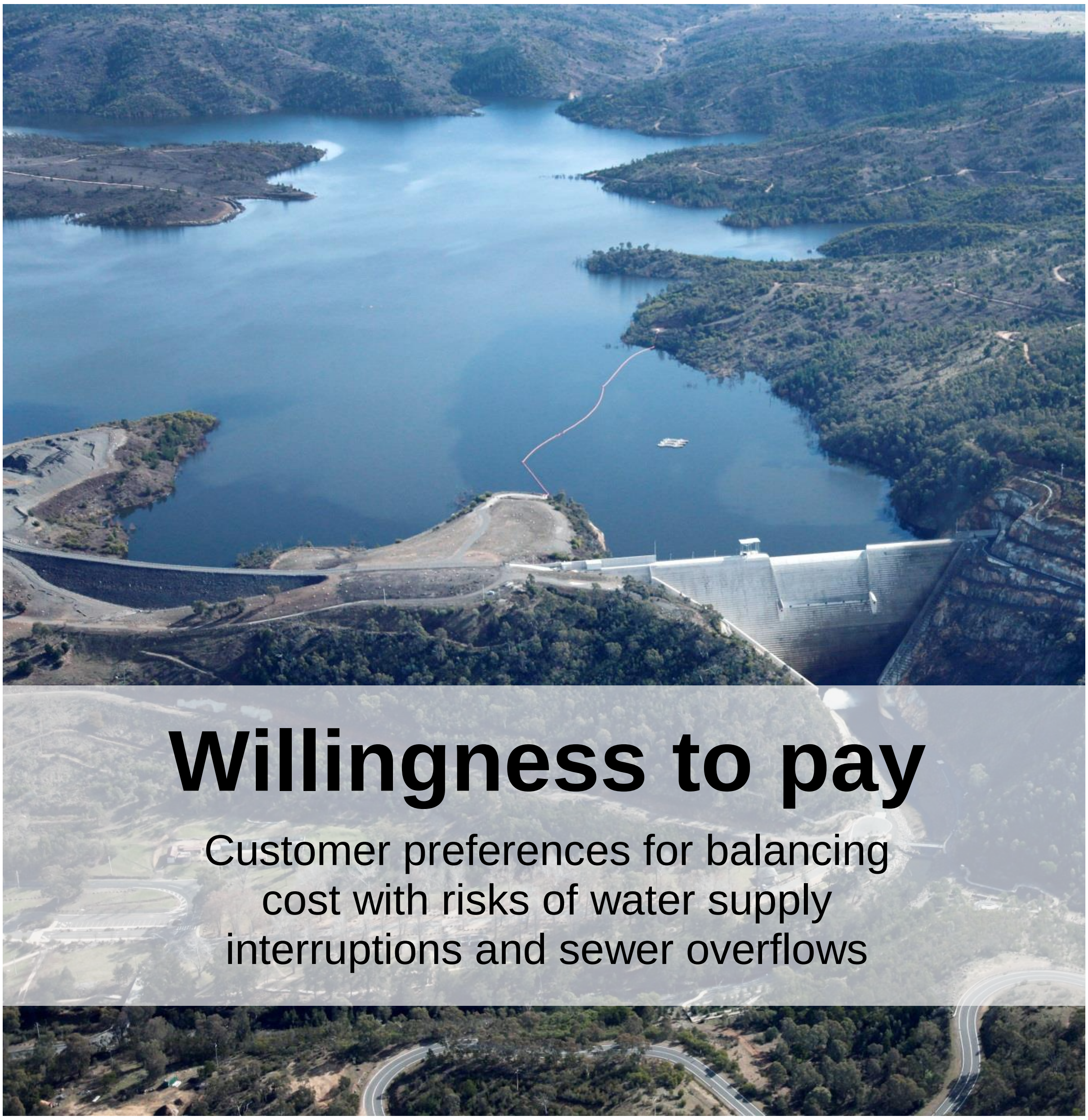

# Willingness to pay

## Customer preferences for balancing cost with risks of water supply interruptions and sewer overflows

icon WATER

in partnership with

THE UNIVERSITY OF WAIKATO
*Te Whare Wānanga o Waikato*

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### The research team

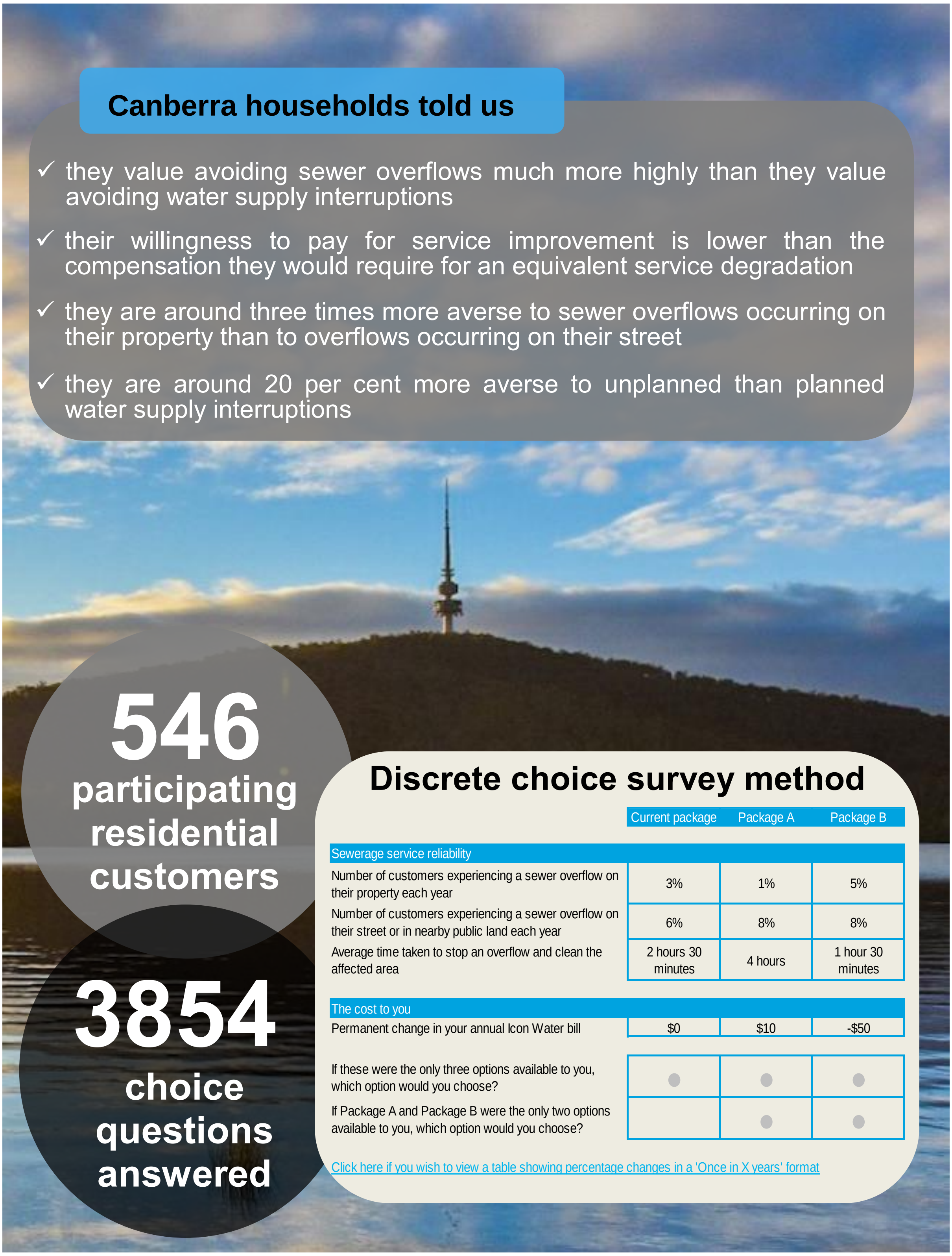
This research was undertaken by Dr Ben McNair, Principal Economist for Icon Water, and Professor Riccardo Scarpa of University of Waikato.

Dr McNair has managed or contributed to several choice modelling studies across a range of utilities and environmental contexts, including a 2012 study on household willingness to pay to avoid water restrictions undertaken as part of his previous role as a post-doctoral fellow at the Australian National University (ANU).

Professor Scarpa has been involved in numerous discrete choice surveys in the utilities and environment contexts, including for water utilities in the United Kingdom, for the Australian Energy Market Operator, and for the ANU as part of the 2012 study in partnership with Icon Water. Professor Scarpa has a reputation as one of the world's leading authorities on stated preference techniques and was named in the top 30 most influential environmental economists in the 2000s (Hoepner et al 2012).

Market research services were provided by Survey Help and Orima Research. Survey Help scripted and hosted the online questionnaires. Orima Research managed recruitment of respondents during the first phase of the survey fieldwork.

# Summary



## Canberra households told us

- ✓ they value avoiding sewer overflows much more highly than they value avoiding water supply interruptions
- ✓ their willingness to pay for service improvement is lower than the compensation they would require for an equivalent service degradation
- ✓ they are around three times more averse to sewer overflows occurring on their property than to overflows occurring on their street
- ✓ they are around 20 per cent more averse to unplanned than planned water supply interruptions

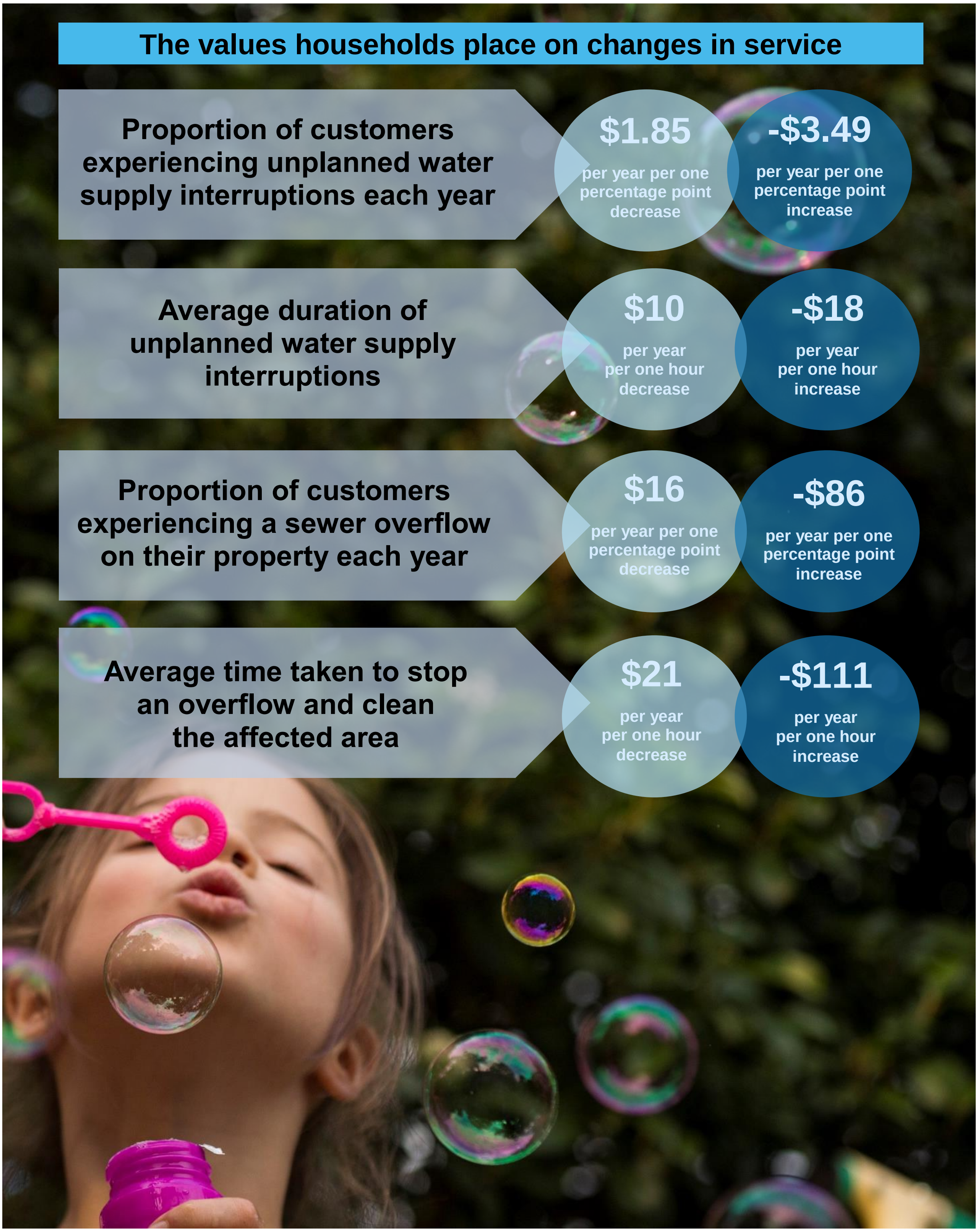
**546** participating residential customers

**3854** choice questions answered

## Discrete choice survey method

| | Current package | Package A | Package B |
|---|---|---|---|
| **Sewerage service reliability** | | | |
| Number of customers experiencing a sewer overflow on their property each year | 3% | 1% | 5% |
| Number of customers experiencing a sewer overflow on their street or in nearby public land each year | 6% | 8% | 8% |
| Average time taken to stop an overflow and clean the affected area | 2 hours 30 minutes | 4 hours | 1 hour 30 minutes |
| **The cost to you** | | | |
| Permanent change in your annual Icon Water bill | $0 | $10 | -$50 |
| If these were the only three options available to you, which option would you choose? | ● | ● | ● |
| If Package A and Package B were the only two options available to you, which option would you choose? | | ● | ● |

Click here if you wish to view a table showing percentage changes in a 'Once in X years' format


The values households place on changes in service
Proportion of customers experiencing unplanned water supply interruptions each year
$1.85
per year per one percentage point decrease
-$3.49
per year per one percentage point increase
Average duration of unplanned water supply interruptions
$10
per year per one hour decrease
-$18
per year per one hour increase
Proportion of customers experiencing a sewer overflow on their property each year
$16
per year per one percentage point decrease
-$86
per year per one percentage point increase
Average time taken to stop an overflow and clean the affected area
$21
per year per one hour decrease
-$111
per year per one hour increase

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# Introduction

## Background

Icon Water needs to make decisions about how much of its customers' money it spends on reducing the risks of water supply interruptions and sewage overflows. When developing its plans for the 2018-2023 regulatory period, Icon Water wants to strike a balance that reflects what its customers want. To do this, Icon Water needs to understand how much of a change in price customers are willing to trade for changes in various attributes of service reliability. A study quantifying these customer preferences had been undertaken by NERA and AC Nielsen in 2003 (Hensher et al 2005), but applying those estimates to current planning could not be justified without first testing whether customer preferences had changed over the intervening thirteen years.

In September 2015, Icon Water commenced a research project to develop up-to-date estimates of customer preferences for balancing price and service reliability. The project was conducted in partnership with University of Waikato, with specific support services provided by market research businesses.

This report details the data collection that was undertaken by the research team and the main results from data analysis for residential customers in the Australian Capital Territory.

## Objective

The broad objective of the project was to understand customer preferences with respect to the trade-off between price and service reliability. In particular, the aim is to understand customers' willingness to pay for improvements (and willingness to accept compensation for degradation) in the following service attributes:

- the frequency of water supply interruptions
- the duration of water supply interruptions
- advance warning of water supply interruptions
- the frequency of sewer overflows
- the duration of sewer overflows.

This information will allow Icon Water to undertake benefit-cost analysis of asset management options that result in differing service levels. That analysis will help Icon Water to move towards the community's preferred balance between price and service levels. It is consistent with:

- demonstrable balancing of cost, risk and performance under the ISO 55000 international standard for management of physical assets
- the objective set out for Icon Water's economic regulator to promote the efficient investment in, and efficient operation and use of regulated services for the long term interests of consumers in relation to the price, quality, safety, reliability and security of the service (Legislative Assembly for the Australian Capital Territory 1997, s19L).

## Approach

When investigating the value placed by customers on changes in service levels, debate over potential methods is often confused by differences in stakeholders' understanding of the term 'value'. It is therefore helpful to define value within a formal theoretical framework. The measures of value in this report are those defined in the economics literature as the Hicksian compensating and equivalent variations. These values are equal to the maximum amount that customers would be willing to pay (or the minimum amount they would be willing to accept) for a service improvement (or deterioration) (for example, see Randall and Stoll 1980).

The natural monopoly nature of urban water supply and indivisibilities in the network service mean that customers are generally unable to choose their preferred version of the service. Customers are offered only one version of the service for a given property. As a result, it is difficult to observe customers trading off price against water and sewerage service reliability in a real market. That is, there are few *revealed* preference data. However, these trade-offs can be observed in the context of a *stated* preference survey.

The stated preference method chosen by the project team was the discrete choice experiment (DCE) technique, which is also referred to as choice modelling or conjoint analysis. DCE surveys involve presenting respondents with one or more choice questions. Each choice question presents two or more hypothetical scenarios with specified cost and asks the respondent to indicate their preferred option. In DCE, the scenarios are described by multiple attributes and the levels assigned to attributes vary over scenarios and over questions. Such variation is systematic and provides the necessary identification and accuracy of the statistical estimates of the value placed by respondents on marginal changes in each attribute.

This technique is increasingly being used to understand consumers' preferences for utilities services, both in electricity networks (for example, by the UK Office of Gas and Energy Markets (Accent 2008), Essential Services Commission of South Australia (KPMG 2003), ActewAGL (McNair et al 2011b, Hensher et al 2014), and the Australian Energy Market Operator (AEMC 2014)) and water and sewerage services (for example, Icon Water (Hensher et al 2005, McNair and Ward 2012), Yorkshire Water (Willis et al 2005), Southern Water (Accent 2013b), and South East Water (Accent 2013a). It is being used as an input to economic regulation – either as a means of quantifying benefits for benefit-cost analysis of a given project (ACTEW 2005) or to set the incentive rates (financial rewards and penalties) for under- or over-performance on various service attributes (NCA 2006; AER 2015, pp18-21).

DCE holds a major advantage over many other survey techniques in that it is consistent with the economic concepts of compensating and equivalent variation (Small and Rosen 1981). It is well suited to simultaneously valuing multiple attributes, such as frequency, duration, advance notice, and time of day of supply interruptions. It generates a rich data set that can be applied across more than one context. DCE was recommended by the Centre for International Economics in its review of alternative methodologies for the Independent Pricing and Regulatory Tribunal of New South Wales in 2001 (CIE 2001). DCE has been used by several water utilities in the United Kingdom to meet Ofwat's assessment criteria in relation to robust and meaningful customer engagement. Ofwat's 2011 customer engagement policy statement indicates that a key characteristic of good customer engagement is "taking account of current good practice (such as that published on willingness to pay surveys and cost-benefit analysis)" (Ofwat 2011, p. 14). One of the key assessment criteria for the risk-based review tests applied by Ofwat at its 2014 round of reviews was:

> How far has the company demonstrated a robust approach to gathering willingness to pay information and in mapping this to its outcomes, performance commitments, and outcome delivery incentives? (Ofwat 2013, p. 77)

A criticism sometimes made of surveys is that they simulate a market that is hypothetical and therefore do not replicate the financial constraints confronted by consumers in real markets. Hypothetical surveys raise significant challenges in contexts where respondents have little or no experience with the good or service in question and where respondents have no incentive to answer carefully and truthfully. In the context of water and sewerage network reliability, however, respondents have generally experienced some form of supply interruption and Icon Water's experience confirms customers generally understand that price-reliability options could be applied on the basis of survey findings, particularly where the survey has been commissioned by a utility or regulatory body.

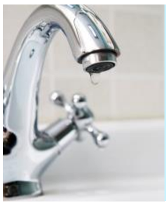
The DCE techniques applied in this study are state-of-the-art and include:

- the generation of efficient experimental designs (combinations of attribute levels across choice alternatives that maximise the statistical significance of the ultimate estimates of willingness to pay), adapted over four waves of survey fieldwork
- estimation of willingness to pay using models that allow for
    - differences in the values placed on service improvements as distinct from service degradation
    - distributions of preferences across respondents for each service attribute and correlation between those distributions.

# The research topic

This research estimates residential customer values for a range of service attributes associated with network reliability, in particular, attributes associated with:

- water supply interruptions
- sewer overflows.



**Water supply interruptions**

Planned interruptions

Sometimes, Icon Water needs to turn off mains water supply in order to undertake work on the water network, such as replacing water meters. Customers receive at least two days written notice of these planned interruptions.

Unplanned interruptions

On other occasions, water supply may need to be turned off without notice (an unplanned interruption) due to an unexpected fault. For example, a water main may burst due to wear and tear or increased pressure in the water supply network and Icon Water will need to turn off supply to some customers in order to repair or replace the damaged pipe.

How interruptions affect customers

While the water supply is turned off, customers are not able to get water from the taps on their property (except where water is supplied from other sources such as a water tank).

This may mean that customers cannot:

- pour a glass of drinking water;
- flush the toilet (after it's been flushed once);
- wash their hands;
- rinse or wash dishes;
- wash clothes; or
- have a shower or bath.

In the event of an unplanned supply interruption, information on the estimated time to restore supply is provided on the Icon Water website and on the Icon Water faults and emergencies phone line.

Reducing the risk of water supply interruptions

Icon Water can undertake activities to reduce the risk of water supply interruptions, including:

- installing more pressure-reducing valves in the water network; and
- replacement of ageing pipes.

Icon Water can also reduce the time taken to restore water supply by increasing the number of crews undertaking works during planned interruptions and repairing burst mains during unplanned interruptions.

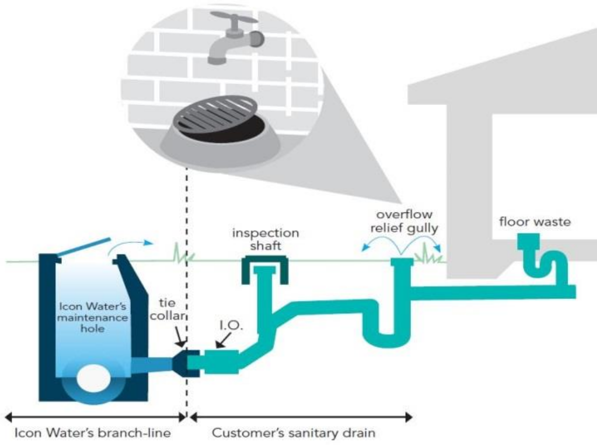
All of these activities come at a cost that is ultimately recovered in Icon Water bills paid by customers. The purpose of this research is to discover customers’ views on how we should balance cost against the risk of water supply interruptions.

## Sewer overflows

Sometimes, the pipes that carry sewage away from customers’ properties become blocked due to pipe breakage, incursion of tree roots or incorrect disposal of waste (such as cooking grease or baby wipes). The blockage will cause sewage to build up in the pipe until it overflows from a manhole or an overflow relief gully.

Manholes are placed every 50 to 150 metres along sewer pipes. Most households have a manhole either on their property or nearby in their street.

Overflow relief gullies are typically situated immediately outside of buildings. They provide a point of release to prevent sewage from overflowing indoors.




How sewer overflows affect customers

Sewage is 99.7 per cent water, but the 0.3 per cent of dissolved and suspended matter can contain many micro-organisms that may be harmful to humans, animals and the environment such as viruses, bacteria, fungal, and parasitic organisms. In the event of an overflow, customers need to keep away from the affected area until the blockage has been cleared and the area has been thoroughly cleaned and disinfected by Icon Water staff. There may be an odour from the sewage, which is unpleasant, but not a health risk itself.

Reducing the risk of sewage overflows

Icon Water can undertake activities to reduce the risk of sewer blockages, including:

- putting cameras down pipes to monitor their condition;
- replacement of ageing pipes; and
- cleaning pipes.

Icon Water can also reduce the time taken to unblock sewers and clean up overflows by increasing the number of crews trained and made available to undertake this work.

All of these activities come at a cost that is ultimately recovered in Icon Water bills paid by customers. The purpose of this research is to discover customers’ views on how we should balance cost against the risk of sewer overflows.

# The survey instrument

Household preferences in relation to balancing price with the risk and nature of supply interruptions or sewer overflows were elicited using online questionnaires. Both the water and sewerage questionnaires followed a similar format, comprising:

- A welcome message, including instructions and information on privacy and contact details
- Information about water supply interruptions or sewer overflows, how they can affect customers, and what Icon Water can do reduce the likelihood and/or impact of those events
- The DCE component of the questionnaire, which included eight choice questions in the water questionnaire and six choice questions in the sewerage questionnaire. This section is discussed in more detail below.
- Debriefing questions about how respondents approached the choice tasks
- Questions about the respondents, including the extent to which they had experienced water supply interruptions or sewer overflows in the past.

The questionnaires were developed through several phases of careful planning and testing, including:

- Review by Icon Water staff
- In-depth interviews
- Four separate waves of survey fieldwork.

## The choice questions

There are several important decisions to be made when designing the DCE component of the questionnaires. These decisions include:

- The service attributes to be included in the choice questions and how those attributes should be defined
- The number of alternatives to be included in each choice question and whether one of the alternatives should represent the status quo
- The number of questions to be answered by each respondent
- The levels that the service attributes can take in the questions
- The combinations of attribute levels in each question (that is, the experimental design)
- The order in which questions are presented to each respondent
- The information, instructions and/or questions used to 'prime' respondents for the choice questions.

<u>Service attributes</u>

The attributes included in the choice questions in the questionnaire on water supply interruptions were:

- Number of customers experiencing a planned water supply interruption each year (%)
- Duration of planned water supply interruptions (hours and minutes)
- Time of day planned interruptions take place

- Number of customers experiencing an unplanned water supply interruption each year (%)
- Duration of unplanned water supply interruptions (hours and minutes)
- Permanent change in your annual Icon Water bill ($).

The first two waves of the survey also included attributes for ‘Average planned time off supply per customer per year’ and ‘Average unplanned time off supply per customer per year’, where the levels of these attributes were equal to the product of the corresponding ‘number of customers’ and ‘duration’ attributes. These attributes were removed from the designs for the third and fourth waves of the survey in response to feedback that the water choice questions were overly complex and cognitively demanding for a self-administered questionnaire.

The attributes in the choice questions in the questionnaire on sewer overflows were:

- Number of customers experiencing a sewer overflow on their property each year (%)
- Number of customers experiencing a sewer overflow on their street or in nearby public land each year (%)
- Average time taken to stop an overflow and clean the affected area (hours and minutes)
- Permanent change in your annual Icon Water bill ($)

These attributes were selected based on analysis of:

- A qualitative telephone survey undertaken by Icon Water in September 2015, which found that network reliability and pricing were two of the three most important aspects of Icon Water’s service to customers
- The attributes included in similar studies by NERA and ACNielsen for Icon Water in 2003 and by Accent Market Research for Southern Water and South East Water in 2013
- Recommendations in relation to describing low probability events from a 2011 report by UK Water Industry Research, *Carrying out Willingness to Pay Surveys*
- Icon Water service performance data.

<u>Number of alternatives in each choice task</u>

Both the water and sewerage questionnaires presented three alternatives in each choice task, with one of those alternatives being the status quo. Each choice task included both an unforced question (allowing the status quo to be chosen) and, if the status quo option is selected in the unforced question, a forced question (a binary choice between the two change alternatives).

Presenting three alternatives per task was judged to strike an appropriate balance between statistical significance and task complexity. In past studies, statistical significance for a given sample size has been low where choice tasks presented only a status quo alternative and a single change option (for example, see Rolfe and Bennett 2009). However, presenting four or more alternative in each choice task was judged to be too cognitively demanding, based on feedback from participants in this questionnaire testing that even the three-alternative tasks were found to be complex.

One of the alternatives was specified as the status quo in order to account for reference-dependent decision making, for which there is now a large body of evidence from behavioural economics, including in support of prospect theory (Kahnemann and Tversky 1979). Including the status quo alternative allows for the estimation of any asymmetric valuation of gains and losses.

Some studies have excluded the status quo alternative from choice tasks on the basis that respondents typically exhibit a strong bias towards the status quo option that is unrelated to the attribute levels. The concern is that this bias is driven to some extent by an unwillingness to do the cognitive work necessary to express true preferences. Accent Market Research has tended to use forced choices (choices with no status quo alternative) in its studies for UK water companies and notes that this approach is consistent with the majority view of practitioners surveyed as part of the UKWIR 2011 study (Accent 2013b, p. 32). NERA and ACNielsen also used a forced choice format in its 2003 study in the ACT.

Our view is that it would be unwise to exclude the status quo alternative, given the weight of evidence relating to reference-dependent choice. To mitigate the risk that preferences cannot be elicited due to a large proportion of respondents opting out of making trade offs by selecting the status quo in most or all choice tasks, we asked both unforced and forced questions on each choice task. This approach was applied in the study undertaken by the ANU in 2012 (McNair and Ward 2012).

<u>Number of questions per respondent</u>

The water questionnaire included eight choice tasks. The sewerage questionnaire included six choice tasks. When questionnaires are self-administered, the risk of respondents dropping out of the survey increases with the number of choice questions presented. The number of respondents required to obtain statistically significant estimates of willingness to pay reduces with the number of choice questions presented to each respondent. The chosen quantities were judged to strike an appropriate balance between these two considerations. The number of questions in the water survey was greater than in the sewerage survey because the greater number of service attributes in the water survey meant that more choice observations would be required to obtain statistically significant estimates of willingness to pay from a given sample of respondents.

<u>Service attribute levels</u>

The service attribute levels used in the water and sewerage surveys are presented in Table 1 and Table 2. These levels were selected taking account of:

- Setting the status quo levels consistent with historical performance, including conversion of measures such as 'mains breaks and chokes' and 'property connection breaks and chokes' into the numbers of customers experiencing overflows on or near their properties
- Including a range of changes in levels that are large enough to allow for statistically significant estimation, but not so large that alternatives are perceived to be infeasible
- Limiting choice complexity by including the status quo levels in the vectors of levels for the change alternatives in the water survey
- Inclusion of both positive and negative changes in levels relative to the status quo to allow for estimation of both WTP for improvement and WTA compensation for degradation
- Where practicable, achieving attribute balance by setting the number of levels as a factor of the number of questions in each survey instrument
- Including a range of cost levels that align with prior estimates of the willingness to pay for the best and worst possible combinations of service attribute levels – a consideration that was re-evaluated prior to each wave of survey fieldwork.

**Table 1: Water service attribute levels**

| Attribute | Status quo level | Alternative levels |
|---|---|---|
| Number of customers experiencing a planned water supply interruption each year | 6% | 2%, 4%, 6%, 10% |
| Duration of planned water supply interruptions | 30 minutes | 15 minutes, 30 minutes, 45 minutes, 1 hour |
| Time of day planned interruptions take place | During business hours (9am-5pm) | During business hours (9am-5pm), During the night (10pm-6am) |
| Number of customers experiencing an unplanned water supply interruption each year | 10% | 2%, 6%, 10%, 14% |
| Duration of unplanned water supply interruptions | 2 hours 30 minutes | 30 minutes, 1 hour, 2 hours 30 minutes, 4 hours |
| Permanent change in your annual Icon Water bill | $0 | Wave 1: -$140, -$80, -$40, $50, $100, $170 |
| | | Wave 2: -$100, -$50, -$20, $10, $20, $40 |
| | | Wave 3: -$90, -$50, -$20, $10, $30, $60 |
| | | Wave 4: -$90, -$50, -$20, $10, $30, $60 |

The research team carefully considered the approach to expressing the levels of the attributes associated with the frequency of events. It was noted that the studies undertaken by Accent Market Research in the UK in 2013 defined likelihoods as ‘1 in *X*’ for probabilities greater than 0.01 and as ‘*X* in [1000, 10000, or 100,000]’ for probabilities below 0.01, consistent with the recommendation in the 2011 report by UK Water Industry Research, *Carrying out Willingness to Pay Surveys*.

We were uncomfortable with using an approach where the denominator varied across levels – a concern shared by Richard Carson in his feedback on the UKWIR report. In questionnaire testing, the attributes were defined in percentage terms, with a separate table showing show specified percentages convert to the ‘1 in *X*’ format. Most participants indicated that they didn’t use the conversion table. In the main survey fieldwork, we decided to retain the percentage-based attribute level format, but provided a link to the conversion table below every choice question.

**Table 2: Sewerage service attribute levels**

| Attribute | Status quo level | Alternative levels |
|---|---|---|
| Number of customers experiencing a sewer overflow on their property each year | 3% | 1%, 5%, 7% |
| Number of customers experiencing a sewer overflow on their street or in nearby public land each year | 6% | 2%, 4%, 8% |
| Average time taken to stop an overflow and clean the affected area | 2 hours 30 minutes | 45 minutes, 1 hour 30 minutes, 4 hours |
| Permanent change in your annual Icon Water bill | $0 | Wave 1: -$900, -$500, -$250, $250, $500, $900 |
| | | Wave 2: -$160, -$75, -$25, $10, $25, $60 |
| | | Wave 3: -$230, -$130, -$60, -$20, $10, $30, $70, $130 |
| | | Wave 4: -$180, -$100, -$50, -$20, $10, $30, $70, $130 |

<u>Experimental design</u>

The combinations of attribute levels assigned to the various alternatives and questions are referred to as the experimental design. The experimental design has a direct impact on the statistical significance of estimates of willingness to pay. If some information about preferences is known, it is possible to generate an experimental design that can elicit statistically significant estimates of willingness to pay from a smaller number of respondents than a randomly generated design.

This study used an adaptive experimental design process, in which four separate designs were used for each survey. These designs were generated to minimise C-error (the sum of the variances of the WTP estimates for each service attribute) (Scarpa and Rose 2008). The prior parameter estimates for generating the trial survey were based on the estimates of WTP in the NERA and ACNielsen study in 2003. The prior parameter estimates for the four waves of the main surveys were based on estimates of WTP from basic multinomial logit models run on the data collected in the waves undertaken to that point. The searches for the designs were performed using the *Ngene* software package.

The water design comprised six blocks of eight questions and the sewerage design comprised six blocks of six questions, with each respondent answering only one randomly selected block. The reason for using multiple blocks was to improve design efficiency and limit the impact of any single choice task on the results. The order in which questions from the blocks were presented to respondents was randomised to ensure the WTP estimates were not influenced by ordering effects (McNair et al 2011a).

Examples of the choice questions used in the two surveys are presented in Figure 1 and Figure 2.

**Figure 1: Example of a choice task in the water survey**

| | Current package | Package A | Package B |
|---|---|---|---|
| **Water supply reliability** | | | |
| ***Planned interruptions*** | | | |
| Number of customers experiencing a planned water supply interruption each year | 6% | 4% | 4% |
| Duration of planned water supply interruptions | 30 minutes | 45 minutes | 30 minutes |
| Time of day planned interruptions take place | During business hours (9am-5pm) | During the night (10pm-6am) | During business hours (9am-5pm) |
| ***Unplanned interruptions*** | | | |
| Number of customers experiencing an unplanned water supply interruption each year | 10% | 14% | 10% |
| Duration of unplanned water supply interruptions | 2 hours 30 minutes | 4 hours | 1 hour |
| **The cost to you** | | | |
| Permanent change in your annual Icon Water bill | $0 | -$50 | $30 |
| If these were the only three options available to you, which option would you choose? | ● | ● | ● |
| If Package A and Package B were the only two options available to you, which option would you choose? | | ● | ● |

Click here if you wish to view a table showing percentage changes in a 'Once in X years' format

**Figure 2: Example of a choice task in the sewerage survey**

| | Current package | Package A | Package B |
|---|---|---|---|
| **Sewerage service reliability** | | | |
| Number of customers experiencing a sewer overflow on their property each year | 3% | 1% | 5% |
| Number of customers experiencing a sewer overflow on their street or in nearby public land each year | 6% | 8% | 8% |
| Average time taken to stop an overflow and clean the affected area | 2 hours 30 minutes | 4 hours | 1 hour 30 minutes |
| **The cost to you** | | | |
| Permanent change in your annual Icon Water bill | $0 | $10 | -$50 |
| If these were the only three options available to you, which option would you choose? | ● | ● | ● |
| If Package A and Package B were the only two options available to you, which option would you choose? | | ● | ● |

Click here if you wish to view a table showing percentage changes in a 'Once in X years' format

Instructions, priming and debriefing

Before being presented with the choice tasks, respondents were asked open-ended contingent valuation questions. These questions asked respondents to report their willingness to pay for a specified service improvement and their willingness to accept compensation for specified service degradation, where the improvement and degradation were described by the best and worst possible combinations of attribute levels in the experimental design. These questions were included to limit anchoring and learning effects in the DCE component of the survey by allowing respondents to become familiar with the description of service packages and consider the value they would place on changes in service prior to the choice questions.

A ‘cheap talk’ script was included to minimise hypothetical bias, emphasising that respondents should answer thoughtfully as though the questions were real situations, because their response to each question will affect the services and bills they receive in future.

A list of debriefing questions was included to probe the respondent’s decision-making process and gather information on their characteristics. The questions covered:

- Difficulty experienced when answering choice questions
- Perceptions of the realism and feasibility of the service alternatives in the choice questions
- The way respondents answered any questions with alternatives they perceived to be unrealistic
- Reasons for choosing the status quo alternative in all questions (where applicable)
- Perceptions of how influential the survey would be on network management
- The respondent’s estimated annual bill
- The respondent’s experience of water supply interruptions and sewerage overflows
- A range of socioeconomic characteristics.

# Sample of households

**Recruitment**

The fieldwork was conducted in four separate waves between November 2015 and July 2016, as described in Table 3 and Table 4. All waves used self-administered online questionnaires, which were scripted and hosted by Survey Help. The recruitment method differed across the waves. The first wave utilised an online panel – the Online Research Unit (ORU). The second and third waves involved conducting computer-assisted telephone interviews (CATI) generated by random-number dialling and then sending email invitations to those indicating they would be willing to participate. Email invitations were also sent to Icon Water's *Think Tank* customers – a panel of customers that had been recruited via a CATI survey earlier in 2015. Reminder emails were sent in both waves and reminder phone calls were used in Wave 3. ORIMA Research managed the recruitment process for Wave 2 and Wave 3. In the fourth wave of fieldwork, Icon Water conducted the recruitment in-house by contacting a random sample of customers directly via email to invite participation. An example of an email invitation is presented at Appendix A.

Incentives were offered to support the response rate and the representativeness of the sample. Participants in the first wave of fieldwork were offered the standard incentive arrangements of the ORU. The other waves used prize draw incentives, with cash prizes for the second and third waves and voucher prizes for the fourth wave.

Around one quarter of the completed questionnaires received during the fieldwork were omitted from the sample used to estimate WTP. These data were excluded to ensure that the estimates would not be biased by choice observations in which the decision maker had not given consideration to the trade offs being presented. This exclusion rate is not unexpected, given the controls carefully and intentionally included in the questionnaire and the cognitively demanding nature of the choice tasks.[1] In particular, responses were excluded if they:

- were completed in less than six minutes, in the case of the water survey, or five minutes, in the case of the sewerage survey (the expected completion times for the two questionnaires were 20 and 15 minutes and the observed median completion times were 15 and 13 minutes);
- selected the status quo alternative in every choice task presented (this was an internally inconsistent response when considering the attribute levels alone) and indicated in debriefing questions that the reason for this response pattern was either:[2]
    - I didn't have enough time to properly evaluate the options
    - I didn't have enough information to be confident choosing the options
    - I disagree with the notion of people paying to avoid sewer overflows
    - I disagree with the notion of offering people money to face more sewer overflows
    - I am concerned that Icon Water might implement the bill increases shown without delivering the associated service improvements, or

[1] It is also significantly lower than the exclusion rate in McNair and Ward 2012.

[2] Including these responses would not significantly affect estimate of WTP for specific attributes, but it would result in a much larger estimate of status quo bias.

    - I am concerned that Icon Water might implement service reductions without delivering the associated bill decrease.
- Indicated in debriefing questions that they found the choice alternatives to be unrealistic and answered the questions as though the alternatives were different, more realistic packages.

**Table 3: Fieldwork for water survey**

| Fieldwork wave | Period | Recruitment | Incentive | Completions | Used in estimation |
|---|---|---|---|---:|---:|
| Wave 1 | 25/11/2015 to 08/12/2016 | Online panel | Panel rewards | 66* | 29 |
| Wave 2 | 12/01/2016 to 21/01/2016 | CATI then email | Cash prize draw | 23 | 17 |
| Wave 3 | 08/02/2016 to 26/02/2016 | CATI then email | Cash prize draw | 67 | 49 |
| Wave 4 | 12/07/2016 to 25/07/2016 | Email | Voucher prize draw | 253 | 194 |
| Total | | | | 409 | 289 |

* Excludes 88 unexpected completions that could not be explained by the Panel service provider.

**Table 4: Fieldwork for sewerage survey**

| Fieldwork wave | Period | Recruitment | Incentive | Completions | Used in estimation |
|---|---|---|---|---:|---:|
| Wave 1 | 25/11/2015 to 08/12/2016 | Online panel | Panel rewards | 56 | 31 |
| Wave 2 | 12/01/2016 to 21/01/2016 | CATI then email | Cash prize draw | 18 | 11 |
| Wave 3 | 08/02/2016 to 26/02/2016 | CATI then email | Cash prize draw | 59 | 42 |
| Wave 4 | 12/07/2016 to 25/07/2016 | Email | Voucher prize draw | 221 | 173 |
| Total | | | | 354 | 257 |

## Sample characteristics

The recruitment process screened out any households that did not directly face both the costs (via utilities bills) and benefits (via living in the residence) of changes in Icon Water's price-service mix. Since Icon Water bills are sent to property owners, the sample was effectively drawn from the population of owner-occupiers in the ACT. Property owners that reside elsewhere and renters whose payments for water are not a direct pass-through of Icon Water charges were screened from participating. Specifically, potential participants were deemed eligible for the survey only if they:

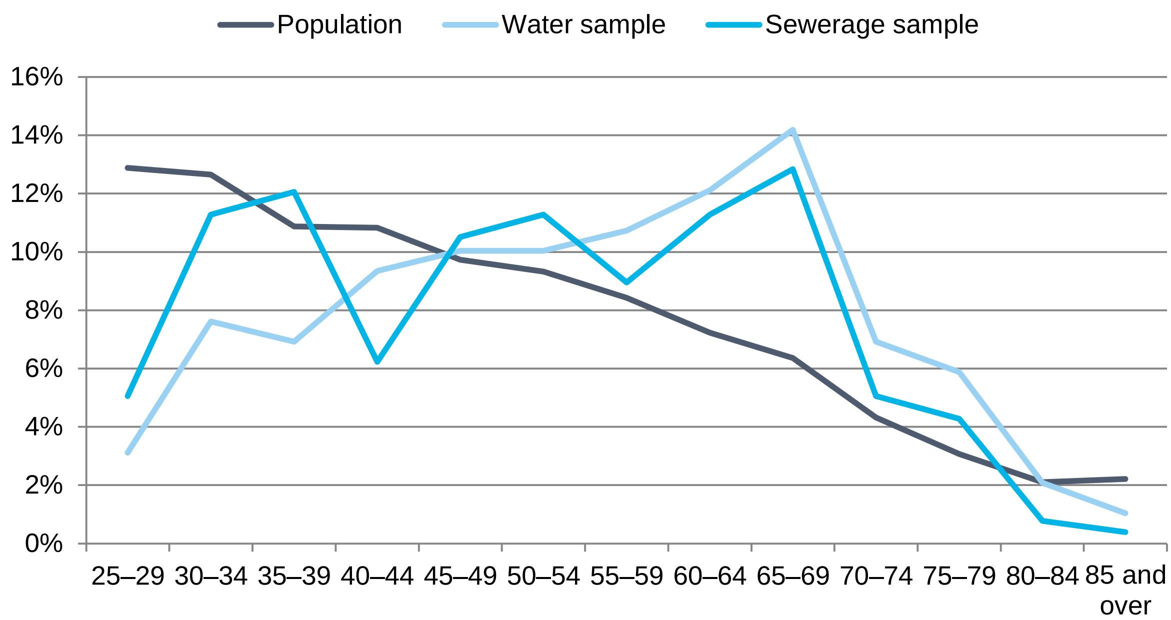
- live in the ACT
- are not and have no immediate family that is an employee of Icon Water (previously ACTEW), ActewAGL, AGL Energy, or Jemena
- are responsible for paying bills for the residence they live in
- receive bills from Icon Water or have a landlord that charges the full Icon Water bill on as a specific charge separate from rent.

While the samples may be reasonably representative of owner-occupiers in the ACT, it is important to understand how the samples compare to the broader population of the ACT. The following sections discuss how the sample characteristics compare to those of the ACT population as measured in the 2011 census.

Age

The samples used in this study include people of a wide range of ages. Relative to the ACT population of persons aged 25 years and over, people under the age of 45 tend to be underrepresented in the sample, while people aged in their 60s are overrepresented (see Figure 3).

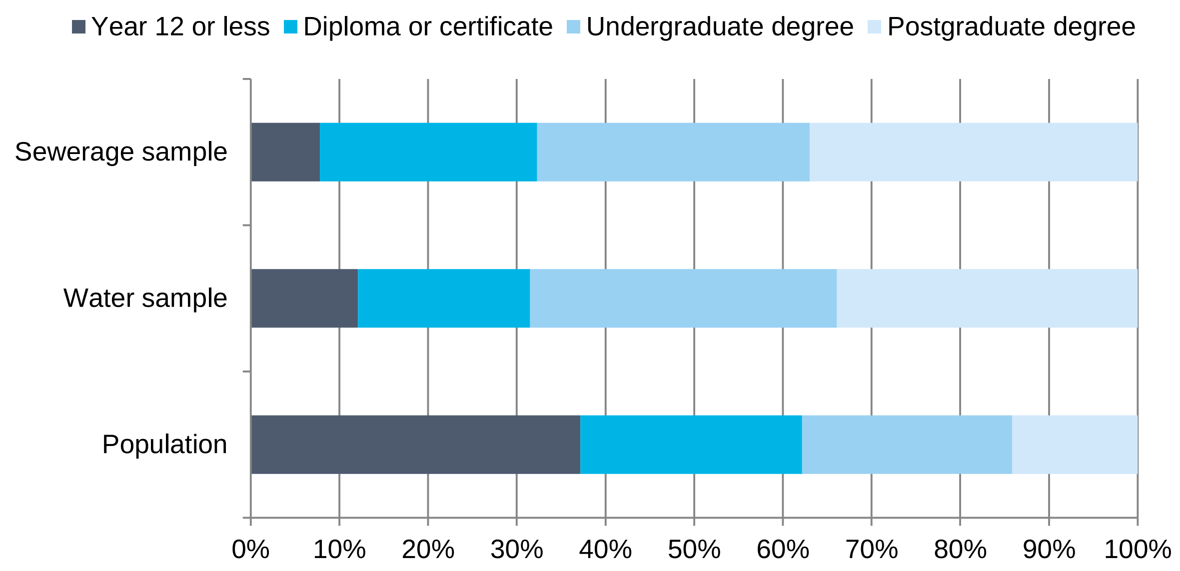
**Figure 3: Proportion of persons aged 25 years and over**



Education

The samples included people with a range of education levels. However, relative to the ACT population of people that have left school, those with a level of education at Year 12 or below are underrepresented, while those with university degrees are overrepresented (see Figure 4). This result is expected due to renters being screened from participation.

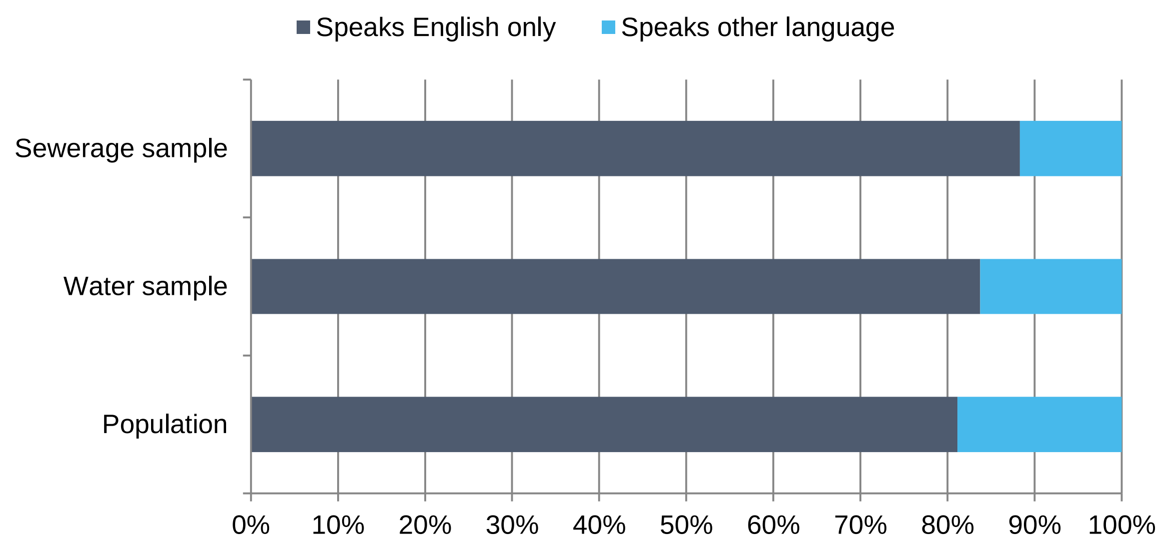
**Figure 4: Highest level of educational attainment**




Language

The samples were reasonably representative of the ACT population in terms of whether the language spoken at home by respondents was English or another language (see Figure 5).

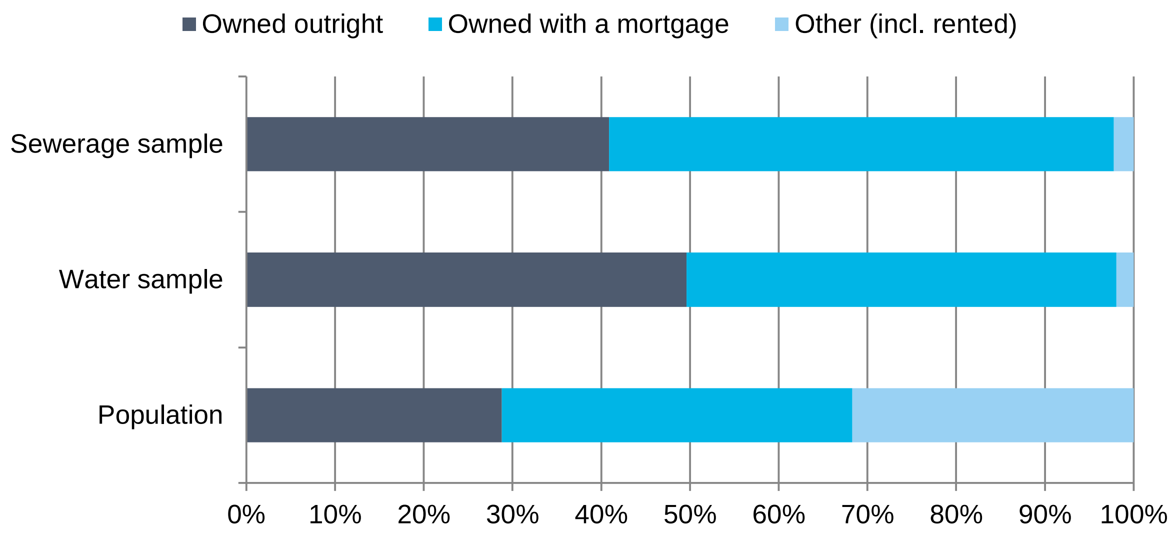
**Figure 5: Language spoken at home**



Tenure type

By construction, the samples comprised almost exclusively people who own their home, either outright or with a mortgage, whereas around 30 per cent of dwellings in the ACT are rented (see Figure 6).

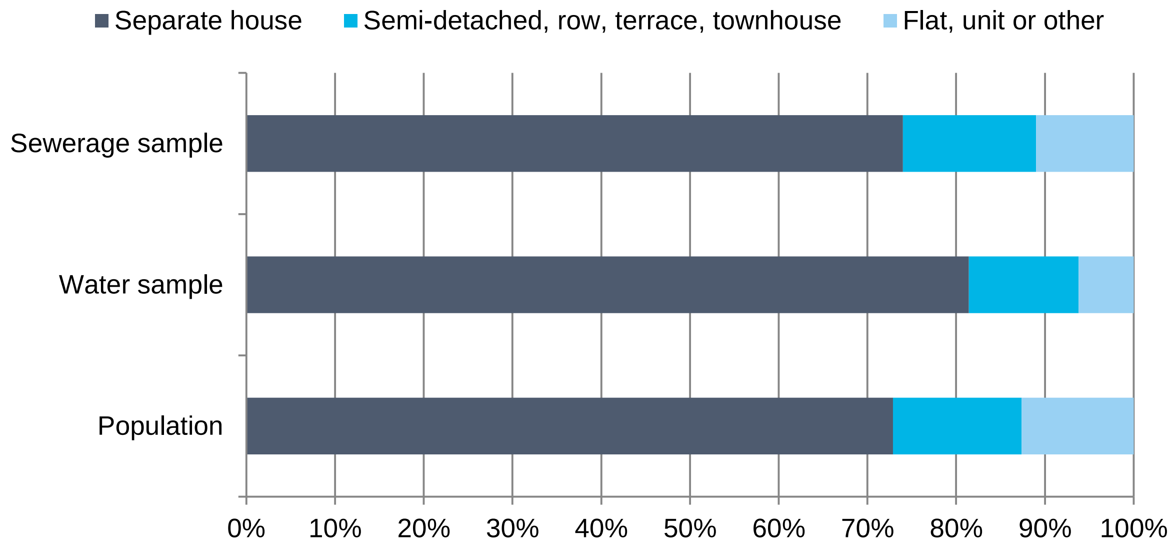
**Figure 6: Tenure type (water n=258, sewerage n=225)**[3]




Dwelling type

The Wave 4 samples were reasonably representative of different types of dwellings.[4] In the water component of the study, separate houses are overrepresented at the expense of flats and units.

**Figure 7: Dwelling type (water n=194, sewerage n=173)**

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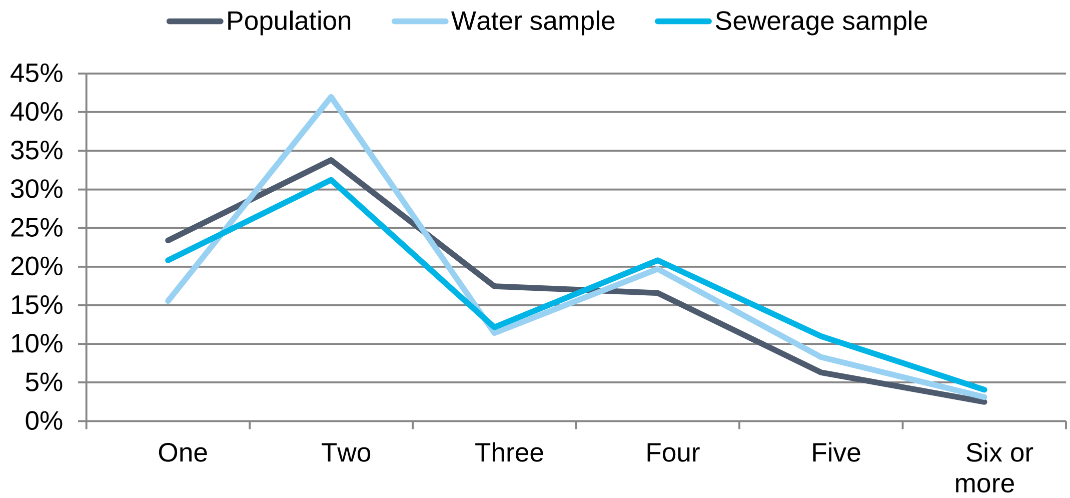
[3] Data on tenure type for the Wave 1 respondents are unavailable.

[4] Data on dwelling type are available only for Wave 4 respondents.

Household size

The Wave 4 samples were reasonably representative of the ACT population in terms of household size.[5]

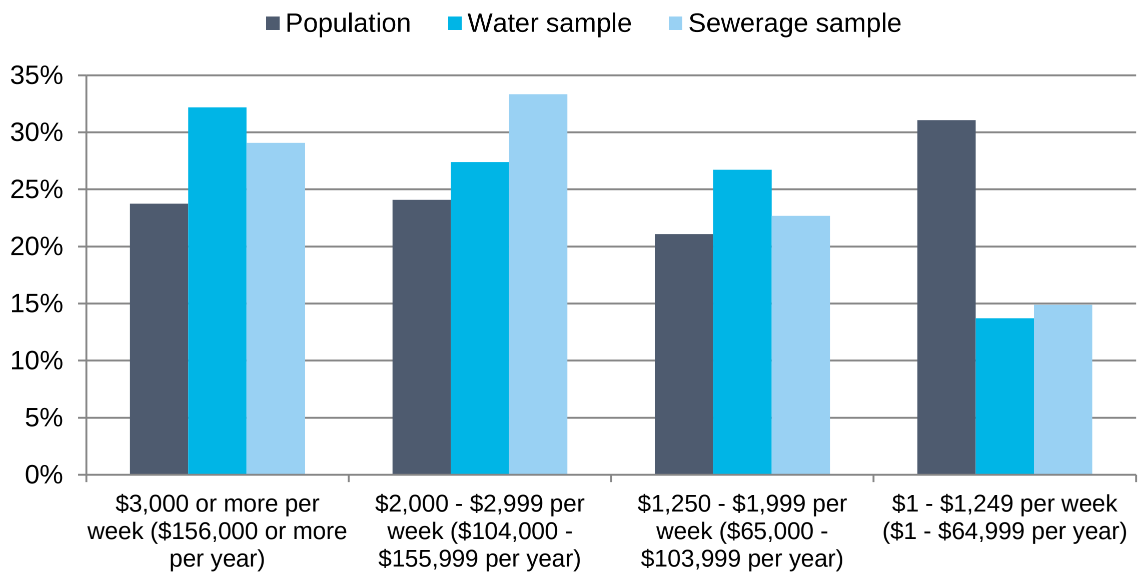
**Figure 8: Household size (water n=194, sewerage n=173)**




Income

Income information was collected via a question in the online questionnaire in Wave 4 of the fieldwork and via a different question in the CATI for Wave 2 and Wave 3 of the fieldwork. Like-for-like comparison is difficult due to a significant proportion of respondents opting to not provide information about their income and due to differences in the income ranges used to measure the distribution both across fieldwork waves and in the 2011 census, since incomes have grown significantly since 2011. It does appear likely, however, that low-income households are under-represented in the samples as we would expect, given owner-occupiers tend to have higher income than renters.

**Figure 9: Nominal household income (water n=146, sewerage n=141)** [6]




[5] Data on household size are available only for Wave 4 respondents.

[6] Data from Wave 4 of the fieldwork, excluding respondents refusing to provide income.

# Results

## Econometric models

DCE is a developing field that has seen several important advances in econometric methods over the past decade. The research team estimated a considerable number of models on the choice data to ensure that the final chosen models are representative of the results that are derived from a range of model specifications. Alternative specifications that were tested include:

- techniques for modelling unobserved heterogeneity, including basic multinomial logit models (no heterogeneity), mixed logit models in preference space, generalised mixed logit models in preference space, and generalised mixed logit models in WTP space
- techniques for modelling observed heterogeneity, with various combinations of respondent characteristics and indicators for fieldwork waves included as interactions with model parameters
- interactions between the service attributes, including between frequency and duration and timing of events
- asymmetric valuation of gains and losses
- logarithmic relationship between WTP and event duration
- models with post-stratification weights
- models estimating endogenous attribute non-attendance.

Following this testing, the preferred models displayed the following features:

- Panel mixed multinomial logit models, with fixed parameters for cost-related attributes and random (normal distribution) parameters for service attributes, allowing for full correlation between the distributions of the random parameters
- The models do not include parameters linking preferences to respondent characteristics, as these parameters were not statistically significant across various model specifications
- The models account for only one interaction between the service attributes presented in the choice tasks, since including further interactions did not significantly improve model fit (the interaction included was between the number, duration and timing of planned water supply interruptions, since respondents did not appear to value avoiding planned interruptions taking place during the night 10pm-6am)
- Inclusion of an interaction between the cost variable with an indicator variable for whether the cost change is positive or negative, since there is strong evidence in support of asymmetry in WTP for service improvement and WTA compensation for service degradation
- Linear relationships between WTP and each service attribute, since the logarithmic transformation on event duration did not significantly improve model fit
- The models represent the preferences of the sample of owner-occupiers and do not include poststratification weights for estimation of the preferences of the broader population, since the large range in required weights caused difficulties in estimation
- The models are based on an assumption that respondents attended to all attributes as part of their decision-making process, since the tasks included relatively few attributes and endogenous attribute attendance models on the sewerage survey data indicated attendance was relatively equal across attributes.

The state of the art is currently the panel mixed multinomial logit model estimated in WTP space. We estimated this model on both data sets, but decided against using it as the preferred model, since it cannot easily accommodate asymmetry in WTP for service improvement and WTA compensation for service degradation. The research team judged that capturing asymmetry of WTP and WTA, which was marked in this study and had a considerable impact on estimates of average WTP, was more important than finessing the estimation of unobserved heterogeneity in preferences. We provide the results from models estimated in WTP space in Appendix B as examples of alternative model specifications.

The preferred choice model on the water data is presented in Table 5, which shows:

- respondents gave considered responses to the choice questions on the basis of the service attributes presented, as evidenced by the large z-values on the parameter estimates
- respondents exhibited no aversion to or bias towards the status quo on average, however, there is significant heterogeneity in this preference, as evidenced by the standard deviation on the status quo constant being much larger than the mean
- there is considerable variation in household preferences in relation to planned supply interruptions taking place during business hours, as evidenced by the statistically significant estimate of standard deviation for the random parameter associated with those events
- respondents' WTP for service improvements is lower than the compensation they would require for the equivalent service degradation, as evidenced by the significant coefficient on the interaction variable between change in bill and the dummy variable for a bill increase.

The preferred choice model on the sewerage data is presented in Table 6, which shows:

- respondents gave considered responses to the choice questions on the basis of the service attributes presented, as evidenced by the large z-values on the parameter estimates
- respondents are more averse to overflows occurring on their property as distinct from those occurring on their street or in nearby public land, in accordance with prior expectations, as evidenced by the relative magnitudes of the coefficients on the two overflow frequency attributes
- respondents exhibited an aversion to the status quo alternative of around $15 per annum[7] on average, however, there is significant heterogeneity in this preference, with many respondents evidencing a bias towards the status quo alternative, as evidenced by the standard deviation on the status quo constant being much larger than the mean on the status quo constant
- there is considerable variation in household preferences as evidenced by the statistically significant estimates of standard deviations for all of the random parameters, except the parameter for number of overflows on the street or in nearby public land
- respondents' WTP for service improvements is significantly lower than the compensation they would require for the equivalent service degradation, as evidenced by the highly significant coefficient on the interaction variable between change in bill and the dummy variable for a bill increase.

[7] Calculated as -0.2966/(-0.0036-0.0157)

**Table 5: Model of household choice of water reliability scenarios**

| | Coefficient | z-value |
|---|---|---|
| *Fixed parameters* | | |
| Permanent change in your annual Icon Water bill (dollars) | -0.016 | -10.87 |
| Permanent change in your annual Icon Water bill (dollars) x dummy variable for bill increase (=1 for bill increase, =0 for bill decrease) | -0.014 | -4.06 |
| *Random parameters: means* | | |
| Alternative-specific constant (Current package =1, otherwise =0) | -0.118 | -0.79 |
| Expected time off supply due to planned supply interruptions taking place during business hours each year (Number x duration) | -4.594 | -2.56 |
| Number of customers experiencing an unplanned water supply interruption each year (%) | -5.589 | -4.74 |
| Duration of unplanned water supply interruptions (hours) | -0.294 | -6.59 |
| *Random parameters: standard deviations* | | |
| Alternative-specific constant (Current package =1, otherwise =0) | 1.704 | 12.94 |
| Expected time off supply due to planned supply interruptions taking place during business hours each year (Number x duration) | 11.572 | 4.12 |
| Number of customers experiencing an unplanned water supply interruption each year (%) | -4.860 | -1.46 |
| Duration of unplanned water supply interruptions (hours) | 0.139 | 0.54 |
| *Random parameters: cross-parameter correlations* | | |
| ASC: Planned time off supply during business hours | -1.923 | -0.81 |
| ASC: Number of unplanned supply interruptions | -1.916 | -1.29 |
| ASC: Duration of unplanned supply interruptions | -0.149 | -2.58 |
| Planned time off supply during business hours: Number of unplanned supply interruptions | 10.479 | 5.11 |
| Planned time off supply during business hours: Duration of unplanned supply interruptions | 0.126 | 1.2 |
| Number of unplanned supply interruptions: Duration of unplanned supply interruptions | -0.426 | -4.86 |
| *Model fit* | | |
| Choice observations | 2312 | |
| Individuals | 289 | |
| Log likelihood | -2020 | |

**Table 6: Model of household choice of sewerage reliability scenarios**

| | Coefficient | z-value |
|---|---|---|
| *Fixed parameters* | | |
| Permanent change in your annual Icon Water bill (dollars) | -0.004 | -4.05 |
| Permanent change in your annual Icon Water bill (dollars) x dummy variable for bill increase (=1 for bill increase, =0 for bill decrease) | -0.016 | -7.16 |
| *Random parameters: means* | | |
| Alternative-specific constant (Current package =1, otherwise =0) | -0.297 | -2.01 |
| Number of customers experiencing a sewer overflow on their property each year (%) | -31.300 | -8.40 |
| Number of customers experiencing a sewer overflow on their street or in nearby public land each year (%) | -11.392 | -4.61 |
| Average time taken to stop an overflow and clean the affected area (hours) | -0.404 | -7.43 |
| *Random parameters: standard deviations* | | |
| Alternative-specific constant (Current package =1, otherwise =0) | 1.470 | 9.95 |
| Number of customers experiencing a sewer overflow on their property each year (%) | 35.923 | 8.66 |
| Number of customers experiencing a sewer overflow on their street or in nearby public land each year (%) | -0.264 | -0.04 |
| Average time taken to stop an overflow and clean the affected area (hours) | -0.390 | -3.16 |
| *Random parameters: cross-parameter correlations* | | |
| ASC: Number of overflows on property | -20.291 | -4.43 |
| ASC: Number of overflows near property | -4.633 | -1.49 |
| ASC: Time taken to stop overflow | -0.040 | -0.56 |
| Number of overflows on property: Number of overflows near property | 17.854 | 5.65 |
| Number of overflows on property: Time taken to stop overflow | 0.228 | 3.05 |
| Number of overflows near property: Time taken to stop overflow | -0.175 | -0.75 |
| *Model fit* | | |
| Choice observations | 1542 | |
| Individuals | 257 | |
| Log likelihood | -1388.54 | |

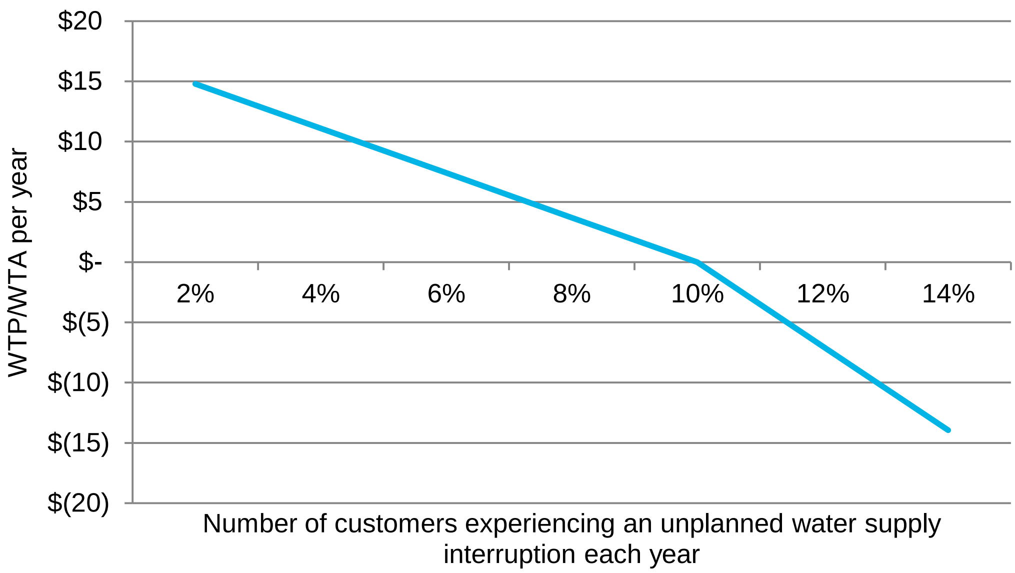
## Estimates of average willingness to pay

The estimates of average WTP and WTA compensation for changes in the water service attributes are set out in Table 7. There is some asymmetry in the value placed on service around the status quo, with WTA compensation for a service degradation estimated at around double the size of the WTP for the equivalent service improvement. Values for other changes in service levels can be calculated simply by scaling the numbers in the table, since the model is linear as shown in Figure 10. For example, the value placed on a two percentage point change in the number of interruptions will simply be double the number provided in the table for a one percentage point change.

**Table 7: Average WTP and WTA compensation for specified changes in water network reliability (95 per cent confidence intervals in parentheses)**

| | Service improvement (WTP) | Service degradation (WTA) |
|---|---|---|
| One minute change in expected time off supply (probability x duration) due to planned supply interruptions taking place during business hours each year | **$2.53**<br>($0.58, $4.48) | **-$4.78**<br>(-$8.42, -$1.14) |
| One percentage point change in the number of customers experiencing an unplanned water supply interruption each year | **$1.85**<br>($1.05, $2.65) | **-$3.49**<br>(-$4.91, -$2.07) |
| One hour change in the duration of unplanned water supply interruptions | **$9.73**<br>($6.62, $12.85) | **-$18.38**<br>(-$24.28, -$12.48) |

**Figure 10: Average WTP/WTA compensation for various frequencies of unplanned water supply interruptions relative to a baseline of 10 per cent**

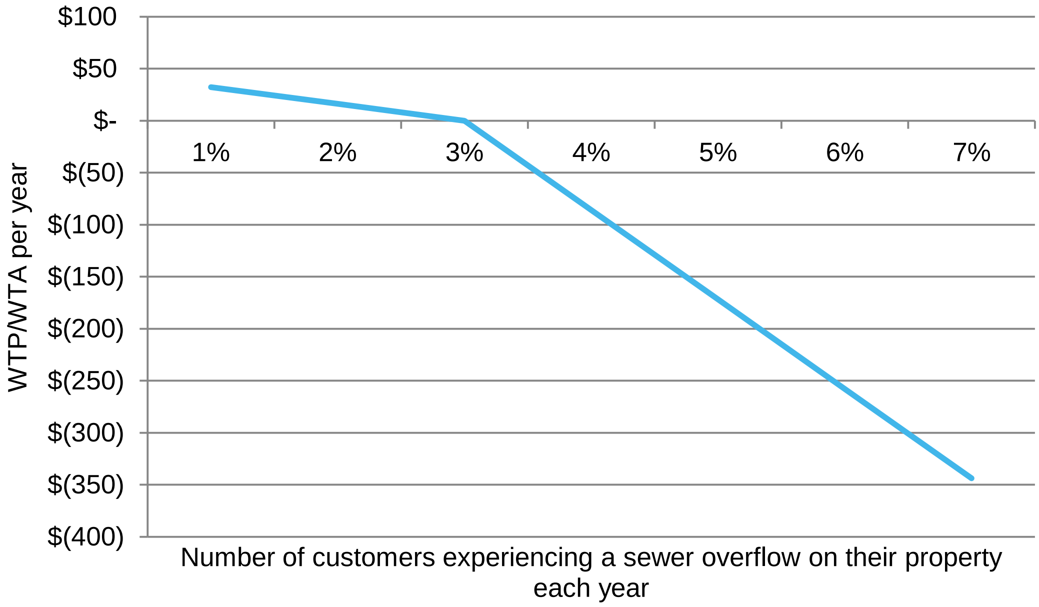


The estimates of average WTP and WTA compensation for changes in the sewerage service attributes are set out in Table 8. The asymmetry in the average value placed on service around the status quo is even more marked than in the water estimates, with WTA compensation for a service degradation estimated at five times the size of the WTP for the equivalent service improvement. This asymmetry is illustrated in Figure 11, which also demonstrates how values for changes in service levels can be calculated simply by scaling the numbers in the table. As expected, households care about the proximity of the overflow, with the value placed on avoiding overflows on the customer property around three times higher than the value placed on avoiding overflows in the street or on nearby public land.

**Table 8: Average WTP and WTA compensation for specified changes in sewerage network reliability (95 per cent confidence intervals in parentheses)**

| | Service improvement (WTP) | Service degradation (WTA) |
|---|---|---|
| One percentage point change in the number of customers experiencing a sewer overflow on their property each year | **$16.16** ($12.07, $20.24) | **-$85.97** (-$127.52, -$44.41) |
| One percentage point change in the number of customers experiencing a sewer overflow on their street or in nearby public land each year | **$5.88** ($3.43, $8.33) | **-$31.29** (-$50.30, -$12.28) |
| One hour change in the average time taken to stop an overflow and clean the affected area | **$20.83** ($14.94, $26.72) | **-$110.83** (-$166.01, -$55.65) |

**Figure 11: Average WTP/WTA compensation for various frequencies of sewer overflows relative to a baseline of 3 per cent**



## Debriefing questions

Responses to the debriefing questions showed:

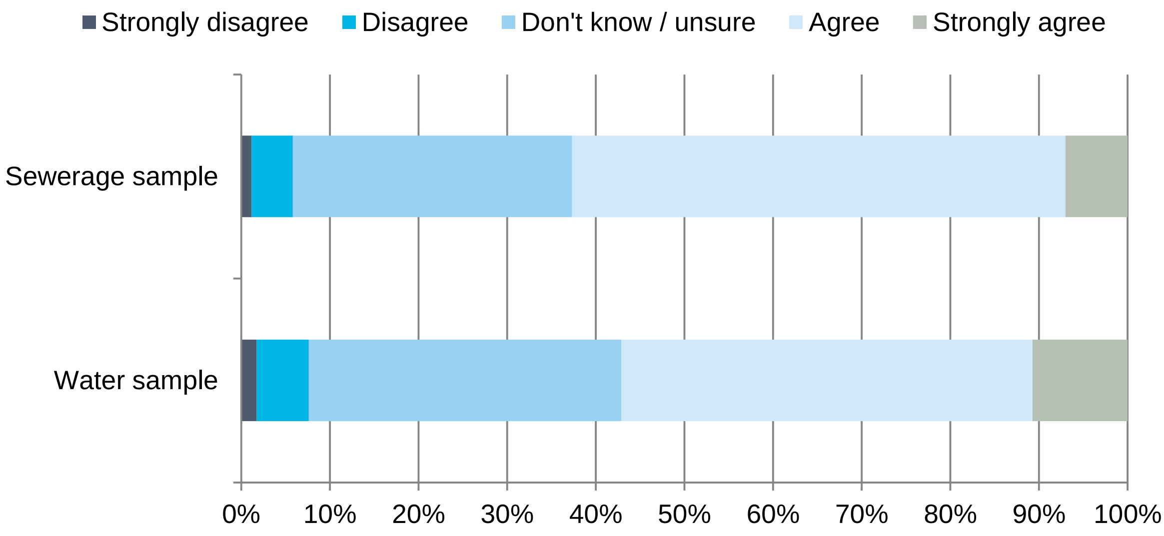
- Respondents in the samples perceived the service alternatives to be realistic.

  Only 4 per cent and 6 per cent of respondents in the water and sewerage samples indicated that they were not satisfied that the current package presented in each choice question reasonably reflected the level of service they currently receive. Around 9 per cent and 14 per cent of respondents in the two surveys indicated that they did not believe that all of the packages presented would be possible for Icon Water to deliver. However, all of these respondents indicated that they answered the question(s) as though Icon Water would be able to deliver the packages presented in the question(s), since respondents indicating otherwise were excluded from the sample, as discussed in the 'Sample of Households' section of this report.

- Respondents in the samples perceived the surveys to be consequential.

  Just 8 per cent and 6 per cent of respondents in the water and sewerage surveys indicated that they did not expect the surveys would influence the way Icon Water manages its networks (see Figure 12). This result suggests the incentive properties of the survey were strong and that strategic bias was unlikely to be present in the estimates of WTP.

**Figure 12: "I expect the results of this survey will influence the way Icon Water manages its water/sewerage network"**



# Discussion

## Asymmetry in values placed on service improvement and degradation

One of the notable features of the results of this study is that estimates of WTA compensation for degradation in service are much higher than estimates of WTP for an equivalent improvement in service. This difference should not be considered a weakness in the survey technique. Past research has found that differences between WTP and WTA are to be expected and can be explained by:

- WTA being unconstrained by income
- substitutes being very costly, which they are in the case of water and sewerage network services (Hanemann 1991)
- loss aversion (Kahnemann and Tversky 1991).

## Comparison with 2003 study

Comparisons with the 2003 study by NERA vary depending on the type of service change being considered. Overall, the results for water interruptions were similar, with the present study tending to find higher values for changes in interruption frequency and lower values for changes in interruption duration.

- NERA found that, on average, residential customers would be willing to pay $11 per annum to avoid a water interruption that occurs once every 10 years. The preference model estimated in this study suggests households would now be willing to pay around $18 per year for the same service improvement in relation to unplanned interruptions. After accounting for general price inflation between 2003 and 2016, the two estimates are very similar. Our estimate of WTA compensation for an *additional* interruption once every ten years at $35 is higher than the NERA estimate.
- NERA found that reducing outage duration from two hours to one hour is worth $36 and reducing duration from five to four hours is worth $18 to an average residential customer. These figures are higher than the equivalent estimate in this study of around $10 per year and, after taking account of inflation between 2003 and 2016, higher than our estimate of WTA compensation for a one-hour *increase* in duration of $18.

Overall, this study finds higher values placed on avoiding sewer overflows than NERA's study in 2003. The NERA model tended to find higher values for changes in overflow duration, but found considerably lower values for changes in overflow frequency.

- NERA found that residential customers were willing to pay $21 each year, on average, to avoid a sewer overflow event occurring once every ten years. A change of 10 percentage points in the number of customers experiencing overflows is outside the range of levels used in this study, however it is clear that the value placed on avoiding overflows is much higher in the present study. Similar values are derived in the present study for smaller changes in the number of overflows. For example, the values placed on reducing the number of overflows by two percentage points are $32 per year for an overflow on the customer's property and $12 for an overflow nearby.

- NERA found households were willing to pay $38 per year to reduce the duration of sewer overflow events from four hours to three hours. This estimate is higher than the equivalent value in this study of around $21 per year, but lower than our estimated WTA compensation for a one-hour *increase* in duration of $111 per year.

## Applying the results

When applying these estimates in benefit-cost analysis, we would advise the following:

- The estimates should ideally be used to value only changes in service that are within the range presented to respondents in this study (presented in Table 1 and Table 2 on pages 13 and 14 of this report). Research has shown individuals are risk averse to losses of low probability and that the value placed on changes in risk is non-linear (Tversky and Kahnemann 1992). A linear extrapolation of these results to changes in risk that are outside the range used in the study may overestimate household values.
- Analysts should be aware of the fact that these estimates represent the preferences of owner-occupiers and although respondent characteristics were not found to be statistically significant covariates with preferences, care should be taken when transferring these values to the broader population.
- The economic impacts of changes in service levels on business customers would need to be accounted for separately. Based on our experience recruiting businesses during the early part of this study and in other studies, we would advise against using a self-administered online survey approach with business customers. One option to be considered is the use of in-person interviews with one or more representatives from each business that cover both financial and operational considerations, with financial incentives to participate.

# Conclusion

This report provides estimates of the values placed by households on changes in water and sewerage network reliability for use in benefit-cost analysis or some other technique for balancing cost, risk and performance when developing Icon Water's asset management plans.

The estimates of customer preferences were derived from 3854 stated choices made by 546 Canberra households. Confidence in the estimates as meaningful measures of customer value is supported by:

- the use of best-practice survey design and estimation methods
- consistency of key findings across many model specifications
- evidence from model estimation and debriefing questions indicating respondents included in the final sample found the price-service alternatives in the survey instruments to be realistic and gave careful consideration to the relevant trade offs when stating their preferences
- consistency of results in many respects with prior expectations and the 2003 study by NERA and AC Nielsen.

The key findings in relation to customer preferences are:

- Households value avoiding and reducing the duration of sewer overflows, including sewer overflows occurring both on and near their property
- Households value avoiding and reducing the duration of water supply interruptions, except where they are planned interruptions taking place during the night
- Households value avoiding sewer overflows much more highly than they value avoiding water supply interruptions
- Households are around three times more averse to sewer overflows occurring on their property than to overflows occurring on their street or in nearby public land
- Households are around 20 per cent more averse to unplanned than planned water supply interruptions
- Households' WTP for service improvement is lower than the compensation they would require for equivalent service degradation, with this difference being particularly marked in relation to sewer overflows
- There is considerable variation in preferences across households.

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# Appendix A – Example of email invitation


## Have your say: Balancing price and service levels

As part of our focus on providing the best water services at the optimal price to the Canberra community, we are asking our customers to provide their views on how much we should spend on reducing the risk of sewage overflows.

To have your say, visit:

http://www.surveyhelp.com.au/st8/15072s4/cgi-bin/ciwweb.pl?studyname=15072s4&pw=open

The questionnaire will take around 15 minutes to complete. We are conscious of not taking up too much of your time, but we also want meaningful input from you that can inform our expenditure decisions. In order to get that input, we need to ask some in-depth questions about hypothetical service options.

Your input would be greatly appreciated. By participating you could win one of five $50 gift vouchers of your choice.

Published results will report on survey responses only in a grouped format, so that individuals' responses will not be identifiable.

We're also asking customers to sign up to be a member of our newly established 'Think Tank' which is a community reference group that we will call on from time to time to provide views and opinions on a range of issues. You can sign up to the Think Tank here.

Yours sincerely,

**John Knox**
**Managing Director**

# Appendix B – Choice models in WTP space

This appendix presents the results from panel multinomial mixed logit models estimated in WTP space. These are not the preferred models for estimating WTP/WTA in this study. They are provided as evidence that a range of state-of-the-art estimation techniques were used to understand preferences.

**Table 9: Alternative model of household choice of water reliability scenarios (WTP space)**

| | Coefficient | z-score |
|---|---|---|
| *Random parameters: means* | | |
| Alternative-specific constant (Current package =1, otherwise =0) | 17.38 | 4.73 |
| Expected time off supply due to planned supply interruptions taking place during business hours each year (Number x duration) | -307.10 | -3.76 |
| Number of customers experiencing an unplanned water supply interruption each year (%) | -300.20 | -5.98 |
| Duration of unplanned water supply interruptions (hours) | -21.79 | -7.04 |
| Permanent change in your annual Icon Water bill (dollars) x -1 | -3.59 | -32.19 |
| *Random parameters: standard deviations* | | |
| Alternative-specific constant (Current package =1, otherwise =0) | -62.94 | -13.04 |
| Expected time off supply due to planned supply interruptions taking place during business hours each year (Number x duration) | 220.32 | 3.01 |
| Number of customers experiencing an unplanned water supply interruption each year (%) | -169.25 | -2.51 |
| Duration of unplanned water supply interruptions (hours) | -19.21 | -6.10 |
| Permanent change in your annual Icon Water bill (dollars) x -1 | 0.37 | 1.74 |
| *Random parameters: cross-parameter correlations* | | |
| ASC: Planned time off supply during business hours | -126.12 | -2.12 |
| ASC: Number of unplanned supply interruptions | -5.69 | -0.14 |
| ASC: Duration of unplanned supply interruptions | 7.06 | 4.78 |
| ASC: Change in bill | 0.33 | 2.51 |
| Planned time off supply during business hours: Number of unplanned supply interruptions | 202.69 | 3.59 |
| Planned time off supply during business hours: Duration of unplanned supply interruptions | 1.91 | 1.50 |
| Planned time off supply during business hours: Change in bill | 0.82 | 5.00 |
| Number of unplanned supply interruptions: Duration of unplanned supply interruptions | -10.46 | -4.94 |
| Number of unplanned supply interruptions: Change in bill | -0.57 | -2.42 |
| Duration of unplanned supply interruptions: Change in bill | -0.95 | -4.67 |
| *Model fit* | | |
| Choice observations | 2312 | |
| Individuals | 289 | |
| Log likelihood | -1943 | |

**Table 10: Alternative model of household choice of sewerage reliability scenarios (WTP space)**

| | Coefficient | z-score |
|---|---|---|
| *Random parameters: means* | | |
| Alternative-specific constant (Current package =1, otherwise =0) | 67.53 | 4.65 |
| Number of customers experiencing a sewer overflow on their property each year (%) | -4673.04 | -9.72 |
| Number of customers experiencing a sewer overflow on their street or in nearby public land each year (%) | -1449.43 | -4.70 |
| Average time taken to stop an overflow and clean the affected area (hours) | -62.79 | -9.40 |
| Permanent change in your annual Icon Water bill (dollars) x -1 | -4.57 | -38.81 |
| *Random parameters: standard deviations* | | |
| Alternative-specific constant (Current package =1, otherwise =0) | 130.87 | 8.15 |
| Number of customers experiencing a sewer overflow on their property each year (%) | 2831.09 | 10.21 |
| Number of customers experiencing a sewer overflow on their street or in nearby public land each year (%) | 964.06 | 3.67 |
| Average time taken to stop an overflow and clean the affected area (hours) | 31.27 | 7.28 |
| Permanent change in your annual Icon Water bill (dollars) x -1 | 0.27 | 0.98 |
| *Random parameters: cross-parameter correlations* | | |
| ASC: Number of overflows on property | -2512.77 | -7.78 |
| ASC: Number of overflows near property | -316.32 | -1.21 |
| ASC: Time taken to stop overflow | -11.03 | -2.24 |
| ASC: Change in bill | -0.55 | -2.67 |
| Number of overflows on property: Number of overflows near property | 1297.20 | 5.31 |
| Number of overflows on property: Time taken to stop overflow | 29.26 | 5.22 |
| Number of overflows on property: Change in bill | 0.50 | 3.15 |
| Number of overflows near property: Time taken to stop overflow | 17.45 | 3.91 |
| Number of overflows near property: Change in bill | 0.37 | 1.77 |
| Time taken to stop overflow: Change in bill | 0.82 | 4.15 |
| *Model fit* | | |
| Choice observations | 1542 | |
| Individuals | 257 | |
| Log likelihood | -1398.37 | |