Confidential

Benefits Transfer and Triangulation of Customer Valuation for Service at PR24

Prepared for Yorkshire Water

19 December 2022

CONFIDENTIALITY

Our clients' industries are extremely competitive, and the maintenance of confidentiality with respect to our clients' plans and data is critical. NERA Economic Consulting rigorously applies internal confidentiality practices to protect the confidentiality of all client information.

Similarly, our industry is very competitive. We view our approaches and insights as proprietary and therefore look to our clients to protect our interests in our proposals, presentations, methodologies and analytical techniques. Under no circumstances should this material be shared with any third party without the prior written consent of NERA Economic Consulting.

NERA Project Team

Richard Druce
Zoë Fannon
Teresita Gonzalez
Giovanni Raiteri

NERA Economic Consulting
Marble Arch House
66 Seymour Street
London, UK W1H 5BT
+44 207 659 8500
www.nera.com

Contents

List of Tables

List of Figures

Executive Summary

Yorkshire Water (YW) has commissioned NERA Economic Consulting (NERA) and Qa Research (Qa) to prepare a combined benefits transfer and triangulation report as a companion to the report on our stated preference exercise eliciting willingness to pay (WTP) for changes in service at PR24. The benefits transfer method involves "transferring" to the current context any available valuation evidence from comparable studies that were completed in another location, at another time, or in another context. We then "triangulate" the results of the PR24 stated preference study with the results of the benefits transfer exercise, to produce a set of WTP values that incorporate evidence from a range of stated preference studies. The purpose of the exercise is to improve the reliability and defensibility of customer valuations used in YW's business planning.

Approach to Benefits Transfer and Triangulation

We have examined four different studies for the combined benefits transfer and triangulation exercise. These are:

- YW's own stated preference studies conducted at previous price controls (PR14 and PR19),
- A stated preference exercise conducted by Wessex Water (WW) for PR19, and
- A stated preference exercise conducted by Dŵr Cymru Welsh Water (DCWW) for PR19.

We chose to analyse the WW and DCWW PR19 reports for two reasons. First, the publicly available documentation of these studies is comprehensive. Second, the attributes and service units used in these studies are comparable to those used in our PR24 study, while the method used is somewhat different. The WW and DCWW reports use a methodology to derive per-unit WTP values that combines the results of a MaxDiff exercise and a package choice exercise. Including these studies in our benefits transfer/triangulation exercise allows us to assess the sensitivity of our WTP values to the stated preference methodology used.

To conduct the benefits transfer exercise, we identify the attributes in each of the four studies above that are comparable to the attributes examined in the YW PR24 study, and extract per-unit WTP values for those attributes. We then make adjustments to transfer those values to the context of the YW PR24 study. These include an adjustment for inflation, an adjustment for regional GDP to account for differences in disposable income across regions, and adjustments for differences in units (e.g. if one study reports a WTP for 100 fewer properties to be affected by sewage flooding while another study reports a WTP for 10 fewer properties to be affected). We also make adjustments to account for slight differences in the definitions of attributes; for example, the YW PR14 study only considers unplanned interruptions of 6-12 hours, so we make an assumption to derive a value for unplanned interruptions of 3-6 hours (the attribute examined in the YW PR24 study).

At the triangulation stage, we adopt a four-phase approach to combine the results from the benefits transfer exercise with the results from the YW PR24 study in order to generate a set of triangulated customer valuations. In developing our approach, we relied on guidance set out by Ofwat and the Consumer Council on Water (CCW) for best practice in triangulation in the water sector. Our four-phase approach can be characterised as a systematic judgement rule within the set of triangulation approaches described by Ofwat. We prefer this approach to, for example, a mechanistic rule because it offers the flexibility to account for the specific characteristics of different attributes across different studies, in line with the recommendation of the CCW.

Results of Benefits Transfer

Our analysis shows that, for household (HH) customers:

- The results of our PR24 stated preference exercise are ***above*** the range of values estimated from the benefits transfer exercise for 4 attributes: attribute C (water lost through leaks); attribute G (river water quality); attribute H (sea water quality); and attribute I (pollution of watercourses).
- The results of our PR24 stated preference are ***within*** the range of values estimated from the benefits transfer exercise for 2 attributes: attribute E (sewage flooding inside properties) and attribute F (sewage flooding outside properties).
- The results of our PR24 stated preference are ***below*** the range of values estimated from the benefits transfer exercise for 3 attributes: attribute A (drinking water colour, taste, and smell); attribute B (unplanned interruptions of the water supply); and attribute J (low water pressure).

Overall, these results give us confidence that there is no systematic bias in our PR24 stated preference study as compared to previous stated preference exercises. Broadly speaking, the PR24 WTP values are of a similar order of magnitude to the WTP values found in stated preference exercises conducted at previous price controls. The estimated PR24 WTP values are neither always above nor always below the range of values estimated from previous studies, suggesting that the survey design does not systematically result in higher or lower estimated WTP.

There is also reason to believe that the differences that we do observe between the PR24 results and the results derived from the benefits transfer exercise reflect current customer preferences and priorities. The results suggest that customers increasingly want to see improvements in attributes that relate to protection of the environment and sustainability, that customers continue to be concerned about sewage flooding, and that customers are less concerned than they previously were about attributes related to measures of service that have less impact on them.

Meanwhile, for non-household (NHH) customers, the results of our PR24 stated preference study are ***below*** the range of values estimated from the benefits transfer exercise for all attributes. For attribute H (sea water quality) the result is marginal: the lowest value in the range estimated from the benefits transfer exercise is within 0.01 percentage points of the PR24 result.

Although the NHH WTP observed at PR24 is lower than the WTP observed in for NHH customers at previous price controls, we are confident that this is not a consequence of a bias in the survey design because we do not see a systematic difference in the WTP of HH customers across price controls and the survey design for NHH customers was analogous to that for HH customers. Instead, it is likely that the lack of WTP for improvement among for

NHH customers reflects business concerns around bill affordability in the context of high inflation, rising energy prices, and the aftermath of the COVID-19 pandemic.

Triangulated Results

In light of the findings above, we consider that YW could adopt either of two approaches to selecting results for use in its business planning.

First, YW could simply use the results from the PR24 stated preference study directly. The analysis above shows that the results from the PR24 exercise are not out of line with the results of previous stated preference studies, which therefore gives confidence that there is no systematic bias arising from the particular stated preference approach adopted at PR24.

The PR24 study also captures current customer preferences, whereas the other studies considered reflect customers' preferences as they were five or ten years ago. The economic environment has changed since even five years ago, due to rising inflation and energy bills. The particularly dry conditions observed in summer 2022 and the significant media attention on wastewater discharges into rivers and the sea may also have shifted customer preferences around the relative priority of different aspects of their water service. All of this may give reason to think that stated preference studies from PR19 and PR14 are not reflective of current customer preferences and should not be used to inform business planning decisions for PR24, in the absence of evidence that the PR24 results are unreliable or systematically out of line with previous methods.

On the other hand, YW may prefer to use triangulated results, which adjust the estimates from PR24 to be closer to the estimates observed in previous WTP studies where the PR24 results are above or below the range of estimates derived from previous WTP studies. This approach would make sense if there were reason to believe that customers' responses to the PR24 survey exercise were overly sensitive to prevailing conditions and may not accurately reflect long-term preferences. For example, we may be concerned that HH customers' relatively high WTP to reduce leakage or pollution of watercourses is driven by a reaction to recent media coverage of such events rather than consideration of the long-term costs and benefits. Similarly, we may be concerned that the lack of WTP among NHH customers is driven by concern about bill affordability in the immediate future, rather than over the full PR14 period (2025-2030).

We therefore present two results in this report: the unadjusted PR24 stated preference results, and a set of triangulated results that adjust the PR24 stated preference results towards the results of previous studies where the PR24 results are outside the range estimated in previous studies. These are presented in Table 1, below.

By construction, the triangulated results serve to temper the results of the PR24 study. For those attributes where the PR24 study reported a high WTP, we observe a lower WTP in the triangulated results; and for those attributes where the PR24 study reported a low or zero WTP, we observe higher WTP in the triangulated results. The most notable effects of this are on attributes where we found zero WTP in the PR24 study; the triangulated results yield a positive WTP for almost all such attributes. The exception is attribute J (low water pressure) for which we continue to observe zero WTP among NHH customers and near-zero WTP among HH customers. This may be because attribute J, as defined, relates to chronic low water pressure which is not a widespread problem in the region, meaning that most customers are likely to have limited willingness to pay for improvement.

Overall, we recommend that YW use the triangulated values as the central estimate in its business planning. The triangulated results strike a balance between the robustness that comes from relying on multiple datapoints, and the need to reflect current customer preferences. Our systematic judgement rule for triangulation ensures that the triangulated values reflect evidence from multiple stated preference studies. However, the triangulated results place relatively more weight on the PR24 study than any one other historical study, to reflect the fact that the most recent study is likely to be more reflective of current customer preferences.

Table 1: Results of PR24 Stated Preference Study and Triangulation Exercise

			HH (£/ unit change)		**NHH (% point/ unit change)**	
	Attribute	**Unit**	**Unadj.**	**Tri.**	**Unadj.**	**Tri.**
A	Drinking Water Colour, Taste and Smell	Reduction in number of contacts per 10,000 customers	0.00	0.26	0.00	0.11
B	Unplanned Interruptions to the Water Supply	Reduction in number of properties interrupted per year (1000s)	0.00	0.19	0.00	0.09
C	Water Lost Through Leaks	Reduction in millions of litres lost per day	0.18	0.13	0.00	0.01
E	Sewage flooding inside properties	Reduction in number of properties flooded per year (10s)	0.50	0.50	0.00	0.06
F	Sewage flooding outside properties	Reduction in number of properties flooded per year (100s)	0.52	0.52	0.00	0.12
G	River Water Quality	Increase in kilometres of river improved	0.07	0.04	0.00	0.003
H	Sea Water Quality at Yorkshire's Beaches	Increase in number of beaches rated "good" or "excellent"	5.19	3.38	0.14	0.29
I	Pollution of watercourses	Reduction in number of minor pollution incidents	0.28	0.19	0.00	0.02
J	Low Water Pressure	Reduction in number of properties with chronic low pressure	0.00	0.0003	0.00	0.00

Source: NERA analysis
Notes: "Unadj."=unadjusted results from PR24 stated preference study. "Tri."=triangulated results.

1. Introduction

Yorkshire Water (YW) has commissioned NERA Economic Consulting (NERA) and Qa Research (Qa) to prepare a combined benefits transfer and triangulation report. This report accompanies the report on the stated preference willingness-to-pay study that YW commissioned from NERA and Qa to estimate customers' willingness to pay (WTP) for changes in service at PR24. The purpose of the combined benefits transfer and triangulation report is to review the evidence from the PR24 stated preference study in light of evidence on customer WTP from previous studies and to produce a set of "triangulated" results that combine evidence across studies. YW can then use these triangulated results to inform its PR24 business plan.

The first step in the process is the benefits transfer exercise. This involves "transferring" to the current context any available valuation evidence from comparable studies that were completed in another location, at another time, or in another context.

In this report we make use of four comparable stated preference studies: YW's own stated preference studies conducted at previous price controls (PR14 and PR19, respectively) and stated preference studies conducted by other water companies at PR19 (specifically, Wessex Water and Dŵr Cymru Welsh Water). We selected studies from these two companies because the publicly available reporting on the studies was comprehensive and because the set of service attributes and the units of service used were comparable to those used in the YW PR24 stated preference study.

The output of the benefits transfer exercise is a set of valuations from each of the selected studies, transferred to the PR24 stated preference study context. These transfer process includes, for example, adjustments for inflation and regional GDP, as well as for slight differences in the definitions of service attributes and units of service.

The second step is the triangulation exercise. In this exercise, we first use the outputs from the benefits transfer study to benchmark the results emerging from the PR24 stated preference study, to assess their robustness. Second, we combine the results from the PR24 stated preference study with the results of the benefits transfer study to generate a set of "triangulated" results. While YW could have relied on the results of the PR24 stated preference study alone when formulating its PR24 business plan, the objective of triangulation is to improve the reliability and defensibility of customer valuation research by drawing upon a range of valuation evidence.

The structure of this report is as follows:

- Section 2 sets out the methodology we adopt in both the benefits transfer and triangulation stages of this exercise.
- Section 3 provides an overview of the PR24 stated preference study and the four other studies that we use in this report.
- Section 4 sets out, attribute-by-attribute, the results of the benefits transfer and triangulation exercise for each of the nine attributes considered.
- Section 5 concludes.

2. Methodology

This section sets out the methodology we adopt in conducting the benefits transfer and triangulation exercises. Section 2.1 sets out the methodology for the benefits transfer exercise while Section 2.2 sets out the methodology for the triangulation exercise.

2.1. Benefits Transfer

The first step in the benefits transfer exercise is to select the studies from which we will transfer results. We used results from four different stated preference studies in this exercise.

- We used results from the stated preference studies conducted by YW at previous price controls (PR14 and PR19). YW provided us with the reports on these studies.
- We used results from stated preference studies conducted by Wessex Water (WW)[1] and Dŵr Cyrmu Welsh Water (DCWW)[2] for the PR19 price control. We selected the WW and DCWW PR19 studies because the publicly available documentation was comprehensive, and because of the similarity between the methods and units used in these studies to those of the YW PR24 stated preference study. This helps ensure greater comparability of the WTP values obtained. The publicly available customer valuation research prepared by other water companies at PR19 was less comparable to the YW PR24 study, because of differences in either the methods or the units.

For each study, we identify the attributes that are comparable to the attributes examined in the YW PR24 stated preference study, and extract per-unit WTP values for those attributes. We then make adjustments to transfer those values to the context of the YW PR24 study, as follows:

- **Definition of service attributes:** There are slight differences in the definition of service attributes across studies. For example, in valuing unexpected interruptions to supply some studies consider interruptions of 3-6 hours, whereas others consider interruptions lasting 6-12 hours. To harmonise our studies, where attributes are relatively similar, we normalise them to the unit definitions in YW's PR24 study, using an appropriate adjustment. For instance, we might convert a value of avoiding an interruption lasting 6-12 hours into a value of avoiding an interruption lasting 3-6 hours by dividing the former by 2.
- **Inflation:** We adjust household customers' WTP using the Consumer Prices Index, including owner occupiers' housing costs index (CPIH) reported by the ONS.[3] We convert all prices into 2022 Q3 prices, since the YW PR24 stated preference study was conducted in 2022 Q3. For non-household customers, no inflation adjustment is needed as WTP is reported as a percentage change in the bill rather than in GBP values.
- **Regional GDP:** Disposable income differs across regions, and so for the two studies that we use from outside of the Yorkshire area, we make adjustments for regional differences

[1] Wessex Water (September 2018), Appendix 1.1.D – Willingness to pay research 1 – Accent

[2] Accent and PJM Economics (December 2017), Dwr Cyrmu Welsh Water PR19 Willingness to Pay Research

[3] We use 2022 Q3 as the final result since the PR24 study was conducted in 2022 Q3. CPIH data from https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/l522/mm23 (last accessed 13 November 2022).

in disposable income. This ensures that the final willingness to pay values we provide are comparable to those for individuals earning incomes in line with those observed in YW's catchment area in the period of interest. We adjust the per-unit willingness to pay measures using regional GDP per capita as provided by the ONS.[4]

2.2. Triangulation

The objective of triangulation is to improve the reliability and defensibility of customer valuation research by drawing upon a range of valuation methods and evidence. The basic principle of triangulation is to use several different methods or studies to estimate the same value, and critically assess the different results to get a more robust picture of customers' true valuation.

In this report, we critically assess the results of several stated preference studies to get a more robust picture of customers' valuation for different attributes of their water service. To develop our approach, we first reviewed the available guidance from Ofwat and the CCW. We summarise this evidence in Section 2.2.1, below. Based on this guidance and the characteristics of the studies we use in this triangulation exercise, we adopt a four-phase approach to triangulation, which we describe in Section 2.2.2.

2.2.1. Guidance and best practice on triangulation

Both Ofwat and the Consumer Council for Water (CCW) have set out guidance for water companies on using triangulation to understand customer valuation for water services.

2.2.1.1. Ofwat guidance

At PR19, Ofwat challenged companies to draw upon a wider evidence base of valuation evidence at its PR19 price review, and triangulate evidence from these multiple sources when making decisions based on customer valuation evidence.[5]

Ofwat published a report it commissioned from Frontier Economics, which set out potential triangulation "rules" for companies to follow when triangulating valuation evidence at PR19.[6] The Frontier report defines three rules; (i) a mechanistic rule, taking a weighted average of individual valuations (based on a pre-defined weighting rule), (ii) a systematic-judgment rule, a system based on reasonable judgement, and (iii) a "multi-input CBA approach", based on iterative testing of the outcomes of CBA on customer valuations.[7]

As we describe below, we have chosen to apply a systematic-judgement rule, which balances the need for a systematic assessment of alternative methods with the need for pragmatism and some judgment in assessing the impact of different valuation results. Frontier describes a systematic-judgement rule in full, as follows:[8]

---

4 ONS (30 May 2022), Regional gross domestic product: all ITL region. Link: https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/regionalgrossdomesticproductallnutslevelregions (last accessed 13 November 2022)

5 Ofwat (January 2019), PR19 initial assessment of plans, Technical appendix 1: Delivering outcomes for customers.

6 Frontier Economics (March 2017) Performance commitments and outcome delivery incentives at PR19.

7 Frontier Economics (March 2017) Performance commitments and outcome delivery incentives at PR19, p. 30-31.

8 Frontier Economics (March 2017) Performance commitments and outcome delivery incentives at PR19, p.31.

> *"This approach would be based on a reasoned judgement, informed by a system that is pre-defined, at least to some extent. For example, it may take account of the fact that RP does not reflect the full value that a service improvement brings to customers as, it does not capture the "inconvenience" of an interruption. This may imply that RPs should consistently be used as a lower bound."*

Ofwat also appraised the triangulation of companies' valuation evidence in its initial assessment of business plans at PR19.[9] Ofwat's assessment of plans does not reveal many additional details as to its view of "high quality" triangulation, although its critique of some companies' plans indicates that a lack of triangulation, reliance on a single valuation study, or the absence of cross-checking against other customer engagement research (i.e. qualitative evidence) are all inconsistent with best practice.[10]

2.2.1.2. CCW guidance

Ahead of PR19, the CCW commissioned a report from ICF on the use of triangulation in the water sector. In its report for the CCW, ICF defines triangulation as "using multiple and independent measures to examine a hypothesis or conclusion being investigated, with the intent of using multiple perspectives to minimise bias and maximise validity".[11] ICF further defines the following principles on how triangulation should be applied in practice:[12]

- Triangulation should be transparent in its process used in assessing each source and any final reasoning;
- Triangulation must be flexible to different needs and situations;
- Triangulation must be explicit when evidence is contradictory; and
- Deliberate steps must be taken to avoid confirmation bias.

2.2.2. Our triangulation process

Based on our understanding of the purpose of triangulating valuation, and our review of the guidance on best practice in triangulation, we developed a four-phase triangulation process, which we set out below.

2.2.2.1. Phase 1: Review each study

First, we examine the results from each of the five studies in the round. This allows us to identify any patterns of difference in the valuation estimates across studies, which informs the development of our subsequent triangulation approach. For example, if we identify that one study typically results in higher WTP values than other studies, we investigate whether this may be driven by methodological differences or some form of bias and take that into consideration when constructing the triangulated results.

---

9 Ofwat (January 2019), PR19 initial assessment of plans, Technical appendix 1: Delivering outcomes for customers.

10 Ofwat (January 2019), Northumbrian Water: Test question assessment, p. 1.
Ofwat (January 2019), United Utilities: Test question assessment, p. 1.

11 ICF (July 2017) "Defining and applying 'triangulation' in the water sector", p. 1.

12 ICF (July 2017) "Defining and applying 'triangulation' in the water sector", p. 1 and p. 27-29.

The five studies we examine are:

- The stated preference study we have prepared for YW at PR24, which we refer to as YW PR24.
- The stated preference studies commissioned by YW at previous price controls, which we refer to as YW PR19 and YW PR14 respectively.
- The stated preference studies commissioned by Wessex Water and Dŵr Cymru Welsh Water at PR19, which we refer to as WW PR19 and DCWW PR19 respectively.

We observe that the estimated WTP for PR24 is neither systematically higher nor systematically lower than the estimated WTP from studies at previous price controls but depends on the attribute under consideration and on whether we are looking at results for household (HH) or non-household (NHH) customers. The lack of a systematic difference gives us confidence that there is no bias introduced by the methodology adopted at PR24.

For NHH customers, we observe that WTP at PR24 is typically lower than the WTP observed at previous price controls. For HH customers, we observe that WTP at PR24 is typically higher for attributes relating to environmental protection and water leakage, but lower for attributes related to service. This suggests that at PR24, customers may have traded off service improvements between attributes, opting for less improvement in service attributes in order to allocate more of the total amount they were willing to pay for improvement to attributes related to environmental protection at leakage.

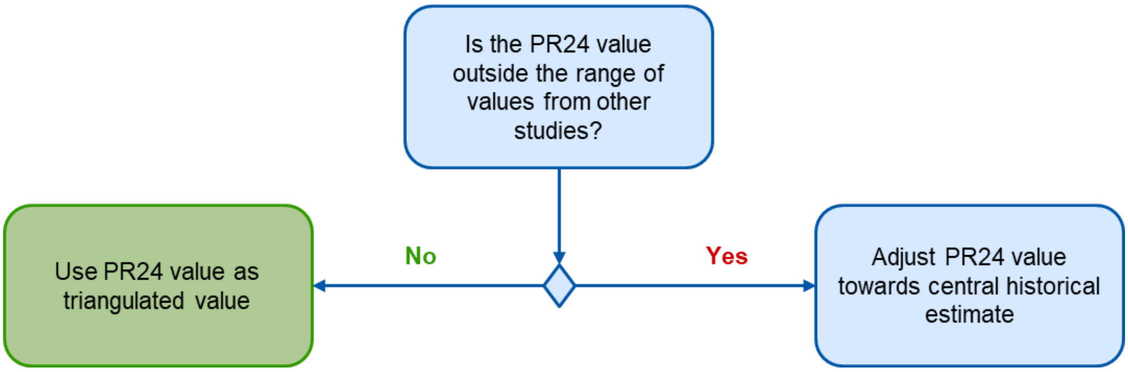
The finding that at PR24 HH customers appear to have opted to trade off service improvements between attributes leads us to reject the approach adopted in previous triangulation studies of identifying a range of WTP values attribute-by-attribute. This approach does not account for the pattern of trade-offs between attributes. The high end of the range would combine the high WTP values seen for environmental attributes at PR24 with the relatively higher WTP values seen for service attributes at previous studies and would thus overstate customers' total WTP.

Instead, we develop the triangulated results in a way that accounts for the fact that customers make trade-offs between attributes by adjusting the estimated values from the PR24 stated preference studies towards the central historical estimate where the estimated value from the PR24 study is outside the range of historical values.

2.2.2.2. Phase 2: Review each attribute

In the second phase, we consider the range of estimated values for each attribute. If the PR24 value lies outside the range of values from other studies, then we calculate the triangulated value by adjusting the PR24 value towards the central estimate from the historical studies, as shown in Figure 2.1.

Figure 2.1: For Each Attribute, We Compare the PR24 Estimate to the Values Derived from the Benefits Transfer

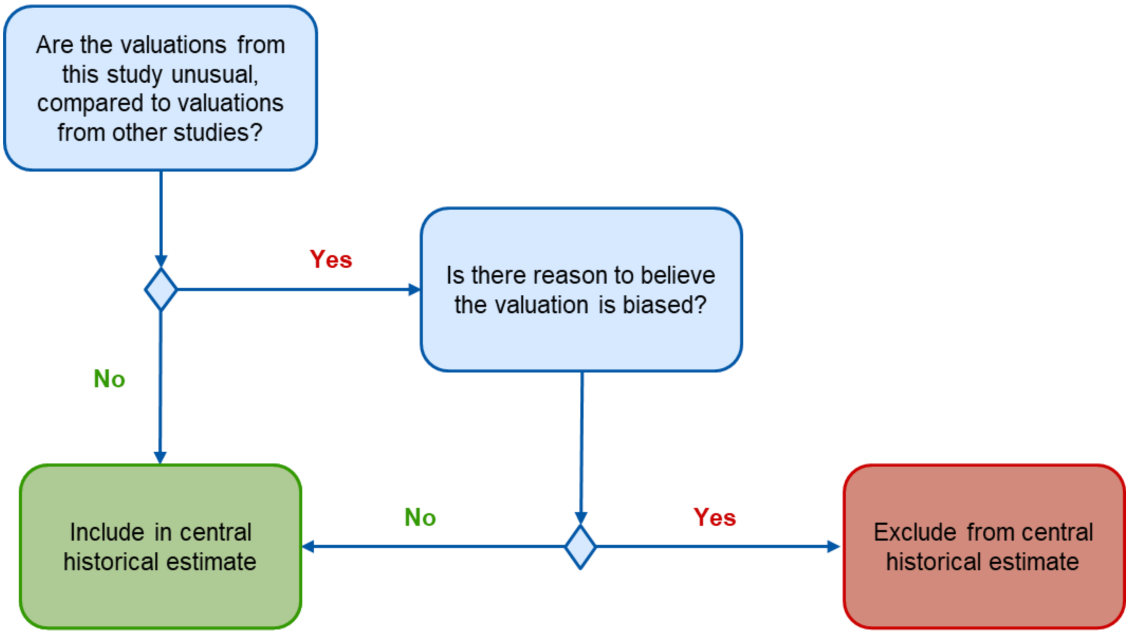


Source: NERA analysis

2.2.2.3. Phase 3: Review each data point

In the third phase, we critically assess the validity of each estimate derived from the benefits transfer exercise. We consider a series of questions, as shown in the chart below, to determine how to treat each value.

Figure 2.2: We Derive a Central Historical Estimate from the Transferred Values

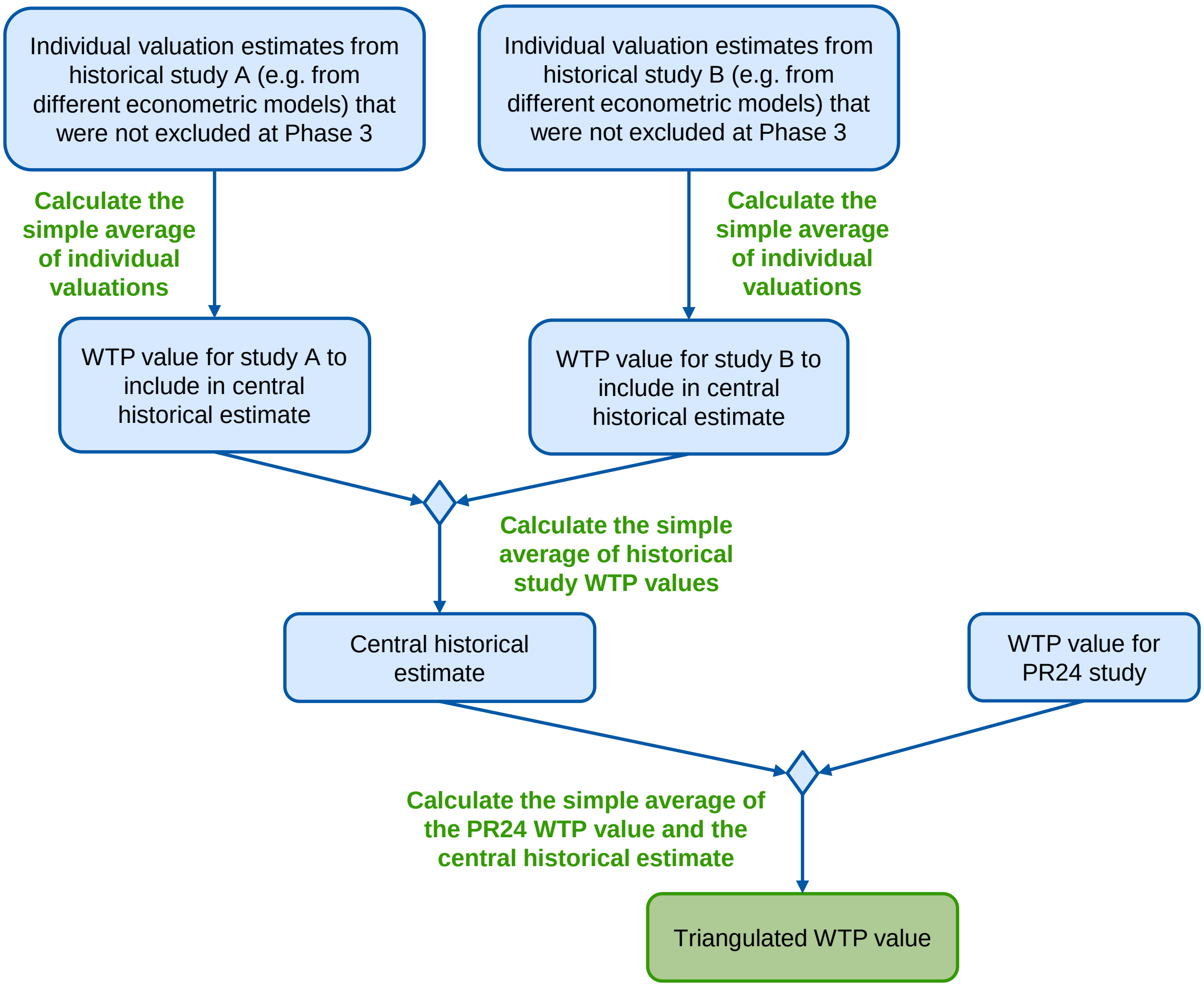


Source: NERA analysis

2.2.2.4. Phase 4: Generate a Triangulated Value

In the final phase, we incorporate each of the estimates identified to be included at Phase 3 into our triangulated estimate. We do this in a systematic manner, following the framework set out in Figure 2.3.[13] The framework in this figure is for a hypothetical case in which valuation estimates are obtained for a particular attribute from two historical studies, study A and study B; any additional historical studies would be included in the same way as studies A and B in this example.

Figure 2.3: We Combine Historical Estimates and the PR24 Estimate to Get the Triangulated Value



Source: NERA analysis

The logic of the approach set out in Figure 2.3 is as follows.

1. In the first step, we obtain a single estimate for each historical study (in this example, study A and study B). For each study, we consider all included estimates from the study for the attribute in question. For example, the YW PR14 and PR19 studies often have three estimates because three different logit models were used in each study. For these studies, we typically include all three estimates, so that the WTP value for that study derived in the first step of Figure 2.3 is equal to the average of those three estimates.

13 We refer to this framework as "systematic" rather than "mechanistic" because of the exercise of judgement in the choice of which studies and datapoints to include for each attribute, as explained in Sections 2.2.2.1 to 2.2.2.3.

2. In the second step, we obtain the central historical estimate. We do this by taking a simple average of the WTP values derived for each study in the first step. This approach ensures that we do not assign extra weight to studies that estimated more models using the same data (e.g. the YW PR14 study, for which we have results from three estimated logit models, does not get more weight that then WW PR19 study, for which we have results from one estimated model).

3. In the final step, we obtain the triangulated value. We do this by taking a simple average of the central historical estimate and the PR24 estimate.

The approach set out in Figure 2.3 can also be understood as a weighted average approach. This can be seen by working backwards through the steps. In the final step, the central historical estimate and the PR24 study have equal weight. In the penultimate step, studies A and B contribute equal weight to the central historical estimate. Combining these steps, this is equivalent to taking a weighted average of the results of study A, study B, and the PR24 study where studies A and B are each assigned 25 per cent weight while the PR24 study is assigned 50 per cent weight. We attach more weight to the PR24 estimate than to the individual historical estimates because it is more recent and therefore more likely to reflect current customer preferences.

3. Studies Used for Benefits Transfer

In this section, we describe each of the studies that informs our benefits transfer and triangulation exercise in turn.

3.1. Yorkshire Water PR24 Study

For the 2024 price review (PR24), YW commissioned a stated preference study from NERA and Qa Research to estimate customers' willingness to pay for changes in service for eleven attributes. We asked customers to make trade-offs between bills and service levels for eleven attributes. The eleven attributes over which we elicited customers' preferences are shown in Table 3.1.

Table 3.1: We Examined Customer WTP for Eleven Service Attributes for PR24

Attribute	
A	Drinking Water Colour, Taste and Smell
B	Unplanned Interruptions to the Water Supply
C	Water Lost Through Leaks
D	Using Less Water
E	Sewage flooding inside properties
F	Sewage flooding outside properties
G	River Water Quality
H	Sea Water Quality at Yorkshire's Beaches
I	Pollution of watercourses
J	Low Water Pressure
K	Creating a River Wharfe safe for swimming

Source: NERA and Qa Research[14]

In the present study, we conduct a benefits transfer and triangulation exercise for nine of these attributes. The two excluded attributes are attribute D (using less water) and attribute K (creating a River Wharfe safe for swimming). We exclude these attributes because we could not find previous studies that elicited customer preferences for similar attributes, and therefore we did not have additional datapoints to include in the benefits transfer and triangulation exercise.

In the PR24 stated preference study, we estimate WTP under the assumption that customers have the same WTP for improvements in service across the full range of possible service levels for each attribute.[15] We adopt this approach because YW's business planning tool and valuation framework requires a single WTP value for each attribute, capturing the WTP for an incremental change in service level of that attribute.

[14] NERA and Qa Research (31 October 2022), Estimating Customers' Willingness to Pay for Changes in Service at PR24 [DRAFT] – Prepared for Yorkshire Water, p. 3

[15] That is, we adopt a model that assumes the utility that customers derive from each attribute is linear in the service level of that attribute.

3.2. Yorkshire Water PR14 Study

For PR14, YW commissioned a stated preference study to inform the development of its capital investment programme for the period 2014-2019. The study was conducted by a group of researchers from the Centre for Research in Environmental Appraisal and Management (CREAM) at the University of Newcastle.

In this section we provide an overview of the study and explain how we convert the values from the study to be comparable to the values from our PR24 stated preference study.

3.2.1. Overview of study

The PR14 study asked customers to make trade-offs between bills and service levels for eleven attributes. The eleven attributes ("service measures", in the terminology of the study) were sorted into four thematic groups, as shown in Table 3.2.

Table 3.2: YW Examined Customer WTP for Eleven Attributes at PR14

Service Measure	Grouping
Discolouration of tap water	Water supply quality (WSQ)
Taste and odour of tap water	
Safe water quality	
Interruption to supply (to property)	Water supply security (WSS)
Security of supply	
External sewage flooding	Waste water disposal (WWD)
Internal sewage flooding	
Sewage treatment works (odour from)	
River water quality	Environment (ENV)
Pollution incidents	
Bathing beaches	

Source: Centre for Research in Environmental Appraisal and Management[16]

For each of the eleven attributes there were five possible service levels: two improvements (1 and 2); two deteriorations (-1 and -2); and the status quo (SQ).

The study used a block design, whereby customers were only asked to consider one group of attributes at a time. For each group of attributes, each customer saw four choice cards which asked them to choose between three package options. Two options were hypothetical alternatives, constructed by combining improvements and deteriorations for each of the attributes within the group and assigning a bill impact value. Bill impact values were

16 Willis, K., Garrod, G., and Scarpa, R. (March 2013), Customer Preferences, willingness-to-pay and willingness-to-accept changes in water service measures: a choice experiment. Centre for Research in Environmental Appraisal and Management, p. 5

expressed as a percentage change in the bill.[17] The third option was always the status quo, for which the bill impact value was zero.[18]

The study adopted the block design to avoid respondents having to simultaneously trade-off too many services, which would have created a cognitive burden for respondents.

The study also included a final choice experiment which combined all four groups of attributes in a "package". Customers were again asked to choose between two hypothetical alternative packages and the status quo. For the hypothetical alternatives, service levels were assigned to either maximum or minimum values block by block and a total bill was assigned.

Both HH and NHH customers were included in the survey. The main survey of HH customers includes 1,200 respondents. The NHH survey includes 500 business customers. HH and NHH customers were analysed separately.

CREAM estimated a variety of different models based on the data collected for both HH and NHH customers. While CREAM's preferred models were a series of piecewise linear error component logistic (ECL) models, piecewise linear models are not suitable for the present exercise as YW's valuation framework requires a constant per-unit WTP across all possible service levels (as explained in Section 3.1).

We therefore focus our attention on the linear models that CREAM estimates.[19] CREAM estimates these models separately for each group of attributes based on the results of the initial block design choice exercise. It estimates three different linear models:

- Conditional Logit (CL)
- Random Parameter Logit (RPL)
- Error Component Logit (ECL)

We report the results from all three models for each attribute, as the differences between the results from each of the three models are relatively limited.

The study reports the fit of each type of model, measured by the pseudo-R2. The ECL model has the best fit for all groups of attributes for the NHH responses and for the WSQ and WSS groups for HH customers. For the WWD and ENV groups for HH customers, the RPL model has the best fit.

3.2.2. Adjustments for triangulation

We use the following attributes from the PR14 study in the triangulation exercise:

---

[17] Willis, K., Garrod, G., and Scarpa, R. (March 2013), Customer Preferences, willingness-to-pay and willingness-to-accept changes in water service measures: a choice experiment. Centre for Research in Environmental Appraisal and Management, p. 21

[18] The study used an efficient design to construct the choice cards. Willis, K., Garrod, G., and Scarpa, R. (March 2013), Customer Preferences, willingness-to-pay and willingness-to-accept changes in water service measures: a choice experiment. Centre for Research in Environmental Appraisal and Management, p. 20-21

[19] Even these models are not fully linear; the CL and RPL models include an additional parameter to allow for the possibility that customers attach additional value to the status quo. The ECL model, meanwhile, allows for correlation in the unobservable components of utility within-customer across non-status-quo options.

- Discolouration of tap water
- Taste and odour of tap water
- Interruptions to supply (unexpected)
- External sewage flooding
- Internal sewage flooding
- River water quality
- Pollution incidents
- Bathing beaches

In some cases, the units are not directly comparable and so we make assumptions to align them (e.g. for discolouration, taste, and odour and for interruptions to supply). We discuss these in further detail in Section 4.

The incremental WTP values in the PR14 study are reported as a percentage point change in bill rather than in GBP values, as this is how the questions were posed to customers in the survey. For HH customers, to convert them to GBP values, we multiply by the average household customer bill estimated by YW for the start of the 2014-2019 period.[20]

Finally, we adjust the WTP values by inflation. We adjust the household customers' WTP using the Consumer Prices Index, including owner occupiers' housing costs index (CPIH) reported by ONS until the first quarter of 2022.[21]

3.3. Yorkshire Water PR19 Study

For PR19, AECOM and DJS Research conducted a stated preference study for YW. In this section we provide an overview of the study and explain how we convert the values from the study to be comparable to the values from our PR24 stated preference study.

3.3.1. Overview of study

The YW PR19 study sought to estimate customer values for thirteen service measures pertaining to water. As for PR14, the attributes were sorted into four groups ("service areas", in the terminology of the study).

[20] Willis, K., Garrod, G., and Scarpa, R. (March 2013), Customer Preferences, willingness-to-pay and willingness-to-accept changes in water service measures: a choice experiment. Centre for Research in Environmental Appraisal and Management, p. 6

[21] We use 2013 Q1 as the baseline since the PR14 report was completed in March 2013, and 2022 Q3 as the final result since the PR24 study was conducted in 2022 Q3. CPIH data from https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/l522/mm23 (last accessed 13 November 2022)

Table 3.3: YW Examined Customer WTP for Thirteen Attributes at PR19

Service area	Service level attribute
Water quality	Poor water pressure: number of properties below standard pressure
	Drinking water quality: proportion of samples of tap water that will pass the DWI's requirement for chemical & biological content
	Taste, smell & colour of drinking water: total number of water quality contacts
Supply of water	Unexpected supply interruption of 3-6 hours: total properties affected
	Leakage
	Water use restrictions e.g. hose pipe ban
Sewerage services	Sewer flooding inside properties: number of incidents per year
	Sewer flooding outside properties: number of incidents per year
	Properties subjected to chronic (seasonal) unbearable smells from sewers and treatment works: complaints to YWS per year
Environment	Number of bathing beaches meeting 'Good' or 'Excellent' standard
	Length of rivers in Yorkshire improved (%)
	Category 3 pollution incidents: number of minor incidents that have a minimal impact on the quality of water in the area
	Area of land conserved or improved by Yorkshire Water: hectares

Source: AECOM and DJS Research[22]

For each of the thirteen attributes there were six possible service levels: three improvements (+1, +2, and +3); two deteriorations (-1 and -2); and the status quo (SQ).

The study used a block design, whereby customers were only asked to consider one group of attributes at a time. For each group of attributes, each customer saw three choice cards which asked them to choose between three package options. Two options were hypothetical alternatives, constructed by combining improvements and deteriorations for each of the attributes within the group and assigning a bill impact value. Bill impact values were expressed as monetary values for HH customers and as a percentage change in the bill for NHH customers.[23] The third option was always the status quo, for which the bill impact value was zero.[24]

The study adopted the block design to avoid respondents having to simultaneously trade-off too many services.

Both HH and NHH customers were included in the survey. The main survey of HH customers includes 1,020 respondents. The NHH survey includes 542 business customers. HH and NHH customers were analysed separately.

22 AECOM and DJS Research (November 2017), PR19 Understanding Customer Values: Work Package 1 – First Round Stated Preference, p. 6

23 It is not clear whether the monetary value shown for households was household-specific or based on the average customer bill. See AECOM and DJS Research (November 2017), PR19 Understanding Customer Values: Work Package 1 – First Round Stated Preference – Appendices, p. 3, p. 12

24 AECOM and DJS Research (November 2017), PR19 Understanding Customer Values: Work Package 1 – First Round Stated Preference – Appendices, p. 3

AECOM estimated a variety of different models based on the data collected for both HH and NHH customers. While AECOM's preferred models were a series of fixed effect conditional logit models that allow for the WTP to move from the status quo to vary depending on the alternative service level, this model is not suitable for the present exercise as YW's valuation framework requires a constant per-unit WTP across all possible service levels.

We therefore focus our attention on the linear models that AECOM estimates.[25] AECOM estimates these models separately for each group of attributes based on the results of the initial block design choice exercise. It estimates three different linear models:

- Conditional Logit (CL)
- Random Parameter Logit (RPL)
- Generalised Mixed Logit (GML)

We report the results from all three models for each attribute, as the differences between the results from each of the three models are relatively limited.

3.3.2. Adjustments for triangulation

We use the following ten attributes from the PR19 study in the triangulation exercise:

- Poor water pressure
- Taste, smell and colour of drinking water
- Unexpected supply interruptions of 3-6 hours
- Leakages
- Water use restrictions
- Sewer flooding inside properties
- Sewer flooding outside properties
- Bathing water quality
- River water quality
- Pollution incidents

Some of the attributes for which WTP was measured in the PR19 WP1 study map onto the PR24 attributes better than others. For the following attributes that do not match directly, we make assumptions or adjustments to align them: taste, smell, and colour of drinking water; the two sewer flooding attributes; and river quality. The adjustments and assumptions are discussed in further detail in Section 4.

[25] Even these models are not fully linear; all models include an additional parameter to allow for the possibility that customers attach additional value to the status quo.

Finally, we adjust all the PR19 WTP results for inflation using CPIH.[26]

3.4. Wessex Water PR19 Study

Wessex Water (WW) commissioned Accent and PJM Economics to estimate customer WTP for a range of different service levels in the lead-up to PR19.

In this section we provide an overview of the study and explain how we convert the values from the study to be comparable to the values from our PR24 stated preference study.

3.4.1. Overview of study

Accent and PJM Economics examine customer WTP for improvement in both water and wastewater service attributes. In their final reporting, they present per-unit WTP values for HH customers for eleven water attributes and eight wastewater attributes, as set out below.

Table 3.4: Wessex Water Examined Customer WTP for 19 Attributes at PR19

Water attributes	Wastewater attributes
Restrictions on essential use of water	Bathing waters at good but not excellent
Planned interruptions (3-6 hours)	Miles of river at less than good status
Response time for fixing leaks	Sites where dilute sewage spills into rivers and estuaries
Miles of river with less than ideal flow levels	Bathing waters at less than good status
Hosepipe bans	Sewer flooding outside customers' properties
Unexpected interruptions (3-6 hours)	Sewer flooding in public areas
Discoloured water (few days)	Restricted toilet use due to sewers being overloaded
Unexpected interruptions (6-12 hours)	Sewer flooding inside customers' properties
Planned interruptions (6-12 hours)	
Persistent low water pressure	
Non ideal taste and odour (few days)	

Source: Accent and PJM Economics[27]

Accent and PJM Economics construct the WTP analysis based on customer responses to two distinct choice exercises. Each customer completes both exercises in the same order. The two exercises are as follows:

- A 'MaxDiff' exercise containing choice cards in which participants are asked to choose which service issue among a list of four would have the most impact on them and which would have the least impact. Each customer saw ten choice cards, generated using a design algorithm intended to *"maximise the statistical precision of the estimates"*.[28]

[26] Data available at https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/l522/mm23 (last accessed 13 November 2022).

[27] Accent and PJM Economics (June 2017), Customer Valuation Research (PR19): WTP and Stage 2 Results, pp. 24 and 27

[28] Accent and PJM Economics (January 2018), Wessex Water PR19 Willingness to Pay Research: Final Report, pp. 14-16

- A 'Package' exercise in which participants are asked to choose between two packages of service levels, each with a different bill impact.[29] There were four different packages, defined as follows:
  - -1: all service measures deteriorate, and the bill is lower than the SQ.
  - 0: status quo (SQ) all service measures unchanged; bill either remains constant or experiences an increase or decrease of 2.5 per cent of the customer's current bill.[30]
  - +1: all service measures improve, and the bill is higher than the SQ.
  - +2: all service measures further improve, and the bill is higher than in +1.
- Each participant was asked to make four pairwise choices between combinations of the different packages. All participants faced the same pairwise combinations, which were as follows:
  - Status quo (0) vs small improvement (+1)
  - Status quo (0) vs large improvement (+2)
  - Small improvement (+1) vs large improvement (+2)
  - Status quo (0) vs small deterioration (-1)

The aim of the MaxDiff exercise is to obtain estimates of the *"relative impact that each type of service issue would have on customers"* (i.e., relative measures of utility). In turn, the Package level provides evidence on the *"customers' willingness to trade off money for service level changes at the package level"*.[31]

For the MaxDiff analysis, Accent and PJM Economics use a rank-ordered logit model to estimate the relative importance of different service attributes. Accent and PJM Economics then exponentiate the coefficients from the rank-ordered logit regression to obtain impact scores.

Accent and PJM Economics analyse the data from the Package exercise using a Conditional Logit (CL) model. The model treats the SQ as the baseline and estimates two "alternative-specific constants (ASC)": one representing the deterioration option and one pooling together the improvement options.[32] The coefficient on the second ASC was used to derive a WTP to move from the SQ package to the +1 package (under the assumption that there was no additional WTP to move to the +2 package).

Accent and PJM Economics then derive per-unit WTP values by combining the impact scores from the MaxDiff exercise with the WTP to move from the SQ to the +1 package estimated

---

29 Accent and PJM Economics (January 2018), Wessex Water PR19 Willingness to Pay Research: Final Report, pp. 18-20

30 The assignment to increase, decrease, or constant SQ bill is random.

31 Accent and PJM Economics (January 2018), Wessex Water PR19 Willingness to Pay Research: Final Report, p. 5

32 Accent and PJM Economics (January 2018), Wessex Water PR19 Willingness to Pay Research: Final Report, p. 77

from the package exercise. In effect, they apportion the total WTP to move to the +1 package between attributes using the impact scores.[33]

3.4.2. Adjustments for triangulation

We use the following attributes from the Wessex PR19 study in the triangulation exercise:

- Unexpected interruptions (3-6 hours)
- Sewer flooding outside customers' properties
- Sewer flooding inside customers' properties
- River water quality less than 'Good' to 'Good'
- Persistent low pressure
- Bathing water 'Sufficient' to 'Good'
- Discoloured water (few days)
- Non ideal taste and odour (few days)

For all WW PR19 attributes analysed, we make at least two transformations to the willingness to pay estimates provided by Accent and PJM Economics.

1. The first transformation is for inflation. This is done to ensure compatibility with the PR24 willingness to pay values. As was the case in sections above, we adjust household customers' WTP using the Consumer Prices Index, including owner occupiers' housing costs index (CPIH) reported by ONS until the first quarter of 2022.[34]

2. The second adjustment we make is one for regional differences in disposable income. We do this to ensure that the final willingness to pay values we provide are comparable to those for individuals earning incomes in line with those observed in YW's catchment area in the period of interest. We adjust the per-unit willingness to pay measures provided by Accent and PJM Economics by the ratio of the regional GDP per capita in Yorkshire and the Humber in 2018 over that in the South West (in 2019 GBP), as provided by the ONS.[35] We multiply the WTP estimates by 0.91 to adjust for the fact that the real GDP per capita was higher in regions served by WW than in those served by YW.

The final Accent and PJM Economics report only contains per-unit WTP values on a GBP basis, and not on the basis of a percentage point change in the bill. It also does not report the average value of the NHH bill collected in the survey. Given the potential variability of NHH bills, without this information we cannot compare the NHH WTP values from the WW

[33] Note that in some cases, the definitions of attributes differed between the MaxDiff and Package exercises and so Accent and PJM Economics were required to use conversion factors to map between the two. See Accent and PJM Economics (January 2018), Wessex Water PR19 Willingness to Pay Research: Final Report, p. 71

[34] Data available at https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/l522/mm23 (last accessed 13 November 2022)

[35] ONS (30 May 2022), Regional gross domestic product: all ITL region. Link: https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/regionalgrossdomesticproductallnutslevelregions (last accessed 13 November 2022)

PR19 survey to the NHH WTP values from the YW PR24 survey. Therefore, we only consider HH WTP values from this study in the benefits transfer/triangulation exercise.

3.5. Dŵr Cymru Welsh Water PR19 Study

Dŵr Cymru Welsh Water (DCWW) commissioned Accent and PJM Economics to estimate WTP amongst customers for a range of different service levels in the lead-up to PR19.

In this section we provide an overview of the study and explain how we convert the values from the study to be comparable to the values from our PR24 stated preference study.

3.5.1. Overview of study

Accent and PJM Economics examine customer WTP for improvement for six water attributes and seven wastewater attributes, as set out below.

Table 3.5: DCWW Examines Customer WTP for 13 Attributes at PR19

Water attributes	Wastewater attributes
Short-term interruptions	River water quality
Temporary use ban	Bathing water quality
Long-term interruptions	Minor pollution
Non-essential use ban	Sewer flooding outside
Discoloured water	Sewer flooding inside
Persistent low pressure	Odour from sewage works
	Significant pollution

Source: Accent and PJM Economics[36]

Accent and PJM Economics employ an identical research design to that adopted in their work for Wessex Water at PR19. That is, they ask customers to complete two separate choice exercises: a MaxDiff exercise, in which customers identify which attributes have the most and least impact on them, and a Package exercise, which elicits customers' WTP to move from the status quo to a hypothetical alternative involving only deteriorations or only improvements in service. They then combine the results of the two surveys to get per-unit WTP values, effectively using impact scores derived from the MaxDiff exercise to allocate the total WTP from the package exercise to different attributes.

Section 3.4.1 provides a more detailed description of the approach as applied to Wessex Water. The only difference in the application to DCWW is the set of attributes included. Otherwise, the survey design and modelling approaches are identical.

The DCWW survey involved 1,000 dual service households, 50 wastewater only households, and 500 dual-service non-households.[37]

[36] Accent and PJM Economics (December 2017), Dwr Cyrmu Welsh Water PR19 Willingness to Pay Research, p. 39

[37] Accent and PJM Economics (December 2017), Dwr Cyrmu Welsh Water PR19 Willingness to Pay Research, p. 6

3.5.2. Adjustments for triangulation

We use the following attributes from the DCWW PR19 study in the triangulation exercise:

- Short-term interruptions
- Persistent low pressure
- Sewer flooding outside
- Sewer flooding inside
- Minor pollution
- Discoloured water

As was the case for WW, for all DCWW PR19 attributes analysed we make at least two transformations to the willingness to pay estimates provided by Accent and PJM Economics.

1. The first adjustment is for inflation. This is done to ensure compatibility with the PR24 willingness to pay values. As was the case in sections above, we adjust household customers' WTP using the Consumer Prices Index, including owner occupiers' housing costs index (CPIH) reported by ONS until the first quarter of 2022.[38]

2. Second, we adjust for regional differences in disposable income. We do this to ensure that the final willingness to pay values we provide are comparable are proportional to the average incomes faced in YW's catchment area in the period of interest. To do so, we adjust the per-unit willingness to pay measures provided by Accent and PJM Economics by the ratio of the regional GDP per capita in Yorkshire and the Humber in 2018 over that in Wales (in 2019 money value), as provided by the ONS.[39] In this case, this involves adjusting the willingness to pay estimates upwards by a factor of 1.09 to reflect the fact that real GDP per capita in Yorkshire was higher than in Wales in 2018.

The final Accent and PJM Economics report only contains per-unit WTP values on a GBP basis, and not on the basis of a percentage point change in the bill. It also does not report the average value of the NHH bill collected in the survey. Given the potential variability of NHH bills, without this information we cannot compare the NHH WTP values from the WW PR19 survey to the NHH WTP values from the YW PR24 survey. Therefore, we only consider HH WTP values from this study in the benefits transfer/triangulation exercise.

38 Data available at https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/l522/mm23 (last accessed 13 November 2022)

39 ONS (30 May 2022), Regional gross domestic product: all ITL region. Link: https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/regionalgrossdomesticproductallnutslevelregions (last accessed 13 November 2022)

4. Results by Attribute

In this section, we report the results of our benefits transfer and triangulation exercises for each of the nine considered attributes in turn. We follow the triangulation process defined in Section 2.2.2 to construct triangulated values for each attribute. For HH customers, the final triangulated value differs from the unadjusted value derived from the PR24 stated preference study for seven of the nine attributes (that is, we apply an adjustment to bring the triangulated value more in line with the historical customer valuation data). For NHH customers, we make adjustments to get the triangulated value for eight of the nine attributes.

4.1. Drinking Water Colour, Taste and Smell

For attribute A (drinking water colour, taste and smell), we transfer values from all four historical studies. We rely on estimates from two of these studies (YW PR14 and YW PR19) to derive our final triangulated value.

4.1.1. Transferred values from previous stated preference studies

At PR24, in the stated preference study performed for YW by NERA and Qa Research, we asked customers about their WTP to reduce the number of customers contacting YW about an unexpected change in the colour, taste, or smell of their drinking water. The question was framed in terms of the number of customers per 10,000 contacting YW. The current situation was presented as follows: *"Each year around 11 in 10,000 households (NHH: properties) in the region contact Yorkshire Water about a change in the look, taste or smell of their drinking water."*

We then asked customers to choose between five different service levels ranging between 13 and 9 per 10,000 customers per year.

Customers were also asked questions about changes to the colour, taste, or smell of their drinking water in each of the other four studies we considered. However, the format of the question varied across all studies.

YW's own PR19 study framed the question in a very similar way to our PR24 study. The attribute was framed in terms of the number of customers contacting YW about problems with their water *"quality (e.g. water the colour of weak tea coming out of the tap)"*. To convert to the number of customers per 10,000 we multiply the PR19 value by 240, since YW reports that it served 2.4 million customers at the time of the PR19 study.[40]

In both the YW PR14 study and the WW PR19 study, discolouration was evaluated separately from taste and odour. We therefore combine results for these two attributes in order to map to the single YW PR24 attribute "Drinking Water Colour, Taste and Smell".

In order to combine these two attributes into one, we took the following steps:

- We converted the units to be comparable to the units of the YW study. The YW PR14 study reports values for a reduction in number of affected properties per 1,000 properties, so we divide by 10 to convert to the number of customers per 10,000. The WW PR19

[40] We understand from analysis files provided by YW related to the PR19 study that there were 2.258 million HH customers plus 148,000 NHH customers, giving 2,406,000 customers (approximately 2.4 million) in total.

study reports values for a reduction in the total number of affected properties by one property, so we multiply by 125 to convert to the number of customers per 10,000.[41]

- We weighted the two measures to combine them into one. Since the PR24 WTP indicates that the colour, taste *or* smell of water is affected, this suggests that only one of the three occur. Therefore, we take an average of the WTP to avoid the discrete events of discolouration or taste/odour events, rather than adding the two values. We assign each of the three equal weight in the average. We assign the 'Discoloured water (few days)' attribute a weight of one-third, and the 'Non ideal taste and colour (few days)' a weight of two-thirds.

An implicit assumption in these calculations is that the mapping from *contacts* due to water colour, taste and smell onto *cases* of unpleasant water colour, taste and smell (lasting a few days) is roughly one-to-one. The WW PR19 study explicitly reports WTP in terms of cases; and although the YW PR14 study reports WTP in terms of contacts, the questions were posed to customers in terms of cases.[42]

The DCWW PR19 study only asks customers about WTP to reduce the number of *"properties facing discoloured water for a week (per year)"*, that is, it does not ask about taste and odour. To transfer the DCWW PR19 results to the YW PR24 context, we take the following steps:

- We assume that respondents have similar WTP to avoid taste and odour events as they do to avoid discolouration events. There is some evidence from YW PR14 and WW PR19, for which the two were examined separately, that customers have higher WTP to avoid taste and odour events and so introducing this assumption means that we are likely to slightly understate the true WTP for improvement in the YW PR24 attribute.
- We again assume that the mapping between *contacts* and *cases* is roughly one-to-one.
- To convert from the DCWW WTP to the PR24 WTP units, we multiply the value obtained by Accent and PJM Economics by the number of customers served by DCWW, divided by 10,000. Accent and PJM Economics report that DCWW serves 1.4 million total customers, so the converting coefficient is 140.[43]

Figure 4.1 shows the estimated incremental WTP values for HH customers, while Figure 4.2 shows the values for NHH customers. As explained in Section 3, the per-unit NHH values for the WW PR19 and DCWW PR19 studies are in GBP rather than in percentage point change on the bill and are therefore not comparable to the YW PR24 estimates, so we do not include them in Figure 4.2. From Figure 4.1, we see that the DCWW PR19 values are lower

---

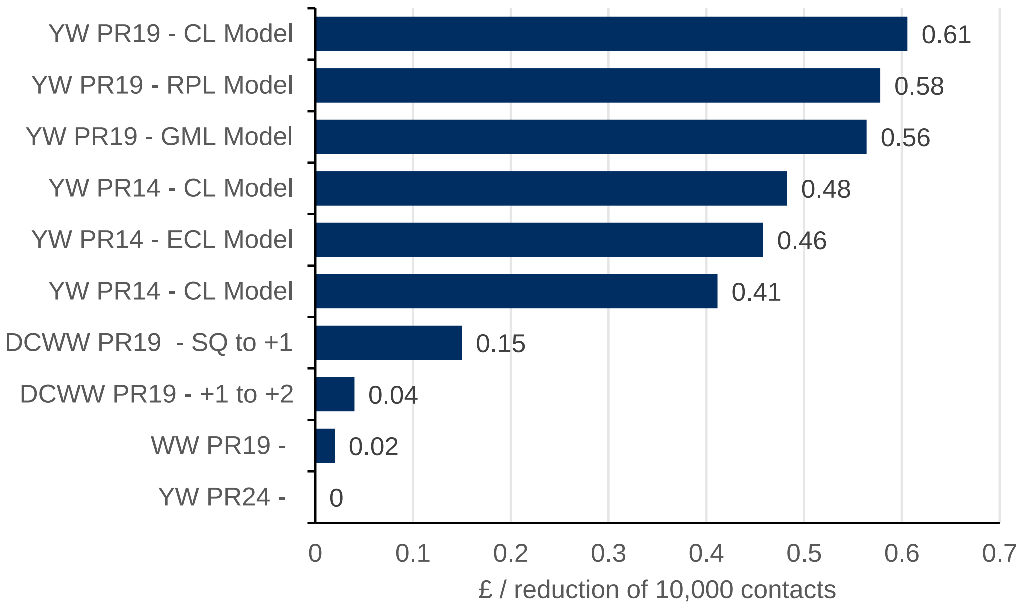
41 Wessex Water served 1.25 million customers at the time of the PR19 report, so the reported WTP values from that study are WTP for a reduction in the number of affected properties per 1.25 million properties; we convert to WTP for a reduction in the number of affected properties per 10,000 by multiplying by 1,250,000/10,000.

42 The specific phrasings were as follows: for discolouration, *"The chance of you being affected by a one- or two-day long discolouration event in any one year, where water is discoloured but very unlikely to cause illness e.g. noticeable in a bath"*; and for taste/odour *"The chance of you being affected by a one- or two-day long taste and odour event in any one year, where the water has a taste or odour but is very unlikely to cause illness e.g. slight smell and taste of disinfectant".* We have confirmed with YW that the study imposed a one-to-one case-to-contact assumption to derive the WTP values as reported.

43 Accent and PJM Economics (December 2017), Dwr Cyrmu Welsh Water PR19 Willingness to Pay Research, p. 8

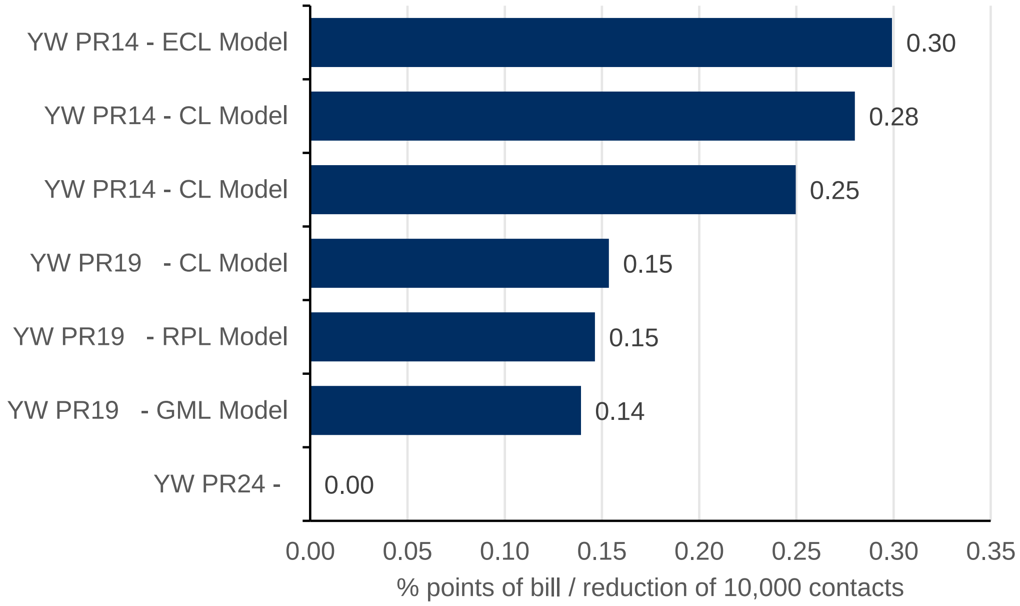
than the YW PR19 values, which may be because the DCWW PR19 study only asked about discolouration and not about problems with taste or odour.

Figure 4.1: HH Customer Incremental WTP to Reduce Contacts Regarding Drinking Water Colour, Taste, and Smell



Source: NERA analysis
Notes: (1) Values are WTP to reduce the number of contacts per 10,000 customers by 1 in GBP. (2) Estimates for YW PR24, YW PR14, and YW PR19 are significant at 5 per cent significance level. We do not have this information for WW PR19 and DCWW PR19.

Figure 4.2: NHH Customer Incremental WTP to Reduce Contacts Regarding Drinking Water Colour, Taste, and Smell



Source: NERA analysis
Notes: (1) Values are WTP to reduce the number of contacts per 10,000 customers by 1 as % point reduction on the bill. *(2) Estimates for YW PR14, and YW PR19 are significant at 5 per cent significance level.*

4.1.2. Triangulated values

To construct the triangulated value, we follow phases two to four of the process set out in Section 2.2.2. First, we compare the PR24 value to the range of transferred values, and we observe that for both HH and NHH customers it is at the lower end of the range. In line with our triangulation process, we must therefore incorporate the historical estimates in the final triangulated value.

To incorporate the historical estimates, we first construct a central historical estimate. We include both the YW PR14 and YW PR19 values. We exclude the DCWW PR19 values because they are low compared to the YW PR14 and PR19 values, and we have reason to believe they may be biased downwards since customers were only asked about discolouration. We also exclude the WW PR19 values, since they are below the DCWW PR19 values – this may reflect regional differences in preference related to this attribute. The central historical estimate is therefore the simple average of all six estimated values from the YW PR14 and YW PR19 studies, for both HH and NHH customers.

We then get the final triangulated value by taking the simple average of the central historical estimate and the PR24 estimate. We report the final triangulated estimates in Table 4.1.

Table 4.1: PR24 Triangulated Values for Drinking Water Colour, Taste and Smell

	PR24 Unadjusted	PR24 Triangulated
HH (£/unit change)	0.00	0.26
NHH (% point/unit change)	0.00	0.11

Source: NERA analysis

4.2. Unplanned Interruptions to the Water Supply

For attribute B (unplanned interruptions to the water supply), we transfer values from all four historical studies. We rely on estimates from all four of these studies to derive our final triangulated value.

4.2.1. Transferred values from previous stated preference studies

At PR24, we asked customers about their WTP to reduce the chance of experiencing an unexpected supply interruption of between 3 and 6 hours. The question was framed in terms of the number of properties experiencing an interruption. The current situation was presented as follows: *"Last year 46,000 or 2% of properties experienced their water being cut-off for 3 to 6 hours due to an unplanned interruption. During an interruption Yorkshire Water delivers bottled water to vulnerable people."*

We then asked customers to choose between five different service levels ranging between 55,000 and 36,000 properties interrupted per year.

Customers were asked similar questions in all four of the other studies we examined.

In all three of the PR19 studies we examined (i.e. YW, WW, and DCWW) the question was almost identical: customers were asked to choose the number of properties per year facing a supply interruption of between 3 and 6 hours.[44] The final WTP values in the PR19 studies are presented as WTP per reduction in number of interruptions by one property; therefore, in order to generate values that are comparable to those from the PR24 study, we multiply by 1,000.

In the YW PR14 study, customers were asked a question that differed in two ways. First, they were asked about an interruption lasting 6 to 12 hours. Second, the options were presented as the *chance* of the customer themselves being affected by interruption, rather than as the number of properties affected. For example, the status quo chance of being affected was 1 in 1,100 while the improvement option was 1 in 2,200.

We understand from YW that the number of connected properties for water and sewerage services in 2013 (the year the PR14 study was conducted) was 2,105,052. We use this number to convert the probability of being affected by an unexpected interruption to the number of interruptions.

Regarding the transformation of the estimates from 6 to 12 hours of interruption into 3 to 6 hours, we consider two different approaches.

- For the first approach (Mod 1), we make no additional adjustments. This approach is based on findings from YW PR19 Work Package 2 (W2). In W2, AECOM estimates the values YW customers place on changes in service measures using a stated preference

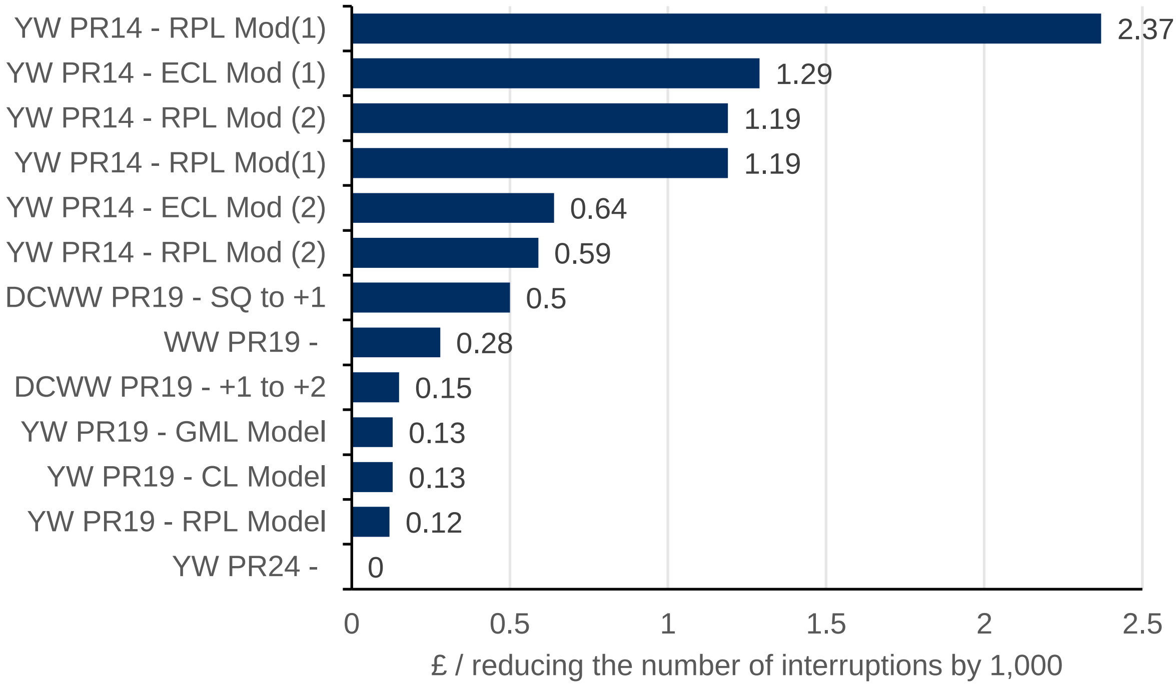
[44] For the WW and DCWW PR19 studies, customers were also asked about short-term interruptions lasting 6 to 12 hours on average. However, only the findings for the 3-6 hour interruption appear to have been used to derive the willingness to pay values displayed in this report.

survey. They found no significant difference from the base case, interruption for 3-6 hours, to interruption for 6-12 hours.[45]

- For the second approach (Mod 2), we assume that customers' WTP is linear in the duration of the supply interruption. Thus, since 6-12 hours has a mean that is twice as long as 3-6 hours, we divide the estimated WTP for a 6-12 hour interruption by two to transfer the value to the PR24 context of a 3-6 hour interruption.

We present the final transferred WTP estimates for HH and NHH customers in Figure 4.3 and Figure 4.4, respectively.

Figure 4.3: HH Customer Incremental WTP to Reduce Unexpected Interruptions

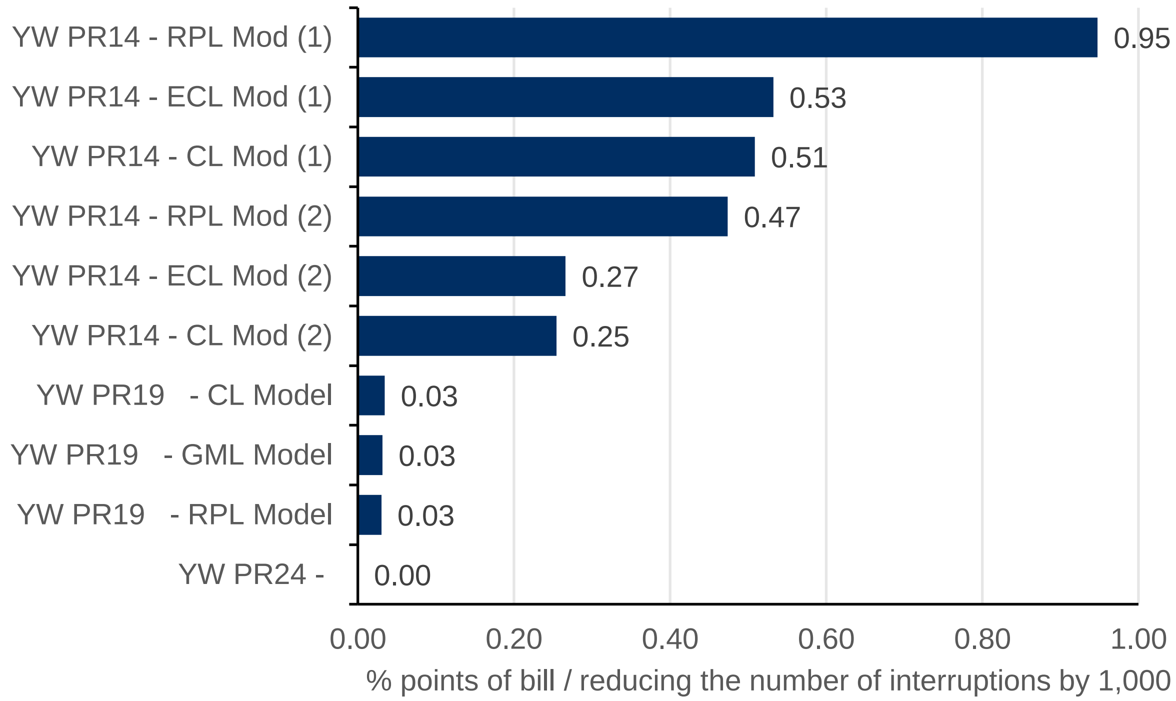


Source: NERA analysis
Notes: (1) Values are WTP to reduce the number of interruptions by 1,000 in GBP. (2) Estimates for YW PR24, YW PR14, and YW PR19 are significant at 5 per cent significance level. We do not have this information for WW PR19 and DCWW PR19.

---

45 In particular, they found that *"Whilst the coefficients increase for each increase in length of interruption, it is only when interruptions of more than 6 hours reach the level of 24-48 hours that the coefficient becomes significant compared to the base case."*

Figure 4.4: NHH Customer Incremental WTP to Reduce Unexpected Interruptions



Source: NERA analysis
Notes: (1) Values are WTP to reduce the number of interruptions by 1,000 as % point reduction on the bill. (2) Estimates for YW PR14, and YW PR19 are significant at 5 per cent significance level.

4.2.2. Triangulated values

First, we observe that for both HH and NHH customers the PR24 estimate is below the range of transferred values from historical studies. Therefore, according to the triangulation process set out in 2.2.2, we apply an adjustment based on the central historical estimate to derive the triangulated value.

Considering the transferred values from historical studies, we observed that the values from YW PR14 Mod (1) are particularly high. These values were calculated under by assuming that customers' WTP to reduce the risk of a 3-6 hour interruption is equal to their WTP to reduce the risk of a 6-12 hour assumption. There is reason to believe this assumption may create a positive bias on the estimated WTP to reduce the risk of a 3-6 hour interruption. Therefore for both HH and NHH customers, we exclude the YW PR14 Mod (1) values from the central historical estimate.

To calculate the central historical estimate, we calculate a single WTP value from each study (i.e. one value for each of YW PR14, YW PR19, WW PR19, and DCWW PR19) by taking the simple average of all values calculated from that study. We then take the simple average of those four values. This approach ensures that we assign equal weight to each included historical study (i.e. we do not assign more weight to a study just because results are available from multiple different types of logit model).

To calculate the triangulated estimate, we then take the simple average of the value from the PR24 study and the central historical value. We report the final triangulated estimates in Table 4.2.

Table 4.2: PR24 Triangulated Values for Unplanned Interruptions to the Water Supply

	PR24 Unadjusted	PR24 Triangulated
HH (£/unit change)	0.00	0.19
NHH (% point/unit change)	0.00	0.09

Source: NERA analysis

4.3. Water Lost Through Leaks

For attribute C (water lost through leaks), we transfer values from just one study, YW PR19, as this is the only historical study in which customers were asked about their preferences regarding leakage. We use the results from this study to derive our final triangulated value.

4.3.1. Transferred values from previous stated preference studies

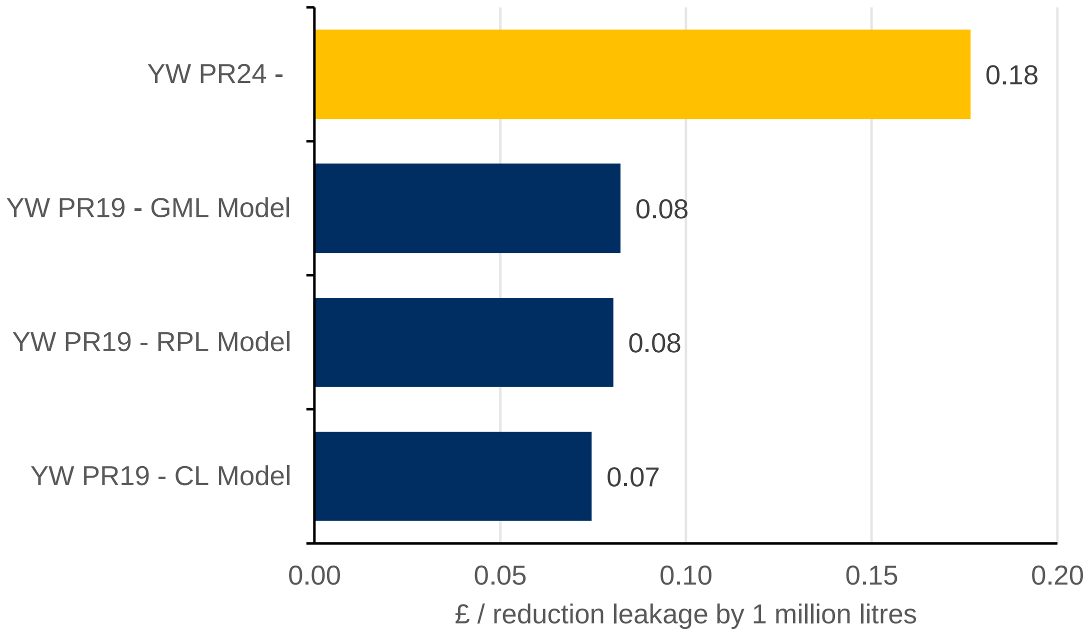
At PR24, we asked customers about their WTP to reduce water lost through leaks in YW's network. The question was framed in terms of litres lost per day. The current situation was presented as follows: *"Last year 22% of water was lost through leaks in the network, which is 283 million litres of water per day. This is the equivalent of supplying the population of Leeds and York each day."*

We then asked customers to choose between five different service levels ranging between 315 and 239 million litres lost per day.

Only one of the other studies that we consider asked customers about preferences regarding leakage directly. This was YW's own study for PR19. The question was framed in the same way as the PR24 question and so the estimates are directly comparable.

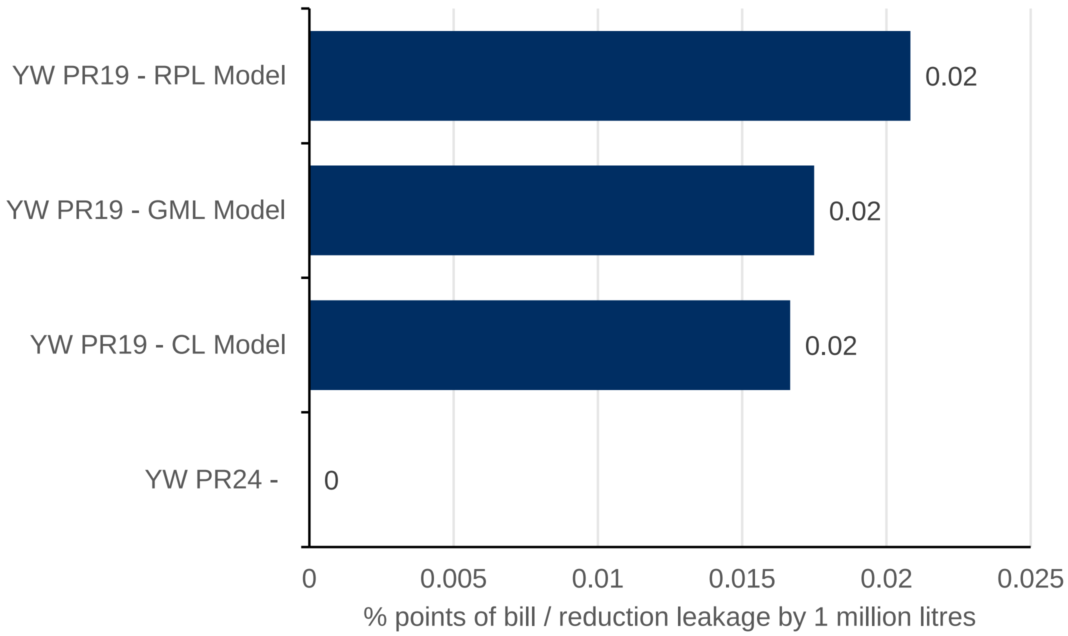
Figure 4.5 and Figure 4.6 present the estimates from the two studies for HH and NHH customers, respectively. We see that HH customers have a higher WTP for reducing leakage at PR24 than they did at PR19, while NHH customers have a lower WTP. The higher WTP of HH customers in the PR24 study may be driven by higher customer awareness of leakage following the dry summer of 2022. The lower WTP of NHH customers is likely driven by the fact that NHH customers exhibited limited WTP for any attribute at PR24, possibly due to concerns around the rising and uncertain cost of doing business in the context of high energy prices and inflation in 2022. NHH customers may also make an assessment of whether leakage reduction affects them specifically, which it may well not do, as compared to changes in the bill that would certainly affect them.

Figure 4.5: HH Customer Incremental WTP to Reduce Leaks



Source: NERA analysis
Notes: (1) Values are WTP to reduce the amount of water lost to leakage by 1 million litres in GBP. (2) Estimates for YW PR24, and YW PR19 are significant at 5 per cent significance level.

Figure 4.6: NHH Customer Incremental WTP to Reduce Leaks



Source: NERA analysis
Notes: (1) Values are WTP to reduce the amount of water lost to leakage by 1 million litres as % point reduction on the bill. (2) Estimates for YW PR19 are significant at 5 per cent significance level.

4.3.2. Triangulated values

We observe that for HH customers, the estimated value for PR24 is above the range of values transferred from YW PR19; whereas for NHH customers, the estimated value for PR24 is below the range of values transferred from YW PR19. Therefore, we must account for the YW PR19 results in our triangulated results.

We have no reason to believe that the YW PR19 estimates are biased. Therefore, for both HH and NHH, we derive a central historical estimate as the simple average of the three different values estimated for YW PR19. We then calculate the triangulated values as a simple average of the central historical estimate and the YW PR24 estimate. We present the final triangulated values in Table 4.3.

Table 4.3: PR24 Triangulated Values for Water Lost Through Leaks

	PR24 Unadjusted	PR24 Triangulated
HH (£/unit change)	0.18	0.13
NHH (% point/unit change)	0.00	0.01

Source: NERA analysis

4.4. Sewage Flooding Inside Properties

For attribute E (sewage flooding inside properties), we transfer values from all four historical studies. For HH customers we find that the PR24 estimated value is within the range of values transferred from historical studies and so we do not apply any adjustment; whereas for NHH customers we find that the PR24 estimated value is below the range of values from historical studies and so we incorporate the historical results in our triangulated value.

4.4.1. Transferred values from previous stated preference studies

At PR24, we asked customers about their WTP to reduce the number of properties affected by sewage flooding inside the property per year. The question was framed in terms of the number of properties experiencing a flooding incident per year. The current situation was presented as follows: *"Around 1 in 3,500 properties each year (which is 664 homes and businesses in Yorkshire) experience a sewer flood inside the property."*

We then asked customers to choose between five different service levels ranging between 1,120 and 310 properties affected per year.

Customers were asked similar questions in all four of the other studies we examined, with varying degrees of detail regarding the flooding level and risks. In all four studies, the question was framed in terms of the number of properties experiencing a flooding incident per year. The final WTP values in all studies are presented as WTP to reduce the number of properties experiencing flooding by one; we multiply the values by ten in order to report WTP to reduce the number of properties experiencing flooding by ten.

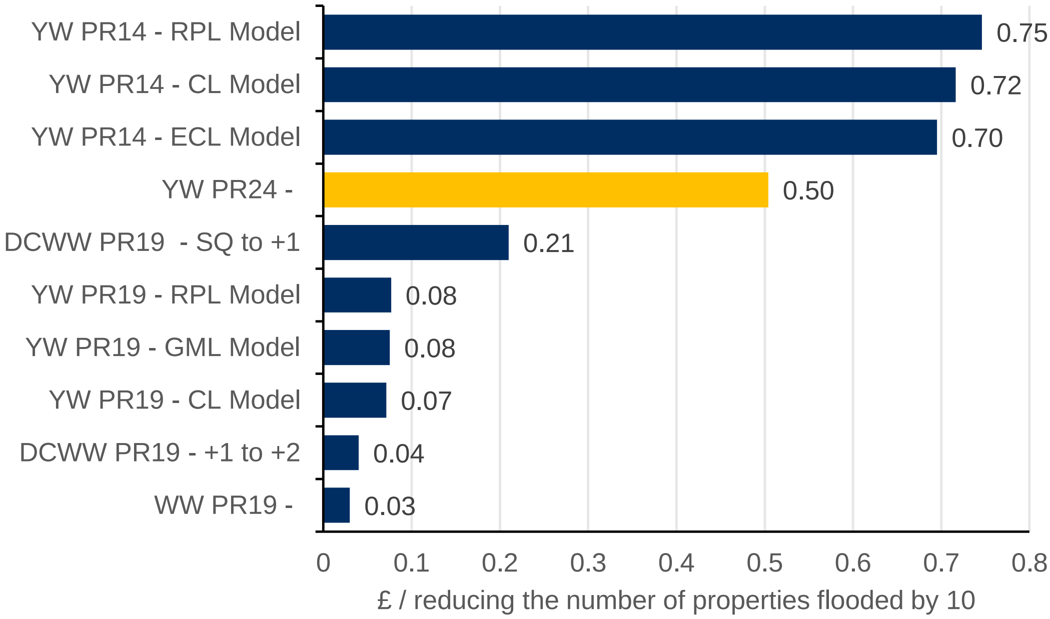
There are some differences in phrasing across the four studies that might be expected to affect customer valuations.

- In YW's PR14 study, customers were asked about the number of properties flooded *"inside their property e.g. unused cellar"*. As compared to the PR24 study, the description provided in PR14 may be expected to result in lower WTP. PR24 respondents may have perceived the issue as more serious, such as flooding in their living room or kitchen. Despite this expectation, the WTP values from the PR14 study are higher than the WTP values from other studies, suggesting that the phrasing did not introduce substantial bias.

- In YW's PR19 study, customers were asked about *"incidents of sewer flooding of the living areas inside properties".* As compared to the PR19 study, this might be expected to affect WTP in two opposite directions:
  - First, the description that the flooding occurs in the living area may make the issue appear more serious, and lead to higher WTP at PR19 than at PR24.
  - Second, if customers envisaged that the same property might face multiple flooding incidents, then their WTP per property might be higher than their WTP per incident. This would lead to lower WTP at PR19 than at PR24. Our comparison of the results across the reports suggests that for households, this may indeed have been the case; the HH estimates of the WTP per incident from the PR19 report are lower than the estimates of the WTP per property from the PR24.
- In the WW and DCWW PR19 studies, the information cards displayed by Accent and PJM Economics to survey respondents describe sewer flooding as "causing damage to property and possible illness". Moreover, the information card said that as a result of flooding, some people may "develop diarrhoea, vomiting and skin infections". If customers envisaged sewage flooding as entailing potential illness, we may expect their willingness to pay to be biased upwards relative to that from other studies. Despite this, the WTP from the WW report (once converted) is actually the lowest out of all HH values for this attribute. The results from the DCWW PR19 are also not high relative to values from the other studies.

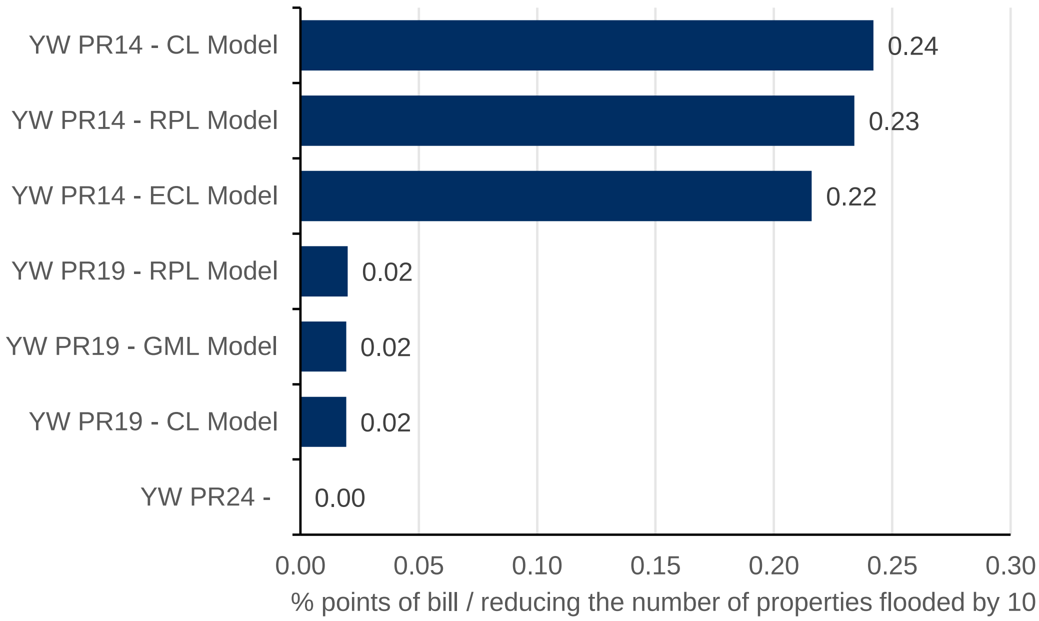
Figure 4.7 and Figure 4.8 present the comparable results for incremental WTP to reduce sewage flooding inside properties for HH and NHH customers, respectively.

Figure 4.7: HH Customer Incremental WTP to Reduce Sewage Flooding Inside Properties



Source: NERA analysis
Notes: (1) Values are WTP to reduce the number of properties flooded by 10 in GBP.
(2) Estimates for YW PR24, YW PR14, and YW PR19 are significant at 5 per cent significance level. We do not have this information for WW PR19 and DCWW PR19.

Figure 4.8: NHH Customer Incremental WTP to Reduce Sewage Flooding Inside Properties



Source: NERA analysis
Notes: (1) Values are WTP to reduce the number of properties flooded by 10 as % point reduction on the bill.
(2) Estimates for YW PR14, and YW PR19 are significant at 5 per cent significance level.

4.4.2. Triangulated values

Figure 4.7 shows that the PR24 estimated WTP for HH customers is within the range of transferred values from historical studies. Therefore, in accordance with the triangulation process set out in Section 2.2.2.2, we simply set the triangulated value for HH customers equal to the value estimated from the PR24 stated preference study.

For NHH customers, the PR24 estimated value is below the range of transferred values from historical studies. Therefore, we adjust this value towards the central historical estimate to get the triangulated value. The central historical estimate is equal to the simple average of all estimated NHH WTP values from YW PR14 and YW PR19. The triangulated value is then the simple average of the central historical estimate and the PR24 estimated value.

We present the final triangulated values for both HH and NHH customers in Table 4.4.

Table 4.4: PR24 Triangulated Values for Sewage Flooding Inside Properties

	PR24 Unadjusted	PR24 Triangulated
HH (£/unit change)	0.50	0.50
NHH (% point/unit change)	0.00	0.06

Source: NERA analysis

4.5. Sewage Flooding Outside Properties

For attribute F (sewage flooding outside properties), we transfer values from all four historical studies. For HH customers we find that the PR24 estimated value is within the range of values transferred from historical studies and so we do not apply any adjustment; whereas for NHH customers we find that the PR24 estimated value is below the range of values from historical studies and so we incorporate the historical results in our triangulated value.

4.5.1. Transferred values from previous stated preference studies

At PR24, we asked customers about their WTP to reduce the number of properties affected by sewage flooding outside the property per year. The question was framed in terms of the number of properties experiencing a flooding incident per year. The current situation was presented as follows: *“There were 4,578 outside sewer floods last year in Yorkshire.”*

We then asked customers to choose between five different service levels ranging between 7,100 and 3,700 properties affected per year.

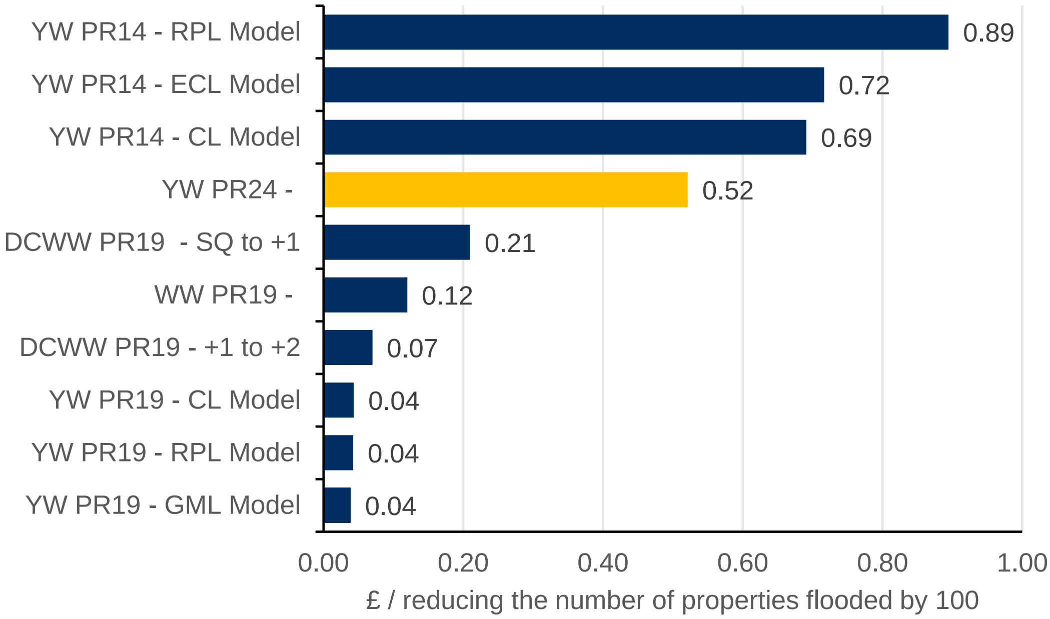
Customers were asked nearly identical questions in all four of the other studies we examined. In all four studies, the question was framed in terms of the number of properties experiencing a flooding incident per year. The final WTP values in all PR19 studies are presented as WTP to reduce the number of properties experiencing flooding by one; we multiply the values by 100 in order to report WTP to reduce the number of properties experiencing flooding by 100. The final WTP values in YW’s PR14 study are presented as WTP to reduce the number of properties experiencing flooding by ten, so for this study we multiply by ten.

There are some differences in phrasing across the four studies that might be expected to affect customer valuations.

- In YW's PR14 study, customers were asked about the number of properties affected by sewer flooding *"in their gardens or close to their properties"*. As compared to the PR24 study, the description provided in PR14 may be expected to result in higher WTP. PR14 respondents may have perceived the issue as something that impacted them more directly.
- In YW's PR19 study, customers were asked about *"incidents of sewage flooding outside customers' homes but on their land blocking access to their property per year"*. As compared to the PR19 study, this might be expected to affect WTP in two opposite directions:
  - First, if customers envisage outdoor flooding as not necessarily blocking access to their properties, then we might expect the reported willingness to pay to prevent outdoor flooding in the PR19 report to be higher than the PR24 value. That being said, for households, the WTP values from AECOM's PR19 study are substantially lower than those from our PR24 analysis.
  - Second, if customers envisaged that the same property might face multiple flooding incidents, then their WTP per property might be higher than their WTP per incident. This would lead to lower WTP at PR19 than at PR24. Our comparison of the results across the reports does not suggest that this was the case; as mentioned, the estimates of the HH WTP per incident from the PR19 report are lower than the estimates of the WTP per property from the PR24.
- The phrasing used in the PR19 study conducted by WW is close to the phrasing adopted in YW's PR24 study. The information cards shown to participants described outdoor flooding as getting *"close to other people's properties"*, or *"into their gardens"*. The focus on other people may have led customers to be more affected by altruistic motives than egoistic ones. However, it is unclear whether this would have biased the results.
- For the DCWW report, Accent and PJM Economics used data from two separate flooding questions to construct the willingness to pay to avoid outdoor flooding. The first is identical to that used in the PR19 WW report. The second question regards flooding from the sewer going into *"public areas like parks, footpaths, and roads"*. Accent and PJM Economics then report a weighted average of the WTP for these two measures, assigning a weight of 0.712 to the former and 0.288 to the latter. Accent and PJM Economics derive these weights from the proportion of actual external sewer flooding incidents belonging to each category.
  - As was the case for the WW PR19 data, the focus on flooding neighbours' properties and public spaces may have framed the issues at hand in terms of altruistic motives rather than egoistic ones. However, once more, the direction of the bias of the results relative to the PR24 values (if any) is indeterminate.

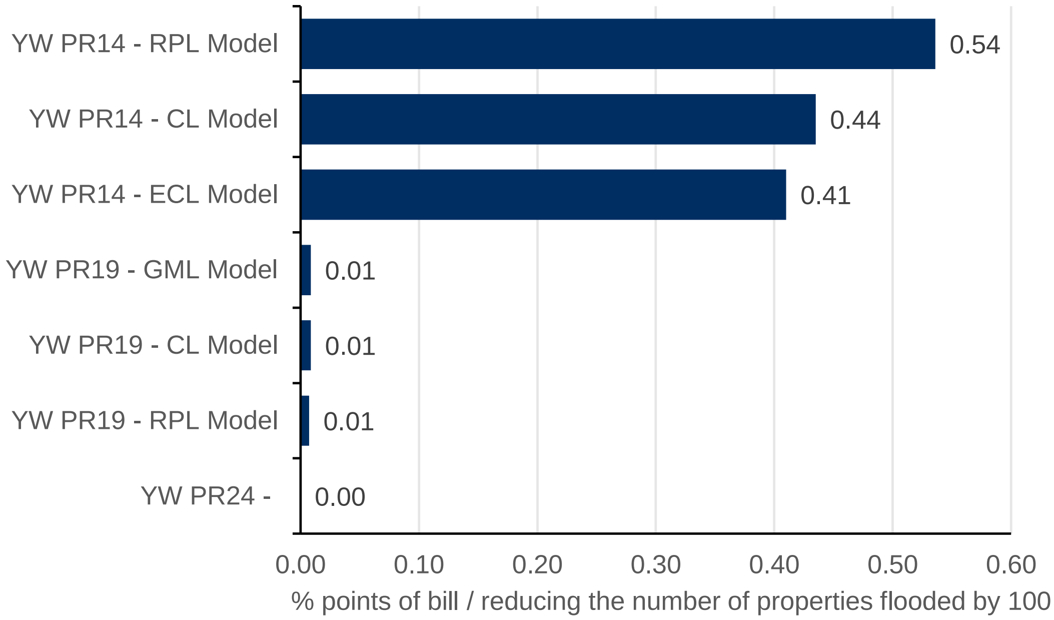
Figure 4.9 and Figure 4.10 present the comparable results for incremental WTP to reduce sewage flooding inside properties for HH and NHH customers, respectively.

Figure 4.9: HH Customer Incremental WTP to Reduce Sewage Flooding Outside Properties



Source: NERA analysis
Notes: (1) Values are WTP to reduce the number of properties flooded by 100 in GBP. (2) Estimates for YW PR24, YW PR14, and YW PR19 (except for the GML model) are significant at 5 per cent significance level. We do not have this information for WW PR19 and DCWW PR19.

Figure 4.10: NHH Customer Incremental WTP to Reduce Sewage Flooding Outside Properties



Source: NERA analysis
Notes: (1) Values are WTP to reduce the number of properties flooded by 100 as % point reduction on the bill. (2) Estimates for YW PR14, and YW PR19 are significant at 5 per cent significance level.

4.5.2. Triangulated Values

Figure 4.9 shows that the PR24 estimated WTP for HH customers is within the range of transferred values from historical studies. Therefore, in accordance with the triangulation process set out in Section 2.2.2.2, we simply set the triangulated value for HH customers equal to the value estimated from the PR24 stated preference study.

For NHH customers, the PR24 estimated value is below the range of transferred values from historical studies. Therefore, we adjust this value towards the central historical estimate to get the triangulated value. The central historical estimate is equal to the simple average of all estimated NHH WTP values from YW PR14 and YW PR19. The triangulated value is then the simple average of the central historical estimate and the PR24 estimated value.

We present the final triangulated values for both HH and NHH customers in Table 4.5.

Table 4.5: PR24 Triangulated Values for Sewage Flooding Outside Properties

	PR24 Unadjusted	PR24 Triangulated
HH (£/unit change)	0.52	0.52
NHH (% point/unit change)	0.00	0.12

Source: NERA analysis

4.6. River Water Quality

For attribute G (river water quality), we transfer values from three historical studies.[46] We rely on estimates from all three of these studies to derive our final triangulated value.

4.6.1. Transferred values from previous stated preference studies

At PR24, we asked customers about their WTP to improve the quality of the water for a portion of the river network within the YW operating area. The question was framed in terms of kilometres of river in which the water quality is improved. The current situation was presented as follows: *"The levels of damaging chemicals in some places are much higher than they should be. Last year Yorkshire Water completed several schemes which improved 50km of the rivers in Yorkshire, out of the 742 which need improving."*

We then asked customers to choose between five different service levels ranging between 0 and 150 km of river improved.

Customers were asked questions on a similar theme in three of the four other studies we considered; however, there are differences and points of ambiguity in some of the questions where we must make assumptions in order to draw comparisons between the results of other studies and the results of our PR24 study.

At PR19, YW also asked customers about WTP for *"kilometres of rivers in Yorkshire improved per year"*. However, the question was posed in terms of the percentage of kilometres of river improved rather than the total kilometres of river improved. The question is also ambiguous as to whether customers should treat this as the percentage of all of

[46] We do not transfer values from DCWW PR19 as this study did not ask about river water quality.

Yorkshire's rivers, or the percentage of the portion of Yorkshire's rivers that required improvement.

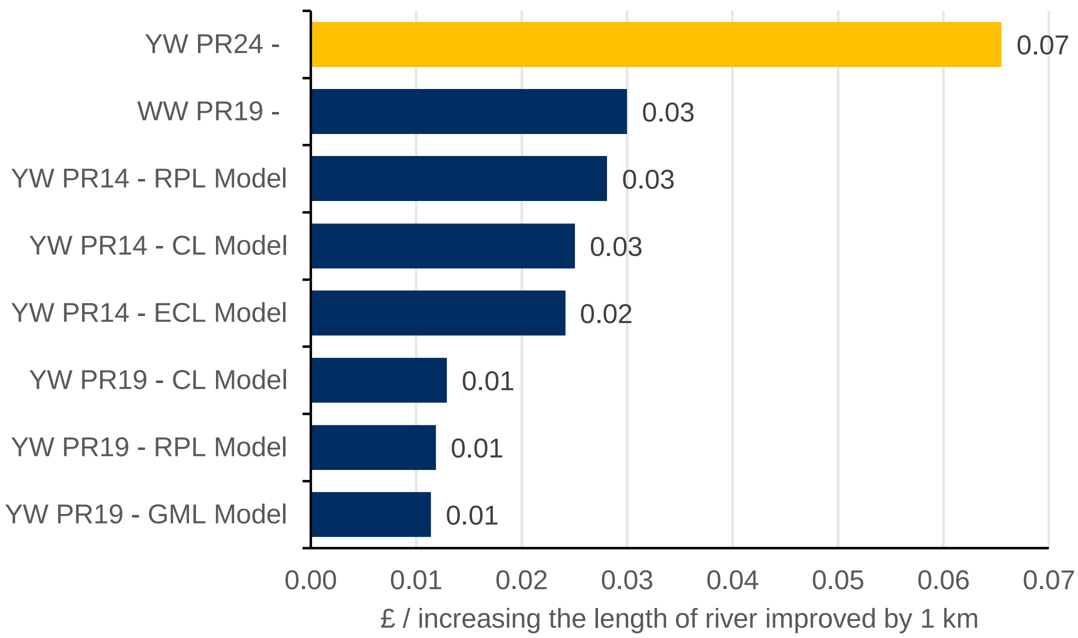
We understand from YW that the number used to calculate the percentages presented in the survey was the length of all of Yorkshire's rivers (4000km) rather than the length of river that needed improving (742km). This interpretation is consistent with the PR14 study. We also see this as the more likely customer interpretation. Therefore, this is the baseline value we use to calculate customer WTP for PR19. That is, we multiply the WTP per percentage point of river improved by 100 and divide by 4000.

At PR14, YW used the absolute length of rivers improved, but measured in miles rather than kilometres. Further, rather than asking about "improving" rivers, YW specified that rivers should achieve *"the 'good' standard for water quality"*. If customers interpreted these two descriptions differently it would affect WTP, although there is no obvious difference in interpretation that would lead to a systematically higher or lower WTP for one.

Wessex Water also asked about improvements in river quality in its PR19 study. The framing in this study was similar to the framing employed by YW at PR14. WW asked about customer WTP for the absolute length of rivers improved from "less than Good" to "Good" status (although it reported the lengths in kilometres rather than miles).

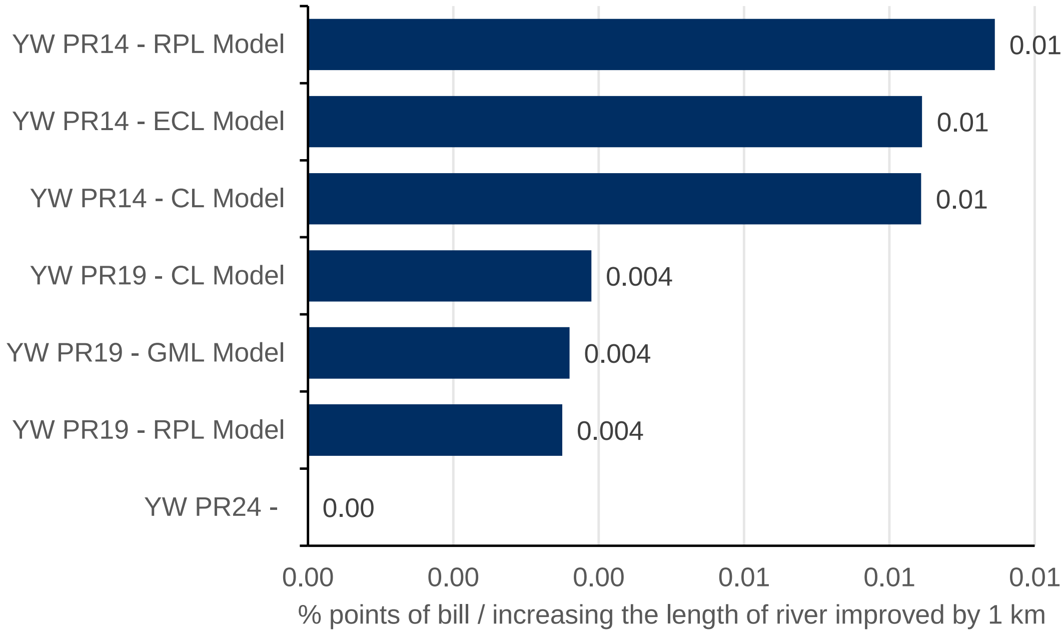
Figure 4.11 and Figure 4.12 report the final WTP for each study. It is notable that HH customers exhibit higher WTP when the question is framed in terms of "improving" river water quality rather than achieving "good" status – this may suggest that there is, in fact, a consistent impact of this difference in framing.

Figure 4.11: HH Customer Incremental WTP to Improve River Water Quality



Source: NERA analysis
Notes: (1) Values are WTP to increase the length of river improved by 1 km in GBP. (2) Estimates for YW PR14, and YW PR19 are significant at 5 per cent significance level. We do not have this information for WW PR19.

Figure 4.12: NHH Customer Incremental WTP to Improve River Water Quality



Source: NERA analysis
Notes: (1) Values are WTP to increase the length of river improved by 1 km as % point reduction on the bill.
(2) Estimates for YW PR14, and YW PR19 are significant at 5 per cent significance level.

4.6.2. Triangulated values

First, we observe that for both HH and NHH customers the PR24 estimate is outside the range of transferred values from historical studies. Therefore, according to the triangulation process set out in 2.2.2, we apply an adjustment based on the central historical estimate to derive the triangulated value.

To calculate the central historical estimate, we calculate a single WTP value from each study (i.e. one value for each of YW PR14, YW PR19, and WW PR19) by taking the simple average of all values calculated from that study. We then take the simple average of those three values. This approach ensures that we assign equal weight to each included historical study (i.e. we do not assign more weight to a study just because results are available from multiple different types of logit model).

To calculate the triangulated estimate, we then take the simple average of the value from the PR24 study and the central historical value. We report the final triangulated estimates in Table 4.6.

Table 4.6: PR24 Triangulated Values for River Water Quality

	PR24 Unadjusted	PR24 Triangulated
HH (£/unit change)	0.07	0.04
NHH (% point/unit change)	0.00	0.003

Source: NERA analysis

4.7. Sea Water Quality at Yorkshire's Beaches

For attribute H (sea water quality), we transfer values from three historical studies.[47] We rely on estimates from all three of these studies to derive our final triangulated value.

4.7.1. Transferred values from previous stated preference studies

At PR24, we asked customers about their WTP to improve the quality of the water at beaches within the YW operating area. The question was framed in terms of the number of rivers rated "good" or "excellent". The current situation was presented as follows: *"Out of the 18 beaches in Yorkshire the quality of the sea water was rated as being 'excellent' at 7 of them, 'good' at 9 and the minimum status of 'sufficient' at 2, with none rated 'poor'. At a beach rated 'sufficient' you could still swim in the sea, but there would be a small increase in the chance that you might get ill if you swallowed some water."*

We then asked customers to choose between five different service levels ranging between 12 and 18 beaches rated either "good" or "excellent".

Customers were asked questions on a similar theme in three of the four other studies we considered; however, there are differences and points of ambiguity in some of the questions where we must make assumptions in order to draw comparisons between the results of other studies and the results of our PR24 study.

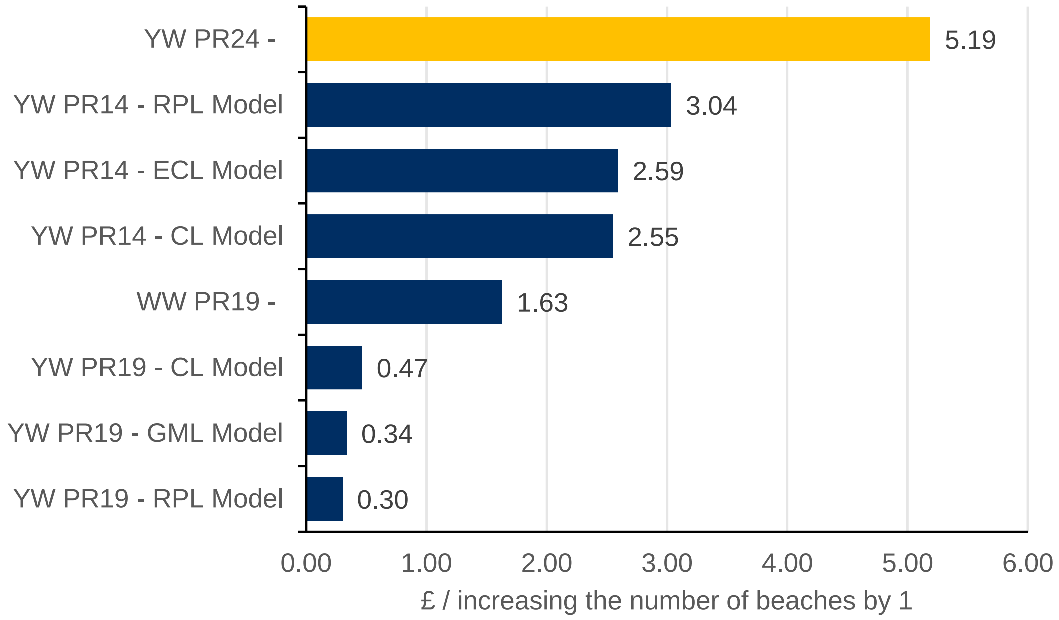
At PR14, YW asked customers about WTP for *"beaches with an excellent level of bathing water quality"* and provided the additional explanation that *"Excellent water quality is equivalent to up to 2 people in every 100 who bathe becoming ill, for example with a sore throat or ear infection"*. A beach rated "excellent" has achieved a higher standard than a beach rated "good", and therefore we would expect that a customer knowledgeable about beach rating schemes would express a higher incremental WTP for "excellent" beaches (the PR14 term) than "good or excellent" beaches (the PR24 term). However, we cannot assume that customers are knowledgeable about beach rating schemes and so there may not, in fact, be a systematic difference between the two.

At PR19, YW asked customers about WTP for *"bathing beaches"* rated "good" or "excellent". This description is more in line with that used at PR24.

Finally, at PR19 WW asked customers about WTP to improve beaches from "sufficient" to "good". A knowledgeable customer might have lower WTP for simply "good" beaches than "good or excellent" beaches, but as explained above we cannot assume that customers are knowledgeable about beach rating schemes.

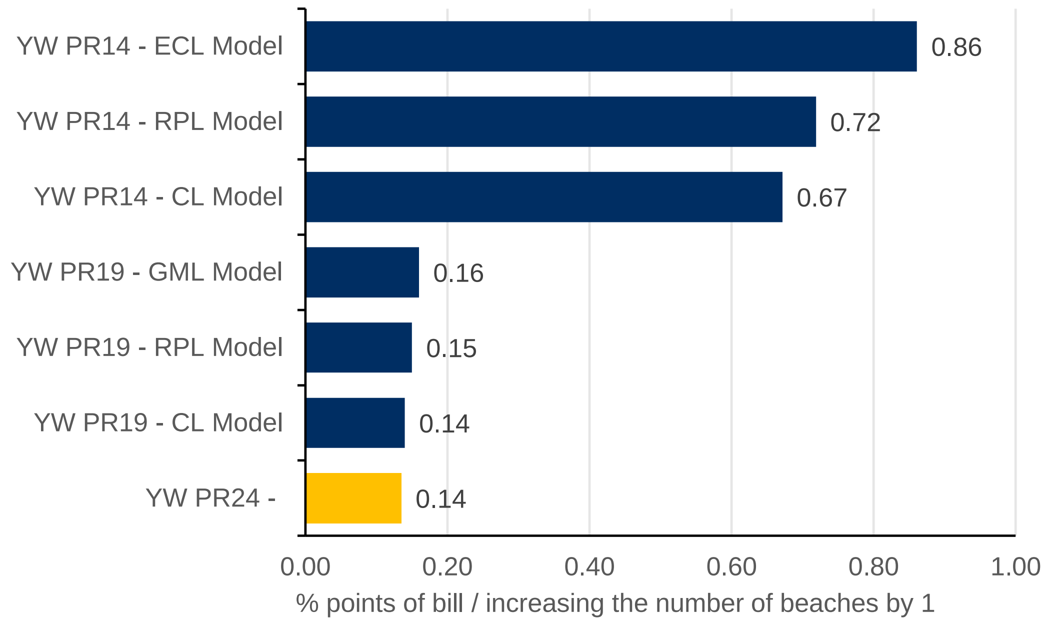
[47] We do not transfer values from DCWW PR19 as this study did not ask about sea water quality.

Figure 4.13: HH Customer Incremental WTP to Improve Sea Water Quality



Source: NERA analysis
Notes: (1) Values are WTP to increase the number of beaches rated "good" or "excellent" by 1 in GBP.
(2) Estimates for YW PR24, YW PR14, and YW PR19 are significant at 5 per cent significance level. We do not have this information for WW PR19.

Figure 4.14: NHH Customer Incremental WTP to Improve Sea Water Quality



Source: NERA analysis
Notes: (1) Values are WTP to increase the number of beaches rated "good" or "excellent" by 1 as % point reduction on the bill. (2) Estimates for YW PR14, and YW PR19 are significant at 5 per cent significance level.

4.7.2. Triangulated values

First, we observe that for both HH and NHH customers the PR24 estimate is outside the range of transferred values from historical studies. Therefore, according to the triangulation process set out in 2.2.2, we apply an adjustment based on the central historical estimate to derive the triangulated value.

To calculate the central historical estimate, we calculate a single WTP value from each study (i.e. one value for each of YW PR14, YW PR19, and WW PR19) by taking the simple average of all values calculated from that study. We then take the simple average of those three values. This approach ensures that we assign equal weight to each included historical study (i.e. we do not assign more weight to a study just because results are available from multiple different types of logit model).

To calculate the triangulated estimate, we then take the simple average of the value from the PR24 study and the central historical value. We report the final triangulated estimates in Table 4.7.

Table 4.7: PR24 Triangulated Values for Sea Water Quality

	PR24 Unadjusted	PR24 Triangulated
HH (£/unit change)	5.19	3.38
NHH (% point/unit change)	0.14	0.29

Source: NERA analysis

4.8. Pollution of Watercourses

For attribute I (pollution of water courses), we transfer values from three historical studies.[48] We rely on estimates from all three of these studies to derive our final triangulated value.

4.8.1. Transferred values from previous stated preference studies

At PR24, we asked customers about their WTP to reduce the number of pollution incidents affecting watercourses in the YW operating area. The question was framed in terms of the number of minor pollution incidents per year. The current situation was presented as follows: *"Last year there were 126 minor pollution incidents in Yorkshire caused by Yorkshire Water. This was an improvement on the previous year where we had 159 minor pollution incidents. Minor incidents have minimal impact or effect on the environment."*

We then asked customers to choose between five different service levels ranging between 175 and 85 minor pollution incidents per year.

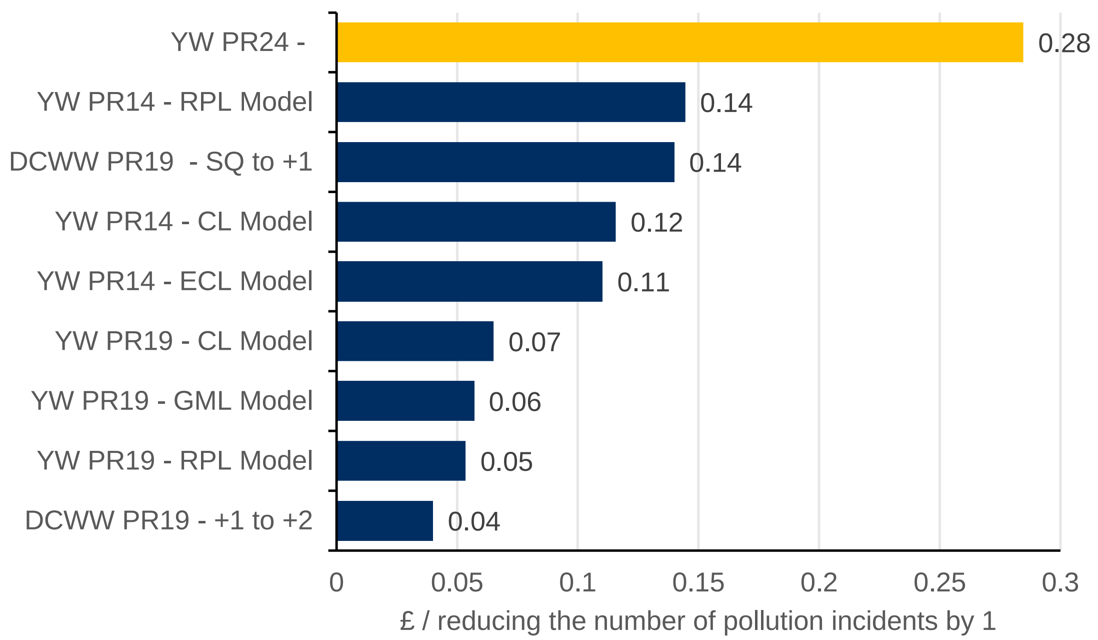
Customers were asked a similar question in three of four other studies considered. All questions were framed in terms of a reduction in the number of minor pollution incidents occurring per year. There were some slight differences in phrasing that may have affected how customers interpreted the question; however, none of the differences is likely to create a systematic bias.

48 We do not transfer values from WW PR19 as this study did not ask about pollution of watercourses.

- At PR14, YW asked customers about incidents *"which can have a minor impact on habitats"*; we assume that the use of the term "habitats" rather than "the environment" is unlikely to substantially alter customers' WTP. We also assume that for PR14 respondents, it was intuitive that the question referred to pollution incidents for watercourses. That specification is expressly mentioned in PR24.
- At PR19, YW asked customers about *"category 3 pollution incidents that have a minimal impact on the quality of water in the area"*. We assume that customers did not find the reference to "category 3 pollution incidents" confusing in a way that might have distorted behaviour.
- At PR19, DCWW asked customers about willingness to pay to avoid a *"minor pollution incident in [their] local area caused by Welsh Water operations"*. We assume that customers appreciate that minor pollution incidents are likely to have a minor impact on the environment.

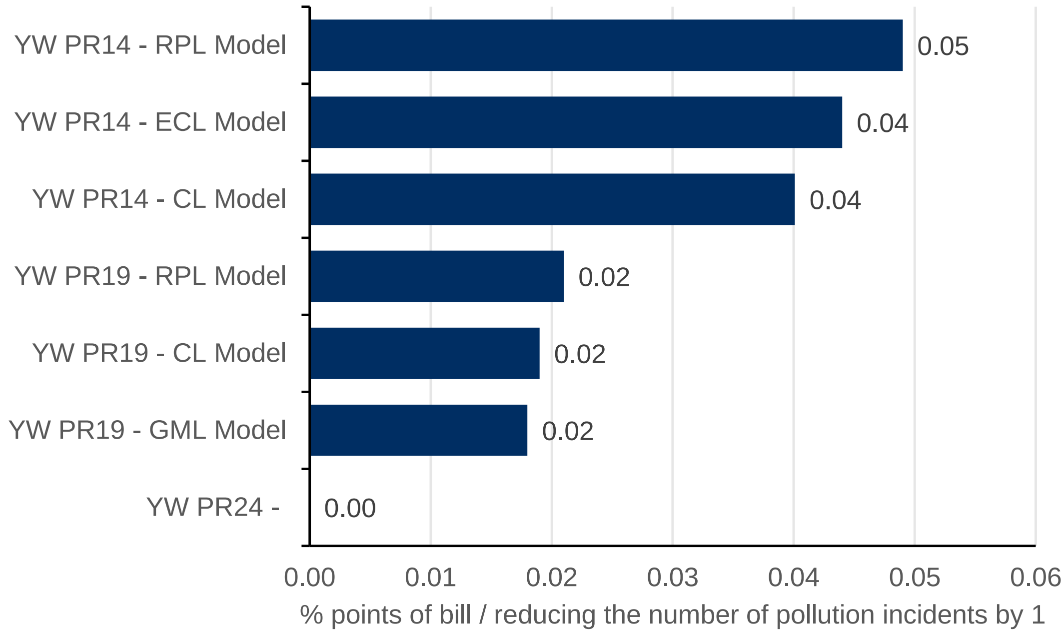
Figure 4.15 and Figure 4.16 present the transferred values from each historical study for HH and NHH customers, respectively.

Figure 4.15: HH Customer Incremental WTP to Reduce Watercourse Pollution



Source: NERA analysis
Notes: (1) Values are WTP to reduce the number of pollution incidents by 1 in GBP. (2) Estimates for YW PR24, YW PR14, and YW PR19 are significant at 5 per cent significance level. We do not have this information for DCWW PR19.

Figure 4.16: NHH Customer Incremental WTP to Reduce Watercourse Pollution



Source: NERA analysis
Notes: (1) Values are WTP to reduce the number of pollution incidents by 1 as % point reduction on the bill. (2) Estimates for YW PR14, and YW PR19 are significant at 5 per cent significance level.

4.8.2. Triangulated values

First, we observe that for both HH and NHH customers the PR24 estimate is outside the range of transferred values from historical studies. Therefore, according to the triangulation process set out in 2.2.2, we apply an adjustment based on the central historical estimate to derive the triangulated value.

To calculate the central historical estimate, we calculate a single WTP value from each study (i.e. one value for each of YW PR14, YW PR19, and DCWW PR19) by taking the simple average of all values calculated from that study. We then take the simple average of those three values. This approach ensures that we assign equal weight to each included historical study (i.e. we do not assign more weight to a study just because results are available from multiple different types of logit model).

To calculate the triangulated estimate, we then take the simple average of the value from the PR24 study and the central historical value. We report the final triangulated estimates in Table 4.8.

Table 4.8: PR24 Triangulated Values for Pollution of Watercourses

	PR24 Unadjusted	PR24 Triangulated
HH (£/unit change)	0.28	0.19
NHH (% point/unit change)	0.00	0.02

Source: NERA analysis

4.9. Low Water Pressure

For attribute I (pollution of water courses), we transfer values from three historical studies.[49] We rely on estimates from two of these studies to derive our final triangulated value.

4.9.1. Transferred values from previous stated preference studies

At PR24, we asked customers about their WTP to reduce the number of customers affected by chronic low water pressure. The question was framed in terms of the number of customers affected. The current situation was presented as follows: *"Last year we helped around 50 customers experiencing low pressure and spent approximately £1.5million on ensuring suitable pressure for all our customers. At the end of the year, we had four (4) customers who experience chronic and ongoing low water pressure and prevented it for many other customers."*

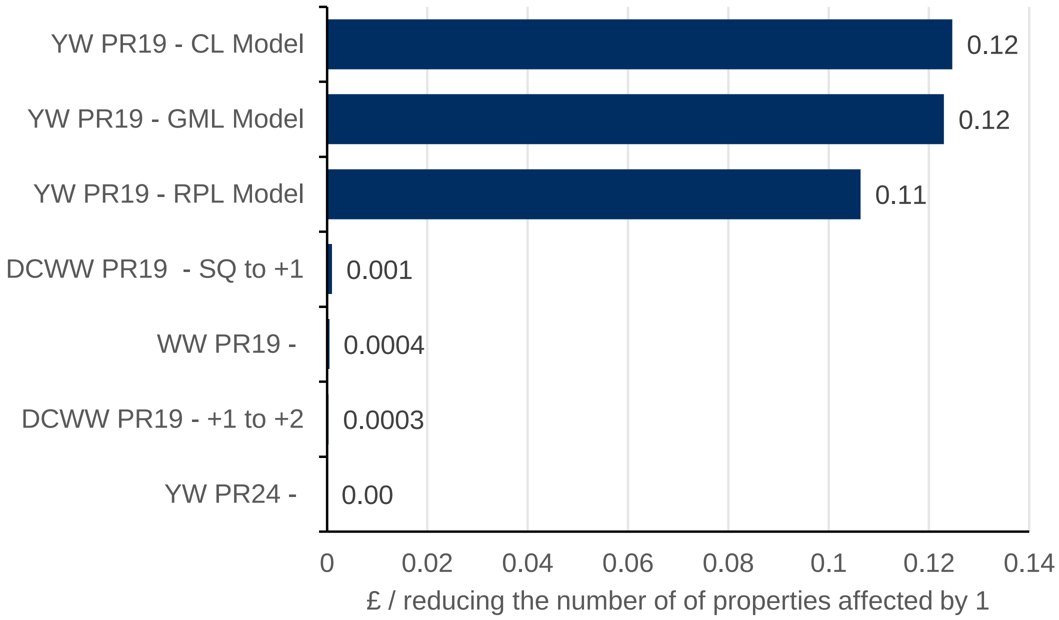
We then asked customers to choose between five different service levels ranging between 14 and 0 properties affected.

Customers were asked a similar question in all three of the PR19 studies we examined, although they were not asked about low water pressure in the PR14 study that we examined (a study conducted for YW).

The question was framed in terms of the number of properties experiencing chronic low water pressure for both WW and DCWW. For YW's PR19 study, the question was not framed in terms of chronic low water pressure but simply in terms of low water pressure. This may explain why we observe a higher WTP in this study than in the other studies (see Figure 4.17 and Figure 4.18 for HH and NHH customers, respectively), if customers who do not experience *chronic* low water pressure thought they might be affected.

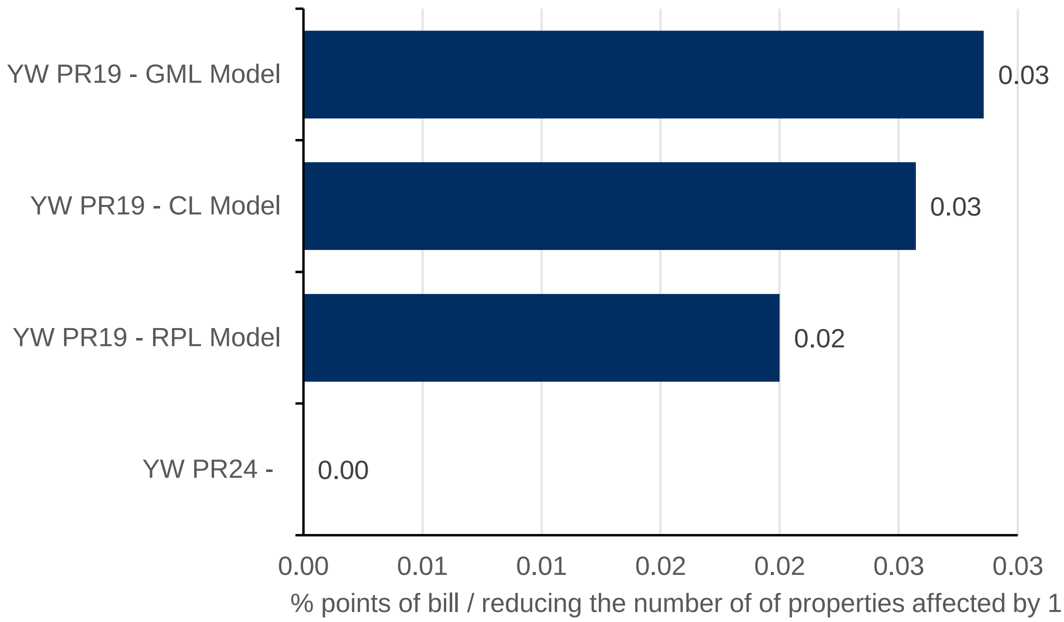
[49] We do not transfer values from YW PR14 as this study did not ask about low water pressure.

Figure 4.17: HH Customer Incremental WTP to Reduce Chronic Low Pressure



Source: NERA analysis
Notes: (1) Values are WTP to reduce the number of properties affected by low water pressure by 1 in GBP. (2) Estimates for YW PR19 are significant at 5 per cent significance level. We do not have this information for WW PR19 and DCWW PR19.

Figure 4.18: NHH Customer Incremental WTP to Reduce Chronic Low Pressure



Source: NERA analysis
Notes: (1) Values are WTP to reduce the number of properties affected by low water pressure by 1 as % point reduction on the bill. (2) Estimates for YW PR19 are significant at 5 per cent significance level.

4.9.2. Triangulated values

First, we observe that for both HH and NHH customers the PR24 estimate is below the range of transferred values from historical studies. Therefore, according to the triangulation process set out in 2.2.2, we must incorporate the historical estimates in the final triangulated value.

To incorporate the historical estimates, we first construct a central historical estimate. We include both the DCWW PR19 and WW PR19 values. We exclude the YW PR19 values because they are high compared to the DCWW PR19 and WW PR19 values, and we have reason to believe they may be biased upwards since customers were asked about low water pressure in general rather than chronic low water pressure.

For NHH customers, after excluding the YW PR19 values we are left with only the YW PR24 values. As explained in Section 3, the per-unit NHH values for the WW PR19 and DCWW PR19 studies are in GBP rather than in percentage point change on the bill and are therefore not comparable to the YW PR24 estimates. Therefore, we set the triangulated value for NHH customers equal to the PR24 estimated value.

For HH customers, to calculate the central historical estimate, we calculate a single WTP value from each study (i.e. one value for each of WW PR19, and DCWW PR19) by taking the simple average of all values calculated from that study. We then take the simple average of those two values. This approach ensures that we assign equal weight to each included historical study.

To calculate the triangulated estimate, we then take the simple average of the value from the PR24 study and the central historical value. We report the final triangulated estimates for both HH and NHH customers in Table 4.9.

Table 4.9: PR24 Triangulated Values for Low Water Pressure

	PR24 Unadjusted	PR24 Triangulated
HH (£/unit change)	0.00	0.0003
NHH (% point/unit change)	0.00	0.00

Source: NERA analysis

5. Conclusion

In this report, we draw on evidence from stated preference studies conducted for previous water sector price controls (PR14 and PR19) to contextualise the findings of the stated preference study conducted by NERA and Qa for YW ahead of PR24.

We rely on four studies to build this context: the studies commissioned by YW at PR14 and PR19 and studies commissioned by two other water companies at PR19 for which the publicly available documentation is comprehensive and the attributes examined are comparable to those we examine in our PR24 stated preference study for YW. For each study, we use a benefits transfer approach to convert the customer valuations derived in those studies to be comparable to the customer valuations identified in the YW PR24 study.

Considering the PR24 results in the context of the historical results, we draw two conclusions:

- First, the PR24 results are neither systematically above nor systematically below the range of results derived from other studies. This gives us confidence that the PR24 methodology does not systematically over- or under-state customer WTP.
- Second, there is evidence to suggest that HH customers make trade-offs between attributes. Considering only the studies commissioned by YW, we find that from PR14 and PR19 to PR24, customers' WTP for improvement in environmental attributes and leakage has increased while their WTP for attributes related to service has decreased. This suggests that HH customers may have a total increase in water bill that they deem acceptable and allocate that across attributes; and that the desired allocation has shifted towards environmental and leakage attributes for the PR24 price control.

We construct a set of triangulated WTP values that incorporate information from both the YW PR24 study and the four selected historical studies. We adopt a systematic judgement-based triangulation process, in line with the guidance on triangulation set out by Ofwat.

These triangulated results may be preferred to the unadjusted PR24 results if there is reason to believe that the PR24 results are overly sensitive to prevailing conditions and may not accurately reflect long-term preferences. For example, HH customers' relatively high WTP for improvement in environmental and leakage attributes may be driven by a reaction to recent media coverage of such events, while the lack of WTP among NHH customers is driven by concern about bill affordability in the immediate future, rather than over the full PR14 period (2025-2030).

The final triangulated results are summarised in Table 5.1. The interpretation of these results is as follows, taking the example of attribute B (unplanned interruptions to the water supply):

- The 0.19 value under HH (£/unit change – PR24 Triangulated) means that each HH customer would be WTP, on average, £0.19 for 1,000 fewer properties to experience a 3-6 hour unplanned interruption to supply per year.
- The 0.09 value under NHH (% point/unit change – PR24 Triangulated) means that each NHH customer would be WTP, on average, a 0.09% higher bill for 1,000 fewer properties to experience a 3-6 hour unplanned interruption to supply per year.

Table 5.1: Results of PR24 Stated Preference Study and Triangulation Exercise

			HH (£/ unit change)		NHH (% point/ unit change)	
	Attribute	**Unit**	**Unadj.**	**Tri.**	**Unadj.**	**Tri.**
A	Drinking Water Colour, Taste and Smell	Reduction in number of contacts per 10,000 customers	0.00	0.26	0.00	0.11
B	Unplanned Interruptions to the Water Supply	Reduction in number of properties interrupted per year (1000s)	0.00	0.19	0.00	0.09
C	Water Lost Through Leaks	Reduction in millions of litres lost per day	0.18	0.13	0.00	0.01
E	Sewage flooding inside properties	Reduction in number of properties flooded per year (10s)	0.50	0.50	0.00	0.06
F	Sewage flooding outside properties	Reduction in number of properties flooded per year (100s)	0.52	0.52	0.00	0.12
G	River Water Quality	Increase in kilometres of river improved	0.07	0.04	0.00	0.003
H	Sea Water Quality at Yorkshire's Beaches	Increase in number of beaches rated "good" or "excellent"	5.19	3.38	0.14	0.29
I	Pollution of watercourses	Reduction in number of minor pollution incidents	0.28	0.19	0.00	0.02
J	Low Water Pressure	Reduction in number of properties with chronic low pressure	0.00	0.0003	0.00	0.00

Source: NERA analysis
Notes: "Unadj."=unadjusted results from PR24 stated preference study. "Tri."=triangulated results.

These results have the following features:

- Across the board, the only attribute for which customers are consistently WTP for improvement is attribute H (sea water quality at Yorkshire's beaches). This is consistent across HH and NHH customers, and across both unadjusted and triangulated results.
- By construction, the triangulated results serve to temper the results of the PR24 study. For those attributes where the PR24 study reported a high WTP, we observe a lower WTP in the triangulated results; and for those attributes where the PR24 study reported a low or zero WTP, we observe higher WTP in the triangulated results. The most notable effects of this are on attributes where we found zero WTP in the PR24 study; the triangulated results yield a positive WTP for almost all such attributes (with the exception of attribute J, low water pressure).

Overall, we recommend that YW use the triangulated values as the central estimate in its business planning, as they strike a balance between the need to reflect current customer preferences and the robustness that comes from not relying on a single study to derive customer valuations.

Appendix A. Service Levels for YW PR14, PR19, and PR24 Attributes

Table A.2: Service Levels for PR14 Attributes (part 1)

Attribute	Unit	-2	-1	SQ	1	2	Block
Discolouration - DIS	The chance of you being affected by a one- or two-day long discolouration event in any one year, where water is discoloured but very unlikely to cause illness e.g. noticeable in a bath	1 in 170	1 in 250	1 in 333	1 in 500	1 in 1000	WSQ
Taste and odour - TAO	The chance of you being affected by a one- or two-day long taste and odour event in any one year, where the water has a taste or odour but is very unlikely to cause illness e.g. slight smell and taste of disinfectant	1 in 333	1 in 500	1 in 1000	1 in 2000	1 in 4000	WSQ
Security of supply - SOS	The chance of a five-month hosepipe ban (i.e. from May to September) occurring in any one year	1 in 10	1 in 15	1 in 25	1 in 35	1 in 50	WSS
Safe water quality - SWQ	The chance that a sample of your tap water will fail to pass the Drinking Water Inspectorate's requirements for chemical and biological content e.g. 0.3% of samples pass with a slight margin of safety	1 in 1,000	1 in 1,700	1 in 2,500	1 in 5,000	1 in 10,000	WSQ
Interruptions to supply (unexpected) - ITS	The chance of you being affected by an unexpected interruption to your water supply lasting 6-12 hours in any one year	1 in 120	1 in 250	1 in 1,100	1 in 2,200	1 in 4,400	WSS

Source: Centre for Research in Environmental Appraisal and Management[50]

[50] Willis, K., Garrod, G., and Scarpa, R. (March 2013), Customer Preferences, willingness-to-pay and willingness-to-accept changes in water service measures: a choice experiment. Centre for Research in Environmental Appraisal and Management

Table A.3: Service Levels for PR14 Attributes (part 2)

Attribute	Unit	-2	-1	SQ	1	2	Block
External sewage flooding - ESF	The number of people's properties affected by flooding from sewers in their gardens or close to their properties	6000	5000	4200	3900	3800	WWD
Internal sewage flooding - INS	The number of people's properties flooded from sewers inside their property e.g. unused cellar	470	420	375	300	220	WWD
Odour from sewage treatment works - STW	The number of people's properties experiencing odour on at least twelve days each year	6400	4500	2350	2050	1900	WWD
River water quality - RQW	The number of miles (out of total) of Yorkshire's rivers which achieve the 'good' standard for water quality	700 out of 2500	900 out of 2500	1100 out of 2500	1300 out of 2500	1400 out of 2500	ENV
Pollution incidents - PI	The number of incidents caused by Yorkshire Water which can have a minor impact on habitats	270	185	100	50	30	ENV
Bathing beaches - BB	The number of beaches with an excellent level of bathing water quality. Excellent water quality is equivalent to up to 2 people in every 100 who bathe becoming ill, for example with a sore throat or ear infection	8 in 18	11 in 18	15 in 18	16 in 18	18 in 18	ENV

Source: Centre for Research in Environmental Appraisal and Management[51]

[51] Willis, K., Garrod, G., and Scarpa, R. (March 2013), Customer Preferences, willingness-to-pay and willingness-to-accept changes in water service measures: a choice experiment. Centre for Research in Environmental Appraisal and Management

Table A.4: Service Levels for PR19 WP1 Attributes (part 1)

Attribute	Units	-1	SQ	+1	+2	+3	Block
Drinking water quality (biochemical)	The number of samples of tap water that will fail the DWI's (a government body) requirement for chemical & biological content	10	4	3	2	1	WSQ
Poor water pressure	Properties per year affected by low pressure	30	15	8	4	1	WSQ
Taste, smell & colour of drinking water	Customer contacts about quality (e.g. water the colour of weak tea coming out of the tap) per year	8,000	6,000	5,000	4,250	3,600	WSQ
Unexpected supply interruptions of 3-6 hours	Total number of properties affected by an unexpected supply interruption of 3-6 hours per year	51,000	41,000	34,000	28,000	25,000	WSS
Leakages	Millions of litres of water lost per day	297	287	275	244	202	WSS
Water use restrictions	Chance of a 5 month hosepipe ban occurring in any one year (May - September)	6.67%	4.00%	2.86%	2.00%	1.33%	WSS

Source: Received from YW

Table A.5: Service Levels for PR19 WP1 Attributes (part 2)

Attribute	Units	-1	SQ	+1	+2	+3	Block
Sewer flooding inside properties	Number of incidents of sewer flooding of the living areas inside properties per year	2,500	1,900	1,750	1,500	1,250	WWD
Sewer flooding outside properties	Number of incidents of sewage flooding outside customers' homes but on their land blocking access to their property per year	15,000	10,500	9,000	8,000	7,000	WWD
Smells from sewers & treatment works	Complaints to Yorkshire Water regarding smells from sewers & treatment works, per year	7,000	6,000	5,000	4,000	3,000	WWD
Bathing water quality	Number of bathing beaches (out of 19) meeting 'Good' or 'Excellent' standard.	11	15	16	17	18	ENV
River water quality	Length of rivers in Yorkshire improved (%) per year	-1.25	0.0	2.5	5	7.5	ENV
Pollution incidents	Number of category 3 pollution incidents that have a minimal impact on the quality of water in the area per year	300	200	190	160	100	ENV
Land conserved or improved by Yorkshire Water	Hectares of land conserved or improved per year	-12,000	0	6,000	12,000	18,000	ENV

Source: Received from YW

Table A.6: Service Levels for PR24 Attributes

Attribute		Large Reduction (-2)	Small Reduction (-1)	Current Level (SQ)	Small Improvement (+1)	Large Improvement (+2)
A	Drinking Water Colour, Taste and Smell	13 contacts per 10,000 customers	12 contacts per 10,000 customers	11 contacts per 10,000 customers	10 contacts per 10,000 customers	9 contacts per 10,000 customers
B	Unplanned Interruptions to the Water Supply	55,000 properties interrupted	50,000 properties interrupted	46,000 properties interrupted	41,000 properties interrupted	36,000 properties interrupted
C	Water Lost Through Leaks	315 million litres per day (26.3% of water supplied)	290 million litres per day (24.2% of water supplied)	283 million litres per day (23.6% of water supplied)	268 million litres per day (22.3% of water supplied)	239 million litres per day (19.9% of water supplied)
D	Using Less Water	-	133 litres per person per day	132 litres per person per day	125 litres per person per day	117 litres per person per day
E	Sewage flooding inside properties	1,120 properties flooded	780 properties flooded	660 properties flooded	550 properties flooded	310 properties flooded
F	Sewage flooding outside properties	7,100 properties flooded	5,000 properties flooded	4,600 properties flooded	4,400 properties flooded	3,700 properties flooded
G	River Water Quality	0km of 742km	25km of 742km	50km of 742km	70km of 742km	150km of 742km
H	Sea Water Quality at Yorkshire's Beaches	12 of 18	14 of 18	16 of 18	18 of 18	-
I	Pollution of watercourses	175 incidents	165 incidents	125 incidents	100 incidents	85 incidents
J	Low Water Pressure	14 properties affected	9 properties affected	4 properties affected	2 properties affected	0 properties affected
K	Creating a River Wharfe safe for swimming	-	-	No – do not make this investment	Yes – do make this investment	-

Source: NERA and Qa Research[52]

[52] NERA and Qa Research (31 October 2022), Estimating Customers' Willingness to Pay for Changes in Service at PR24 [DRAFT] – Prepared for Yorkshire Water

Qualifications, assumptions and limiting conditions

This report is for the exclusive use of the NERA Economic Consulting client named herein. This report is not intended for general circulation or publication, nor is it to be reproduced, quoted or distributed for any purpose without the prior written permission of NERA Economic Consulting. There are no third party beneficiaries with respect to this report, and NERA Economic Consulting does not accept any liability to any third party.

Information furnished by others, upon which all or portions of this report are based, is believed to be reliable but has not been independently verified, unless otherwise expressly indicated. Public information and industry and statistical data are from sources we deem to be reliable; however, we make no representation as to the accuracy or completeness of such information. The findings contained in this report may contain predictions based on current data and historical trends. Any such predictions are subject to inherent risks and uncertainties. NERA Economic Consulting accepts no responsibility for actual results or future events.

The opinions expressed in this report are valid only for the purpose stated herein and as of the date of this report. No obligation is assumed to revise this report to reflect changes, events or conditions, which occur subsequent to the date hereof.

All decisions in connection with the implementation or use of advice or recommendations contained in this report are the sole responsibility of the client. This report does not represent investment advice nor does it provide an opinion regarding the fairness of any transaction to any and all parties.

NERA Economic Consulting
Marble Arch House
66 Seymour Street
London, UK W1H 5BT
+44 207 659 8500
www.nera.com

NERA UK Limited, registered in England and Wales, No 3974527
Registered Office: Marble Arch House, 66 Seymour Street, London W1H 5BT