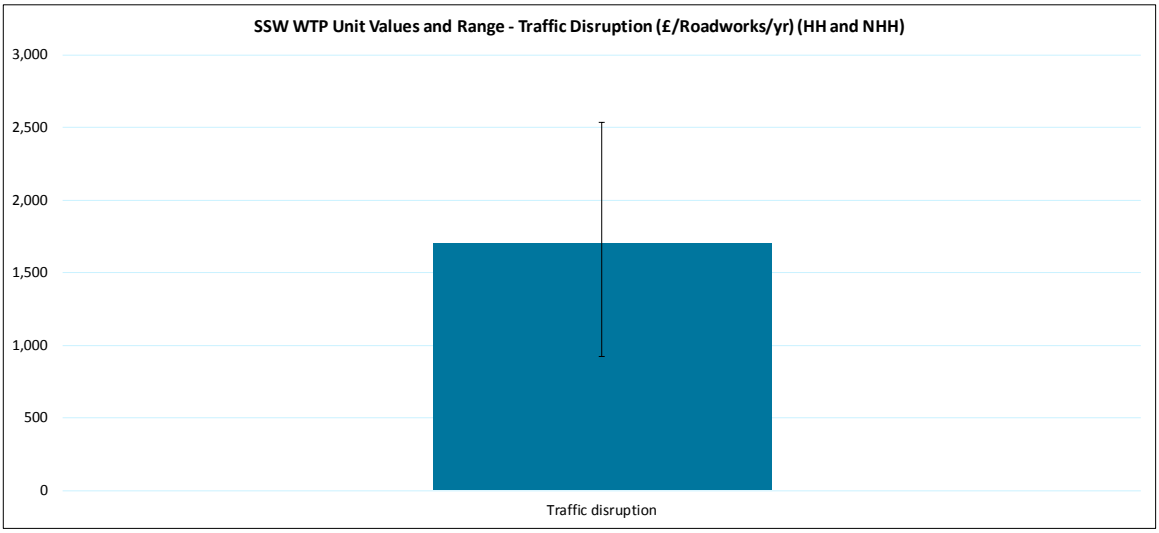


Figure 72: CAM Combined WTP Unit Values and Range- Traffic Disruption: Alternative set of weights

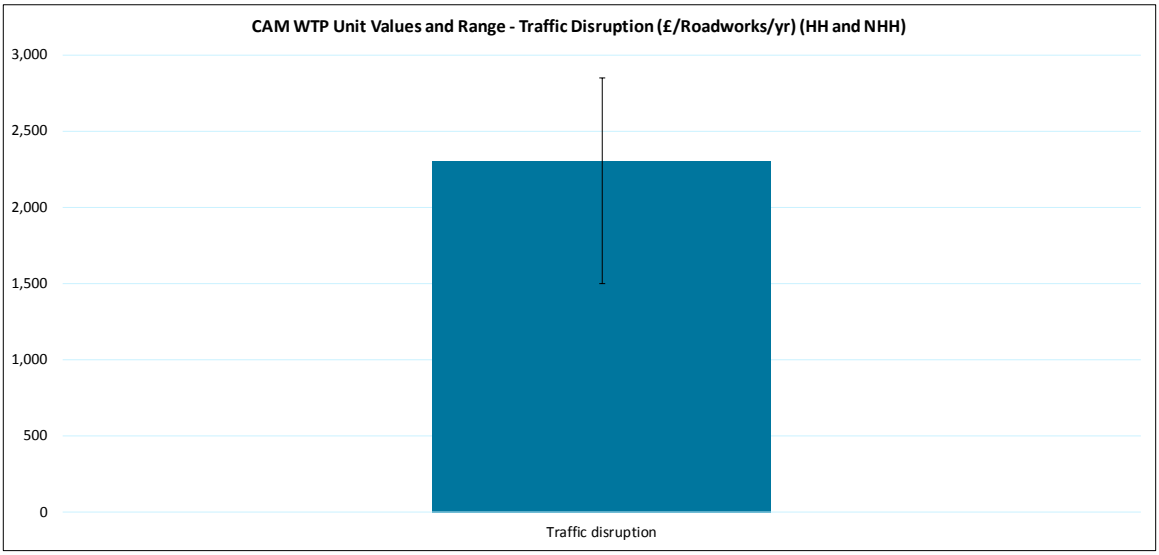


Figure 73: SSC Combined WTP Unit Values and Range- Traffic Disruption: Alternative set of weights

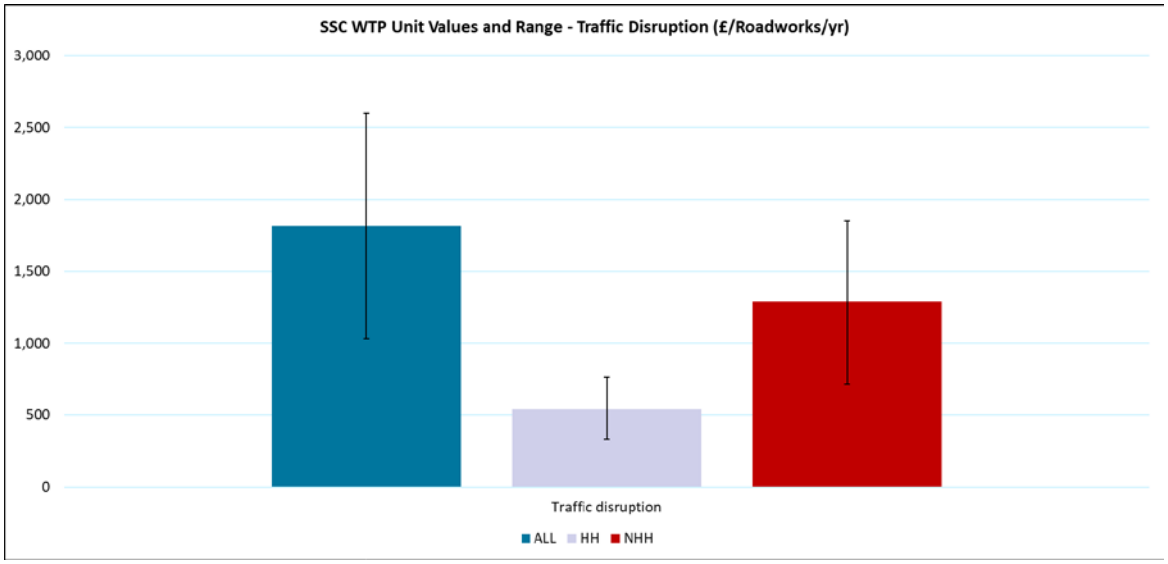


Table 55 presents the SSW main triangulated values in comparison to the triangulated values derived for the sensitivity case. The triangulated WTP estimates for all the core service measures were fairly robust to alternative weights assigned to the various data sources. None of the core measures were found to have a value more than 20% different in the sensitivity case than in the main case. All the differences are within 20% range and are fairly low in the context of WTP measurement, where value estimates can often vary by an order of magnitude or more for the same good (see Accent, 2014, for examples.)

Table 56 presents the CAM main triangulated values in comparison to the triangulated values derived for the sensitivity case. The triangulated WTP estimates for all the core service measures were fairly robust to alternative weights assigned to the various data sources. Most of the core measures were found to have a value less than 20% different in the sensitivity case than in the main case. The only exceptions were Taste and Smell, Leakage and Unexpected Temporary Loss of Water Supply.

Table 55: Comparison of SSW WTP Triangulated Values

	WTP DCE1-HH	WTP DCE2-HH	Combined HH: MAIN	Combined HH: CASE 1	WTP DCE1-NHH	WTP DCE2-NHH	Combined NHH: MAIN	Combined NHH: CASE 1	Combined ALL: MAIN	Combined ALL: CASE 1
Water not safe to drink	£751	£250	£1,004	£1,101	£800	£57	£449	£456	£1,453	£1,556
Discoloured water	£28	£140	£79	£79	£44	£207	£114	£111	£193	£190
Taste and smell of water	£172	£83	£183	£193	£71	£185	£190	£208	£374	£400
Lead pipes	£25	£25	£23	£21	£31	£15	£21	£21	£44	£42
Water hardness	£6	£814	£288	£235	£10	£191	£113	£113	£401	£348
Unexpected temporary loss of water supply	£160	£184	£303	£332	£310	£43	£242	£261	£546	£593
Low water pressure	£41	£32	£37	£38	£38	£4	£27	£29	£63	£67
Flooding from a burst pipe	£475	£366	£435	£440	£534	£270	£383	£376	£818	£816
Temporary use ban	£251,712	£396,645	£295,831	£275,214	£196,426	£326,771	£343,002	£356,291	£638,833	£631,504
Drought restrictions	£92,736		£377,167	£434,791	£392,851		£683,113	£740,593	£1,060,281	£1,175,384
Leakage	£31,319	£26,174	£31,919	£33,905	£23,218	£116,342	£59,303	£55,192	£91,222	£89,097
Water metering	£1.77	£26	£11	£9					£11	£9
Giving customers control of their water usage	£0.4		£0.44	£0.46					£0.44	£0.46
Protecting wildlife habitats	£10,488	£4,904	£9,585	£10,088	£8,184	£5,979	£8,464	£8,766	£18,049	£18,854
Managing impacts on rivers & streams	£1,435	£7,224	£4,675	£4,800	£6,548	£6,299	£5,974	£5,811	£10,649	£10,612
Traffic disruption	£786		£644	£592	£897		£1,102	£1,108	£1,746	£1,700

Table 56: Comparison of CAM WTP Triangulated Values

	WTP DCE1-HH	WTP DCE2-HH	Combined HH: MAIN	Combined HH: CASE 1	WTP DCE1-NHH	WTP DCE2-NHH	Combined NHH: MAIN	Combined NHH: CASE 1	Combined ALL: MAIN	Combined ALL: CASE 1
Water not safe to drink	£495	£548	£1,029	£1,124	£784	£146	£1,516	£1,687	£2,545	£2,811
Discoloured water	£305	£606	£339	£296	£290	£3,004	£699	£781	£1,038	£1,077
Taste and smell of water	£205	£37	£247	£272	£182	£4,537	£1,182	£1,437	£1,429	£1,709
Lead pipes	£25	£4	£16	£17	£23	£147	£36	£40	£52	£56
Water hardness	£6	£306	£115	£98	£6	£2,253	£4	£3	£118	£101
Unexpected temporary loss of water supply	£28	£43	£183	£222	£91	£12	£444	£530	£626	£752
Low water pressure	£18	£114	£60	£59	£23	£72	£85	£101	£145	£161
Flooding from a burst pipe	£613	£408	£491	£484	£2,614	£55	£2,107	£1,962	£2,598	£2,446
Temporary use ban	£452,736	£16,195	£183,864	£161,729	£1,105,920	£190,218	£899,514	£798,892	£1,083,378	£960,622
Drought restrictions	£472,540		£357,268	£319,071	£1,120,150		£1,154,335	£1,133,877	£1,511,603	£1,452,948
Leakage	£140,121	£60,941	£91,862	£92,444	£15,170	£810,506	£125,115	£183,507	£216,977	£275,952
Water metering	£8.6	£9	£7	£6					£7	£6
Giving customers control of their water usage	£2.9		£2	£1					£2	£1
Protecting wildlife habitats	£14,803	£2,728	£11,870	£12,536	£5,120	£115,707	£30,364	£35,685	£42,233	£48,221
Managing impacts on rivers & streams	£1,913	£1,749	£2,131	£2,241	£13,312	£35,976	£11,472	£10,947	£13,604	£13,187
Traffic disruption	£388		£336	£325	£1,683		£1,923	£1,975	£2,259	£2,300

Table 57 presents the SSC main triangulated values in comparison to the triangulated values derived for the sensitivity case. The triangulated WTP estimates for all the core service measures were fairly robust to alternative weights assigned to the various data sources. None of the core measures were found to have a value more than 20% different in the sensitivity case than in the main case.

Table 57: Comparison of SSC WTP Triangulated Values

	Combined HH: MAIN	Combined HH: CASE 1	Combined NHH: MAIN	Combined NHH: CASE 1	Combined ALL: MAIN	Combined ALL: CASE 1
Water not safe to drink	£1,009	£1,105	£676	£718	£1,664	£1,799
Discoloured water	£129	£121	£238	£254	£356	£362
Taste and smell of water	£196	£208	£401	£469	£578	£653
Lead pipes	£21	£20	£24	£25	£46	£45
Water hardness	£260	£215	£151	£162	£407	£373
Unexpected temporary loss of water supply	£280	£311	£285	£318	£561	£623
Low water pressure	£41	£42	£39	£44	£79	£85
Flooding from a burst pipe	£446	£449	£750	£713	£1,162	£1,131
Temporary use ban	£274,355	£253,447	£461,409	£450,461	£724,697	£695,074
Drought restrictions	£373,350	£412,596	£783,373	£824,270	£1,147,454	£1,228,995
Leakage	£43,416	£45,133	£73,306	£82,493	£115,511	£125,188
Water metering	£10	£9			£10	£9
Giving customers control of their water usage	£1	£1			£1	£1
Protecting wildlife habitats	£10,023	£10,558	£13,124	£14,493	£22,720	£24,526
Managing impacts on rivers & streams	£4,187	£4,309	£7,144	£6,904	£11,220	£11,109
Traffic disruption	£585	£541	£1,277	£1,292	£1,845	£1,816

Note: Combined Unit value: MAIN refers to the WTP triangulated values derived in Section 4.4 and Combined Unit VALUE: CASE 1 refers to the WTP triangulated values derived in Section 4.5 for Sensitivity Case 1: Alternative sets of weights. Drought restrictions, smart metering and traffic disruption were not included in the Wave 2 study.

Overall therefore, we find that the triangulated WTP estimates for all the core service measures are robust to alternative weights assigned to the various data sources. This should give SSC and its stakeholders confidence in applying these as measures as a sensitivity checkpoint in CBA and Performance Commitment level and ODI target setting.

5 CONCLUSIONS AND RECOMMENDATIONS

Following Ofwat's methodology for the 2019 price review (PR19), South Staffs Water & Cambridge Water (SSC) asked PJM and Accent to conduct the present study to 'triangulate' evidence from a wide range of sources. This report focusses on the following two key areas where SSC required triangulation support:

- Developing a robust customer priority index, by region, with respect to water resources management plan (WRMP) supply and demand supply options. This index is to be used to fully reflect customers' preferences within SSC's Multi Criteria Analysis investment tool.

- Developing a robust and proportionate evidence base on customers' WTP for different areas of investment. The triangulated values are to be used within SSC's investment optimise tool to undertake Cost Benefit Analysis of investment options and as part of the process of setting ODI rates.

Our triangulation approach built upon and extended the triangulation framework developed by ICF for CCWater. It comprised six steps: screening data sources to identify those with potentially comparable measures, mapping non-core evidence to core measures where possible to enable comparison, assessing theoretical and statistical validity of the resulting measures, rating measures as Red/Amber/Green (RAG) depending on how well they perform with respect to the validity measures, triangulating to conclude on the values to take forward based on applying RAG weights to obtain central values and ranges, and sensitivity testing the results to alternative assumptions and weights.

With respect to WRMP priorities, we found several studies conducted by SSW containing evidence suitable for triangulation. These included qualitative and quantitative 'core' WRMP priorities research, quantitative willingness to pay research, and a quantitative 'Customer Priorities' research study. With respect to WTP, an even wider range of evidence sources are included within the triangulation. In addition to the SSW PR19 WTP core research, data sources included the WRMP research, Customer Priorities research, Performance Commitment engagement, Customer Contacts/complaints, Customer Satisfaction and External WTP evidence (PR14, academic and grey literature).

After mapping the comparable measures derived from the supplementary sources against the core WRMP and WTP measures, we assessed the validity of these measures and rated them against our appraisal criteria. Overall RAG (Red/Amber/Green) ratings were assigned to each source and weights were used based on these ratings to combine measures across sources.

Our WRMP triangulation results showed that `Increased water metering' was the highest priority for South Staffs and 'Building a new water reservoir' was the highest priority for Cambridge water, very closely followed by 'Reducing Leakage'. 'Taking more groundwater' was the least desired option for both South Staffs (SSW) and Cambridge (CAM) regions.

Four sensitivity cases were considered. Across these cases, for both SSW and CAM, there were no differences in priority scores across sensitivity cases larger than 20% of the original score. This should give confidence in the main results as a robust measure of customers' priorities.

Our main WTP results showed that the combined values were close to their WTP core DCE values for some of the core service measures. However, the ranges in almost all cases were highly significant. Overall, we find that the `COMBINED SSC' Unit values seem to have a significant range due to the significant ranges associated with the `Combined NHH' values.

The triangulated WTP estimates for all the core service measures were robust to alternative weights assigned to the various data sources. None of the core measures had a value more than 20% different in the sensitivity case than in the main case. The only exceptions were Taste and Smell, Leakage and Unexpected Temporary Loss of Water Supply in the CAM region.

These differences are all fairly low in the context of WTP measurement, where value estimates can often vary by an order of magnitude or more for the same good (see Accent, 2014, for examples.) This should give SSC and its stakeholders confidence in applying these as measures as a sensitivity checkpoint in CBA and Performance Commitment level and ODI target setting.

In summary, the findings of this study should provide valuable insight into customers' preferences with respect to WRMP priorities and WTP for service improvements and we recommend them to SSC for this purpose.

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APPENDIX A

DATA SOURCES CONSIDERED

APPENDIX A DATA SOURCES

This section presents an overview of the data sources that were considered for triangulation.

Core WRMP Research (used)

In July and August 2017 SSW commissioned a comprehensive programme of qualitative and quantitative engagement with a broad range of its customers and stakeholders, the findings of which were to be used to inform the WRMP and business plan. The research consisted of three elements in both South Staffs Water (SSW) and Cambridge Water (CAM):

- Two phase deliberative workshops (SSW/CAM) with household, non-household SME's and future customers – 62 customers in total
- Roundtables with stakeholders and large business customers – 21 in total across both regions.
- An online survey with 512 household customers across both regions.

This multi-stage project covered priorities / preferences around WRMP and the level of support for various demand and supply side options. One of the main outputs from this research was a weighting scale that could be used to reflect customers' preferences in the multi criteria analysis (MCA) being undertaken by SSW on where and how much they should invest in their demand and supply side options.

Core WTP Research (used)

The primary objective of the PR19 WTP research conducted by SSW was to understand customer's willingness and ability to pay for different service and investment levels for water services for the five-year period 2020-2025. This research was based on two large quantitative surveys (Wave 1 and Wave 2) and a MaxDiff choice exercise (Wave 1) in order to study customers' willingness and ability to pay for different service and investment levels for water services. The Wave 1 survey included a discrete choice experiment (DCE) and a MaxDiff choice exercise to assess customers' willingness to pay for significant service improvements across 17 service measures. In the mainstage of the survey, there were 1573 interviews that were conducted in October and November 2017. These interviews were combined with the surveys from the pilot survey. This resulted in 1,999 interviews overall with 1,309 surveys completed in South Staffs, and 690 completed in Cambridge. A total of 333 NHH interviews were completed across the two regions. The Wave 2 survey included a discrete choice experiment (DCE) to assess customers' willingness to pay for significant service improvements across 18 service measures. In Wave 2, the levels of improvements displayed to respondents were amended, and new attributes relating to retail/community included (i.e. investing in community projects, educating future generations and supporting customers facing difficult situations). 982 interviews were conducted in April and May 2018 across South Staffordshire and Cambridge. These interviews included 142 pilot interviews where the new attribute wording and new community attributes were tested. The lower bill WTP exercise was completed with 290 customers across the two regions and 692 saw the standard WTP version. 719 surveys were completed in South Staffs, and 263 in Cambridge. A total of 244 NHH interviews were completed across the two regions.

Foundation Priorities Research (not used)

The Foundation priorities research program was conducted in June 2017 by Accent, on behalf of SSW and CAM to understand household and business customers' priorities for service delivery both at present and over the longer term (prompted and spontaneous). The research program

was based on a purely qualitative methodology and consisted of pre-tasked extended discussion groups, home interviews with customers in vulnerable circumstances and telephone depth interviews with larger non-household customers. 96 customers took part.

Metering Research (used)

The Metering Uptake research was a quantitative study conducted to explore the attitudes to metering amongst unmetered customers. The study was focussed on understanding customers' reasons for not switching to a meter. The fieldwork was conducted in July 2017 and consisted of 202 CATI interviews with a representative cross section of the customer base in the Cambridge region and the Sutton Coldfield area of South Staffs (101 with CAM customers and 101 with SSW customers).

Customer Priorities Research (used)

The Customer Priorities survey was a quantitative study of uninformed priorities amongst potential improvements to various service measures. Unlike the qualitative Foundation priorities research, where reviewed customers' priorities were reviewed in focus groups, this survey was conducted online and was designed to quantify customers' priorities.

The survey respondents were recruited via a pop-up link to the online survey on the SSW and CAM website home pages. The survey which ran from early December 2017 to the end of January 2018 was completed by 291 SSW customers and 166 CAM customers completed the full survey. The survey asked customers to choose their top 3 priorities from 3 areas: water quality & water supply, customer service & bills and planning for the future and then asked customers to choose their top 3 priorities from all the options together.

Customer Service Tracker (used)

Customer service tracker research was conducted to establish customer perceptions of SSC service performance. This research comprised of a quantitative telephone study conducted in 2017-2018 covering 302 SSW customers and 100 CAM customers. The main output from this study was service perceptions and brand service measure ratings assigned by the customers.

Based on the Customer service tracker research output, Accent conducted a regression analysis to identify the predictors of overall satisfaction. This research estimated several regression models to study the impact of satisfaction with water supply aspects and value for money on overall satisfaction, the impact of service failures experienced over the last twelve months on overall satisfaction and to study the impact of service failures and satisfaction on overall satisfaction. These models were estimated separately for the SSW and CAM regions to explore regional variations in customer perceptions.

Bright and SIM Surveys (not used)

The Service Incentive Mechanism (SIM) survey was introduced by Ofwat in 2010 to encourage water companies to improve their customer service. The overall objective of the study is to measure customers satisfaction of the key interaction points i.e. billing and operations. The research explores the reasons for consumers making a contact with their water supplier and assesses how satisfied consumers are with their water company's overall handling of their contact. The main output from this research are satisfaction mean scores (ranging from 1 to 5 where 5 = very satisfied and 1= very dissatisfied) that are assigned to all the water companies based on the survey results.

The Bright survey is also a customer satisfaction survey which gathers customer data through various channels e.g. email, phone, web etc. and assigns scores to companies based on their handling of customer contacts.

CCWater Research (not used)

The Consumer Council for Water (CCWater) studies that are available to us for triangulation include the CCWater 'Water Matters' (Household customers' views on their water and sewerage services 2016) and the CCWater 'Water Saving' (Helping customers to see the bigger picture) reports.

CCWater Water Matters is an annual household satisfaction tracking survey which aims to identify household customers' views of water and sewerage services across England and Wales and monitors these changes in these views over time. The report based on the 2016 survey comprised of 5,420 telephone interviews with household water bill payers. The survey was designed to carry out atleast 200 interviews with each Water and Sewerage Company (WaSC) and atleast 150 interviews with each Water Only Company (WoC). The survey explored several aspects of customer satisfaction e.g. their likelihood to recommend their water supplier to family/friends, how satisfied they were with the value for money for their water services, fairness and affordability of charges, bill clarity etc.

The CCWater Water Saving report is based on research conducted to explore the current attitudes and behaviours of customers in relation to water and the future supply of water. This research comprised of four day-long face-to-face deliberative workshops with household water customers across four locations (London, York, Neath and Norwich) in June 2017. The output from this research was purely qualitative and discursive.

SSW Contacts and Complaints (used)

The main sources of Customer contacts data are based on the following SSC customer reports:

- Contact call centre report
- Customer services team report
- Contact channel analysis report

For purposes of our study, we focus on the SSC analysis of customer contacts data. This analysis contains information on the Total Number of contacts (all channels), Total Number of unwanted contacts over a 3-year period (2015/2016, 2016/2017 and 2017/2018) and the number of properties affected pertaining to the core WTP service measures.

SSW Web Surveys (not used)

Pop-up web surveys were run on both SSW and CAM websites between June and August 2017 to assess customer perceptions of SSC service performance. This survey asked similar questions as in the Customer service tracker. A total of 4,658 customer completed the survey of which 3,699 were SSW customers and 959 were CAM customers. The main output from this survey comprised of responses to qualitative questions as well as mean satisfaction scores (1-5) regarding the performance of SSC related to various service measures.

Performance Commitment Service Sliders (used)

In order to support SSC in its 2019 price review for Ofwat, a PC slider study was conducted by Explain Research in 2018. This research was based on an online questionnaire that was developed for the Performance Commitment engagement project of SSC. The original sample sizes for SSW and CAM regions were 559 and 225 respectively. The questionnaire asked customers to move the sliders up and down for 11 attributes in order to see the dynamic impact on their bill. The customers could see the levels for each PC which drove the sliders, for example, they could see the bill impact if they wanted, say, an additional 50 hectares of land to be managed by SSC in order to protect and improve areas for wildlife and plants in the places where they operate. Note that 240 SSW and 86 CAM respondents who chose the baseline levels for all the attributes were dropped from our analysis. This task was designed to help SSC evaluate the extent that customers want to achieve for these 11 PCs and help them understand how much customers would like SSC to spend for each of these PCs to deliver the service that they want. The main output from this survey comprised of service levels chosen by the respondents and their associated bill amounts.

External WTP evidence (used)

External WTP evidence examined included the following:

- SSW PR14 study
- Non-SSW PR14 and PR19 studies
- Academic studies
- Grey literature
- WTP evidence from other sectors (GHG emissions and Traffic and transport)

Our main source for the PR14 and PR19 data is a comparative anonymised review of willingness to pay (WTP) study conducted for about 15 water companies by Accent and PJM (2014 and 2018). The studies contain PR14 and PR19 Unit WTP values for different service measures e.g. discoloured water, taste and smell of water, unexpected temporary loss of water supply etc. The overall objective of the study is to provide a comparison of the PR14 and PR19 values across the different companies that can be utilised by companies to check whether their own results are 'within the pack' or are outliers which may invite closer scrutiny by Ofwat or customer challenge groups.

In addition, we considered two other studies for triangulation i.e.

- Academic: 'The demand for tap water quality: Survey evidence on water hardness and aesthetic quality', *Lanz and Provins (2016)* and
- WTP evidence from power sector: 'The Value of Lost Load (VoLL) for Electricity in Great Britain, Final report for OFGEM and DECC, *London Economics (2013*). This study estimates the Value of Lost Load (VoLL) to be £16,900/MWh. The VoLL is the social cost of supply interruptions to customers.