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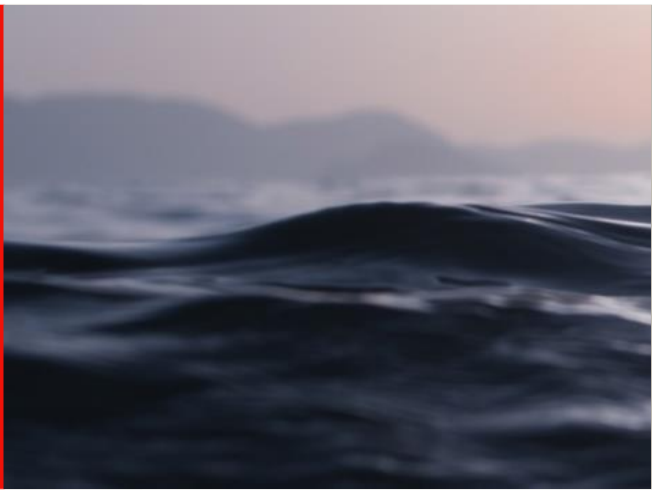
FINAL REPORT

Benefit-cost analysis of water and sewerage network management options



Prepared for
Icon Water

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THE CENTRE FOR INTERNATIONAL ECONOMICS
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Water supply interruptions and sewer overflows impose economic costs on customers, since they are inconvenient, disruptive and may impose health and safety risks. Expenditure by Icon Water on network maintenance can reduce the risk of these events occurring, but is an economic cost itself that will ultimately be borne by customers. For the purpose of developing its forecast expenditure and service levels for the 2018-2023 regulatory period, Icon Water wants to strike a balance between cost and service levels that reflects customer preferences.

This report sets out the benefit-cost analysis of a number of water and sewerage network management options with a view to identifying potential improvements in the balance between cost and service.

Water network analysis

The water network management options involve different levels of expenditure on proactive water mains renewals ranging from zero to $4 million per year. There are two main benefits from proactive renewals:

- a reduction in the number of bursts and the resulting unplanned customer supply interruptions
- a reduction in the reactive maintenance costs incurred in dealing with bursts.

This analysis uses Icon Water's research on customer willingness to pay (WTP) for changes in service levels to place a dollar value on the changes in the number of supply interruptions occurring under each option.

The present value of net benefits from each option over 20 years are set out in table 1, relative to the base case option of maintaining annual expenditure of around $2.25 million on proactive renewals. Even under upper bound assumptions about WTP and the impact of expenditure on interruptions, the results suggest that the best outcome for the community would be to cease proactive water mains renewal.

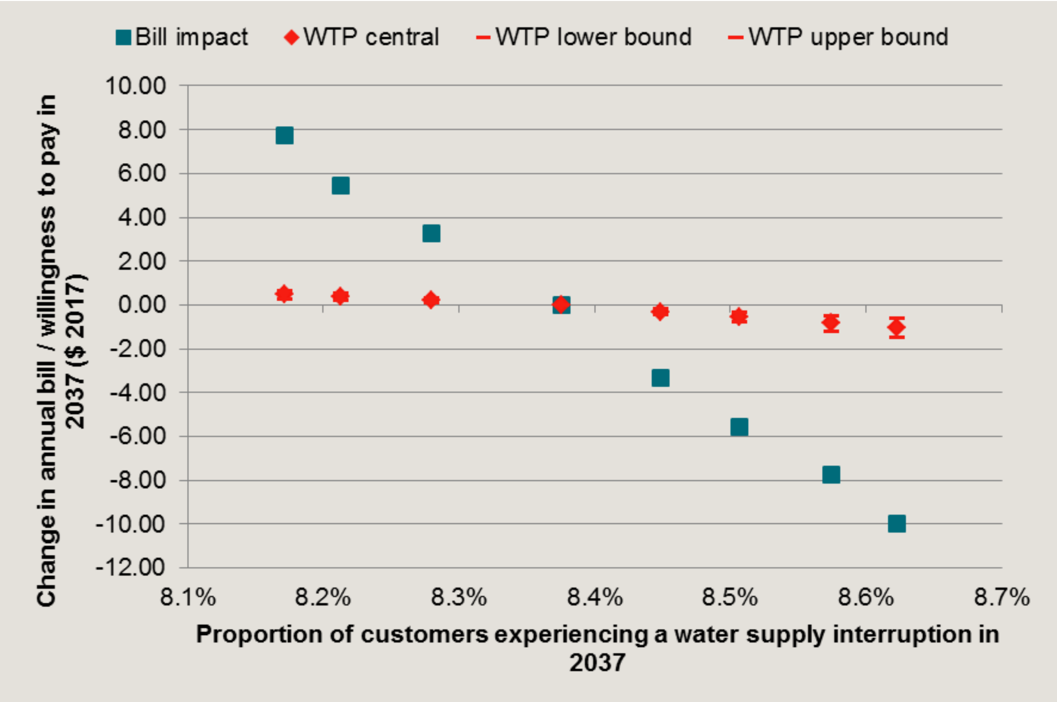
1 Present value of net benefits

Option	Central estimate	Lower bound assumptions	Upper bound assumptions
	$'000 real 2017	$'000 real 2017	$'000 real 2017
Renewal $0	22 750	23 224	21 643
Renewal $0.5m	17 656	18 036	16 768
Renewal $1m	12 683	12 933	12 099
Renewal $1.5m	7 644	7 784	7 317
Renewal $3m	-7 643	-7 761	-7 350
Renewal $3.5m	-12 724	-12 925	-12 227
Renewal $4m	-17 928	-18 180	-17 303

Source: CIE analysis

The bills and service levels experienced by customers vary over time in each of the options. Figure 2 illustrates the costs and benefits in terms of a single customer in 2037, by way of example. It shows that the bill savings from undertaking fewer renewals are significantly greater than the minimum compensation required by the customer for the consequent service degradation. The bill increases that would result from increasing renewals are significantly greater than the maximum amount customers would be willing to pay for the service improvement that would be achieved.

2 Bills and service levels for a residential customer in 2037



Note: Bill impacts based on assumption that all expenditure is treated as operating expenditure

Data source: CIE analysis

Water mains renewals are much more expensive than mains repair, with the modelling indicating that the mains renewal cost per avoided customer interruption is around $8,500 in present value terms (the present value of expenditure on the base case is around $30 million and the present value of customer interruptions avoided relative to the ‘Renewals $0’ option is around 3,500). On average, customers are not willing to incur that cost to avoid a water supply interruption.

- **This analysis clearly indicates there would be net benefits to the community from reducing expenditure on proactive water mains renewal**

This analysis has been based on system-average performance and customer value. While it clearly indicates there would be community benefits from reducing water mains renewal expenditure, it may not be efficient to cease proactive water mains renewal altogether. There may be some areas with sufficient density of customers placing a high value on water supply reliability to derive net benefits from renewal. Icon Water has also indicated there may be equity concerns associated with reducing renewal expenditure, since the increase in unplanned interruptions over time would be borne by the customers currently experiencing the highest rate of interruptions.

Sewerage network analysis

The sewerage network management options involve different levels of expenditure on proactive sewer maintenance, ranging from no proactive investment up to expenditure of more than $300 million over the next 15 years aimed at improving service levels to the national average.

The base (or status quo) alternative is maintaining a budget of around $8.6 million per year. The costs and benefits of the other alternatives are measured relative to this baseline. Other options involve either a fixed level of annual proactive expenditure (‘no proactive investment’ and ‘reduced budget cap’), a fixed level of service (‘maintain service’), or a target level of performance over time (‘decrease performance’ and ‘increase performance’). Each option contains a mix of proactive expenditure on CCTV inspection, mains cleaning, local repair (patch repair) and renewals (replacements).

There are two main benefits from expenditure on proactive sewer maintenance:

- a reduction in the number of blockages and collapses and the resulting sewage overflows
- a reduction in the reactive maintenance costs incurred in dealing with blockages and collapses.

This analysis uses Icon Water’s research on customer WTP for changes in service levels to place a dollar value on the changes in the number of sewer overflows occurring under each option.

The present value of net benefits from each option over 20 years, relative to the base case option, are set out in table 3. The main conclusion to be drawn from the analysis is that the ‘increase performance’ option would not be in the community interest. The differences between the net benefits of the remaining options are within the bounds of error in the estimates.

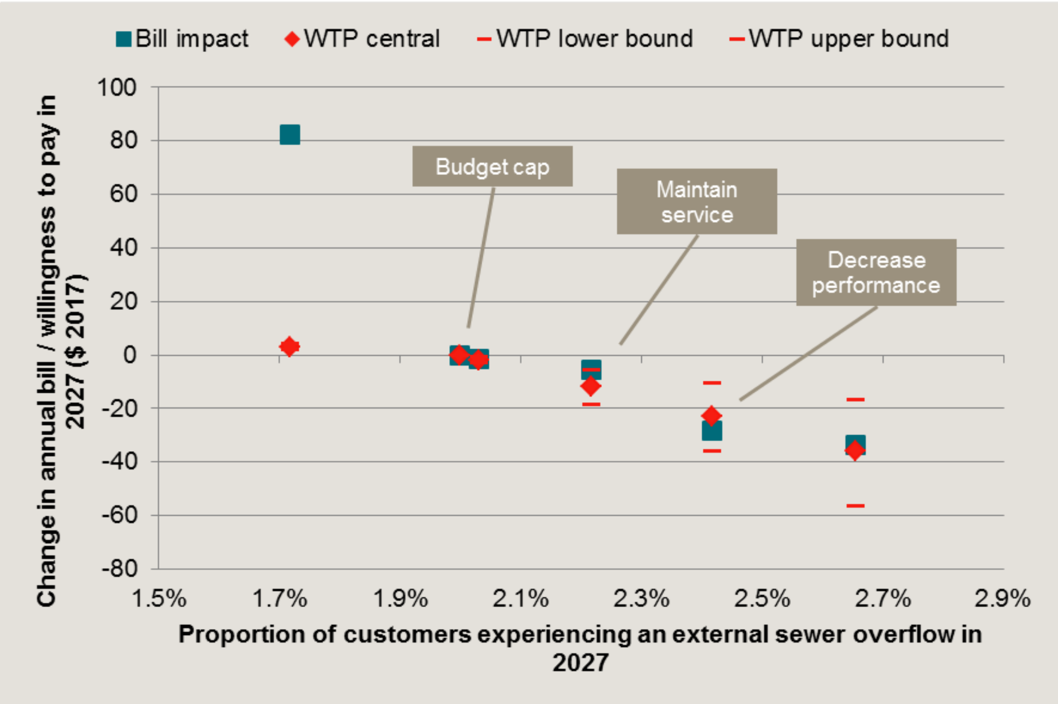
3 Present value of net benefits

Option	Central estimate	Lower bound assumptions	Upper bound assumptions
	$'000 real 2017	$'000 real 2017	$'000 real 2017
No proactive investment	26 557	70 275	-137 716
Reduced budget cap	476	2 584	-7 382
Maintain service	-6 822	5 445	-52 801
Decrease performance (SWC)	36 450	63 079	-63 361
Increase performance (Nat. average)	-163 296	-167 249	-148 857

Source: CIE analysis

The bills and service levels experienced by customers vary over time in each of the options. Figure 4 illustrates the costs and benefits in terms of a single customer in 2027, by way of example. The bill impact from the 'increase performance' option is clearly greater than the maximum amount the customer would be willing to pay for the service improvement achieved under that option. The marginal costs and marginal benefits from degrading service are quite similar. While the bill savings from the 'decrease performance' option are marginally greater than the central estimate of the minimum amount the customer would be willing to accept by way of compensation, they are within the bounds of statistical error.

4 Bills and service levels for a residential customer in 2027



Note: Bill impacts based on assumption that all expenditure is treated as operating expenditure

Data source: CIE analysis

- **There would be a significant net cost to the community from increasing expenditure on sewerage network maintenance above the existing budget cap**

- It is not clear whether the other sewerage network management options analysed would result in positive net benefits, since the results are within the bounds of statistical error
- This analysis suggests Icon Water should maintain or reduce, but not increase, its current level of expenditure on proactive sewerage maintenance

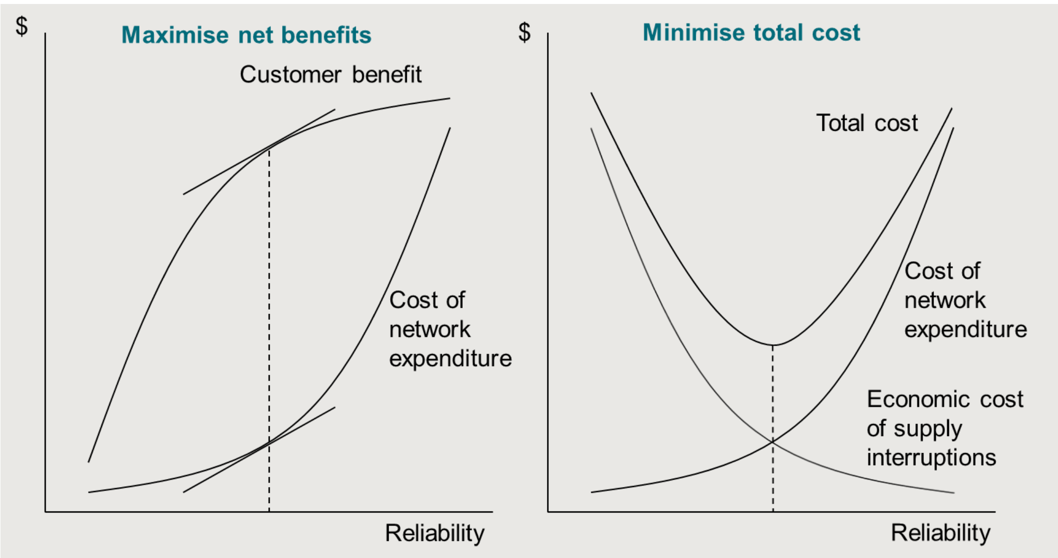
1 Introduction

The problem

Water supply interruptions and sewer overflows impose economic costs on customers, since they are inconvenient, disruptive and may impose health and safety risks. Expenditure by Icon Water on network maintenance can reduce the risk of these events occurring, but is an economic cost itself that will ultimately be borne by customers. For the purpose of developing its forecast expenditure and service levels for the 2018-2023 regulatory period, Icon Water wants to strike a balance between cost and service levels that reflects customer preferences.

This balance is illustrated in figure 1.1. The cost of incremental improvements in network reliability increase with reliability, since the most cost-effective investments will be undertaken first and successive improvements become more costly to achieve. There are two ways of thinking about striking the right balance. The first is to maximise net benefits – that is, the difference between the benefits of reliability and the costs. Where cost and benefit curves are smooth, this maximisation occurs where the marginal cost of improving reliability equals the marginal benefit – so that the slopes of the two lines in the left-hand panel of the figure below are equal. The second way to think about striking the right balance is to minimise social costs – that is, to minimise the sum of network expenditure and the economic cost of supply interruptions/overflows. The outcome of the two approaches is the same, since the incremental economic cost of supply interruptions in the right-hand panel is simply the negative of the incremental customer benefits in the left-hand panel.

1.1 Balancing cost and service



Approach

This report sets out the benefit-cost analysis of a number of water and sewerage network management options with a view to identifying potential improvements in the balance described above. For each of the water and sewerage networks, it follows good practice in economic benefit-cost analysis by:

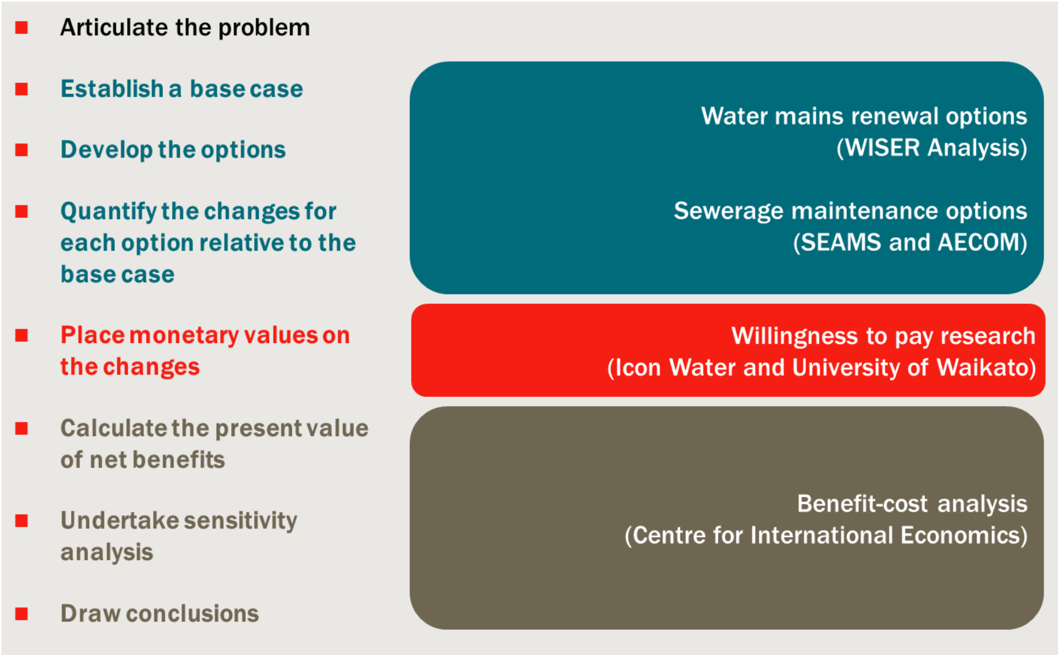
- Articulating the problem
- Establishing a base case
- Developing the options
- Quantifying the changes for each option relative to the base case
- Placing monetary values on the changes
- Calculating the present value of net benefits
- Undertaking sensitivity analysis
- Drawing conclusions.

It brings together the results of three separate major pieces of analysis recently undertaken by Icon Water for this purpose. These analyses and the information they contributed to this report are set out in table 1.2. The roles that each study played in the steps outlined above are illustrated in figure 1.3.

1.2 Sources of information

Topic	Information	Source
Water network management options	Proactive costs Reactive costs Supply interruptions	WISER Analysis 2017. *Investment planning for water reticulation pipes in Icon Water*. Report to Icon Water, January
Sewerage network management options	Proactive costs Reactive costs Internal overflows External overflows	SEAMS 2017. *Scenario summaries*. Data reported to Icon Water, 24 February
Residential customer benefits / economic cost of interruptions/overflows	Value of avoiding unplanned water supply interruptions Value of avoiding external sewer overflows on customer property Value of avoiding external sewer overflows on street or nearby public land	Icon Water and University of Waikato 2016. *Willingness to pay: customer preferences for balancing cost with risks of water supply interruptions and sewer overflows*.
Non-residential customer benefits / economic cost of interruptions/overflows	Value of avoiding water supply interruptions Value of avoiding sewer overflows	NERA and AC Nielsen 2003. *Willingness to pay research study*. A Report for ACTEW Corporation and ActewAGL, September.

1.3 Roles of information sources in benefit-cost analysis approach



Data source: CIE

2 Water network analysis

The base and alternative options

The analysis considers eight water investment options, drawn from the work conducted by WISER Analysis using the Pipeline Asset and Risk Management System (PARMS) modelling system. Each corresponds to a different level of expenditure on proactive water mains renewals, ranging from no renewals up to $4 million expenditure per year (see table 2.1). The lengths of mains renewed under each option range from zero to several kilometres per year.

The zero-cost option involved no proactive renewal. This option is not significantly different from a policy of asset renewal following three failures in a 12-month period, which would trigger only around $100,000 in renewal expenditure per year. The $0.5 million and $1 million options were based on a renewal policy of two failures in a 12-month period, with 100 metres of replacement per renewal. The $1.5 million and $2.25 million options increased the target replacement per renewal to 150 metres and 200-250 metres, respectively. The $3 million and $3.5 million options involved applying a two-interruption policy (more frequent than a two-failure policy) to a problem cohort of cast iron pipes installed between 1965 and 1977. The $4 million option increased the target replacement per renewal to 300 metres, limited by the length in the shut-off block.

The base (or status quo) alternative is expenditure on water mains renewals of $2.25 million per year. This is the option that would maintain the number of water supply interruptions at its current level. The costs and benefits of the other alternatives will be measured relative to this baseline.

2.1 Water mains renewal options

Option label	Annual expenditure on proactive water mains renewal
	$'000 real 2017
Renewal $0	0
Renewal $0.5m	500
Renewal $1m	1 000
Renewal $1.5m	1 500
Renewal $2.25m (baseline)	2 250
Renewal $3m	3 000
Renewal $3.5m	3 500
Renewal $4m	4 000

Source: WISER Analysis 2017. Investment planning for water reticulation pipes in Icon Water. Report to Icon Water, January

We assume for the purpose of this analysis that any real cost escalation will be offset by productivity improvement. The annual expenditure on renewals over the forecast period is therefore constant in real terms in each option.

For further detail on the activities undertaken in each option, see the WISER Analysis report.

Changes from each option

There are two main impacts from expenditure on water mains renewals:

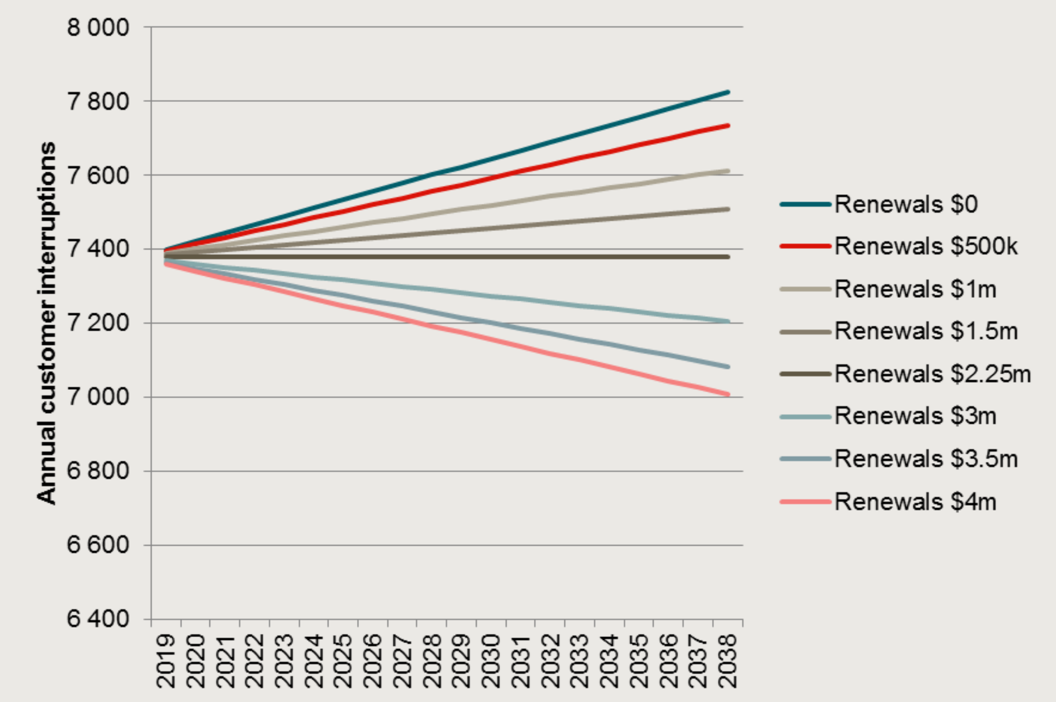
- a reduction in the number of bursts and the resulting unplanned customer supply interruptions
- a reduction in the reactive maintenance costs incurred in dealing with bursts.

When the annual expenditure on mains renewals is increased, these two benefits increase gradually over time, as shown in figures 2.2 and 2.3. The sensitivity of results to these estimates is tested later in the report (see page 18).

2.2 Estimated impact of water mains renewal on operating costs

Data source: WISER Analysis 2017. *Investment planning for water reticulation pipes in Icon Water*. Report to Icon Water, January

2.3 Estimated impact of water mains renewal on unplanned customer supply interruptions



Note: This chart shows the supply interruptions caused only by mains failures (and not interruptions caused by hydrant, valve or maincock failures)

Data source: WISER Analysis 2017. *Investment planning for water reticulation pipes in Icon Water*. Report to Icon Water, January

Valuing the changes

In contrast to the benefit of reduced operating costs, the benefit of reduced customer supply interruptions is not readily expressed in dollar terms. The value placed by customers on this benefit is the maximum amount they would be willing to pay to obtain it. We cannot readily observe this value in a market, since customers cannot choose their level of network reliability. We therefore estimate these benefits using Icon Water's stated preference research on customer willingness to pay (WTP). This research used a choice modelling survey to estimate consumer WTP or willingness to accept (WTA) compensation for changes in the number and nature of water supply interruptions.

The values used in the benefit-cost analysis are set out in table 2.4. These amounts are increased over the forecast period by one per cent per annum, which is equal to the ACT Treasury forecast real increase in wage price index.[1]

Residential values are drawn from the 2016 study conducted by Icon Water in partnership with University of Waikato. Non-residential values are based on the 2003 study conducted by NERA and AC Nielsen and inflated in line with the consumer price index. The lower and upper bounds are used to test sensitivity of results later in this

1 ACT Treasury 2015-16 Budget Review and ACT Treasury 2016-17 Budget Outlook both forecast wage price index growth at 3.5 per cent and consumer price index growth at 2.5 per cent.

report. The bounds for the residential estimates are set at the 95 per cent confidence intervals on the estimates of WTP reported by Icon Water and University of Waikato. The bounds on the non-residential estimates are set proportionately to the residential bounds, since the NERA and AC Nielsen study did not report confidence intervals, but had a similar sample size.

2.4 Values placed on changes in the number of water supply interruptions

	Central	Lower bound	Upper bound
	$ (real 2017) per customer per year	$ (real 2017) per customer per year	$ (real 2017) per customer per year
Residential WTP for 100 basis point decrease in interruption risk	1.85	1.05	2.65
Residential WTA compensation for 100 basis point increase in interruption risk	3.49	2.07	4.91
Non-residential WTP to avoid one interruption	286.39	167.33	405.45

Source: Icon Water and University of Waikato 2016. Willingness to pay: customer preferences for balancing cost with risks of water supply interruptions and sewer overflows. NERA and AC Nielsen 2003. Willingness to pay research study. A Report for ACTEW Corporation and ActewAGL, September. CIE analysis.

The 2016 WTP estimates are measured in terms of changes in the probability of interruptions. By way of example, the central estimate of $1.85 is the amount a customer is willing to pay each year, on average, for a decrease in the proportion of customers experiencing a water supply interruption each year (or equivalently the system average number of interruptions per customer per year) from 4.3 per cent to 3.3 per cent. The study found that customers' willingness to accept (WTA) compensation for an increase in interruptions was around double customers' WTP for a decrease in interruptions.

The residential estimates were based on the stated preferences of only owner-occupier households, since those households are directly affected by changes in both service and price. This meant that older, better-educated individuals, with higher income, were over-represented in the sample relative to the Canberra population. The study found no statistically significant relationship between these characteristics and WTP, but some relationship at least with income would be expected in a larger sample. The WTP estimates could therefore be slightly higher than the true population average. We consider this matter when drawing conclusions.

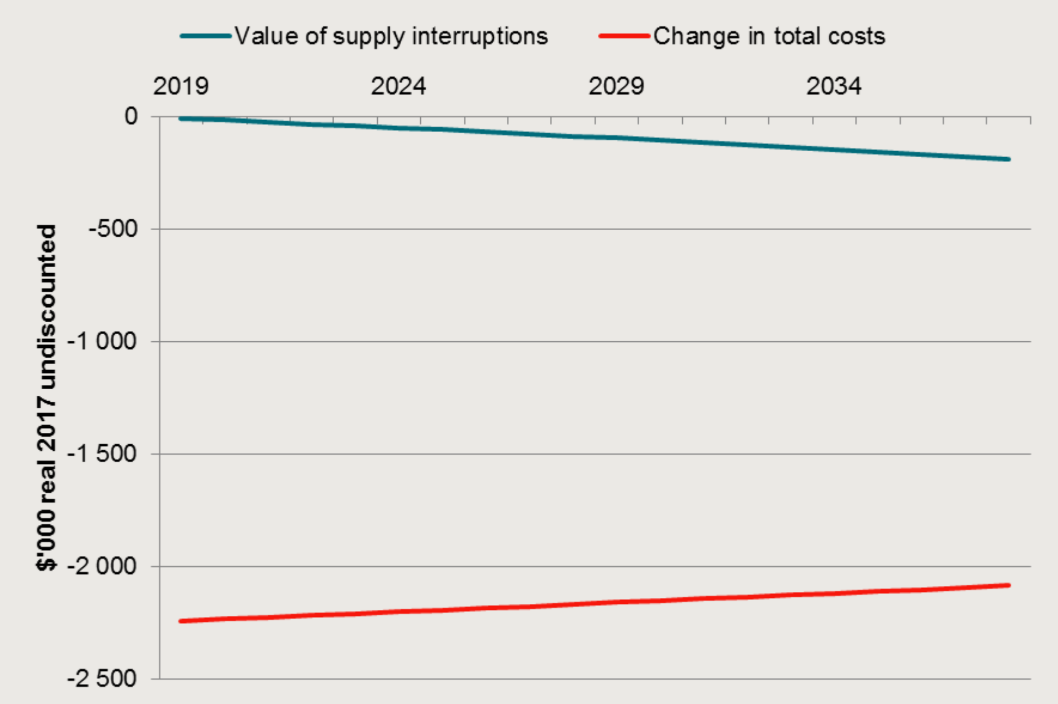
For further detail on the method used to derive these estimates, see the research reports by Icon Water/University of Waikato and NERA/AC Nielsen.

Present value of net benefits

The benefit-cost analysis compares the costs and benefits of each option over a period of 20 years. Costs and benefits occurring in the near future are valued more highly than those occurring further in the future in recognition of the opportunity cost of funds. The rate at which real costs and benefits are discounted to present values is 6 per cent per annum.

Figure 2.5 illustrates the costs and benefits over time for a single option – the 'Renewals $0' option – relative to the baseline option (Renewals $2.25m). It shows that the cost savings to consumers from reduced spending on renewals outweigh consumers' WTA compensation for the degraded service by a significant margin in every year of the next 20 years.

2.5 Costs and benefits of no proactive mains renewal relative to base case over time



Data source: CIE analysis

The present value of net benefits of each option are set out in table 2.6. This analysis, based on central estimates, indicates that the best outcome for the community would be to cease proactive mains renewal and spend slightly more on repair as failure rates increase over time. However, it is important to note the analysis assumes constant WTP across avoided interruptions. After accounting for geographical variation in preferences, for example due to a concentration of commercial customers, there may be net benefits from renewal in specific parts of the network on a much smaller scale to the base case.

2.6 Present value of net benefits relative to the base case

Option	Discounted net benefit
	$'000 real 2017
Renewal $0m	22 750
Renewal $0.5m	17 656
Renewal $1m	12 683
Renewal $1.5m	7 644
Renewal $3m	-7 643
Renewal $3.5m	-12 724
Renewal $4m	-17 928

Source: CIE analysis

Sensitivity analysis

The estimates of WTP are based on a survey completed by a subset of the population. If another subset of similar size were drawn from the population, the estimates of WTP may differ from those derived from the first subset. This sampling uncertainty is reflected in the lower and upper bounds on the estimates of customer values set out in table 2.4 on page 16.

Icon Water has advised that the modelling of the impact on interruptions from specified expenditure levels is based on the reasonably reliable performance of the network over recent years. The results may vary with weather conditions. In particular, prolonged dry periods cause tree root incursion and cause Canberra's clay soils to contract, and afterwards expand, causing damage to pipes. To test sensitivity to different assumptions about the marginal cost of network reliability, we set a lower bound on the impact of expenditure on interruptions at 11 per cent below the central estimates and an upper bound at 40 per cent above the central estimates. These figures are equal to the differences between the average frequency of unplanned interruptions over the past three years and the second highest and second lowest levels of unplanned interruptions observed over the past seven years.

The impact of adopting the lower and upper bound assumptions for both WTP and expenditure effectiveness on the discounted net benefits is shown in table 2.7. It shows the changes in net benefits are relatively minor and do not change the rank order of the options.

2.7 Sensitivity of discounted net benefits

Option	Lower bound assumptions	Upper bound assumptions
	$'000 2017	$'000 2017
Renewal $0m	23 224	21 643
Renewal $0.5m	18 036	16 768
Renewal $1m	12 933	12 099
Renewal $1.5m	7 784	7 317
Renewal $3m	-7 761	-7 350
Renewal $3.5m	-12 925	-12 227
Renewal $4m	-18 180	-17 303

Source: CIE analysis

The analysis does not take account of the fact that proactive renewals would result in short planned supply interruptions of around 15 minutes for some customers while they are being connected to and disconnected from temporary supply. Incorporating customer WTP to avoid these interruptions into the analysis would further increase the net cost of undertaking renewals and would therefore not change the conclusions drawn.

Similarly, reducing the WTP estimates in order to account for any assumption that renters place a lower value on reliability than the owner-occupiers whose stated preferences were used to derive the estimates would only serve to reduce the benefits of undertaking mains renewal.

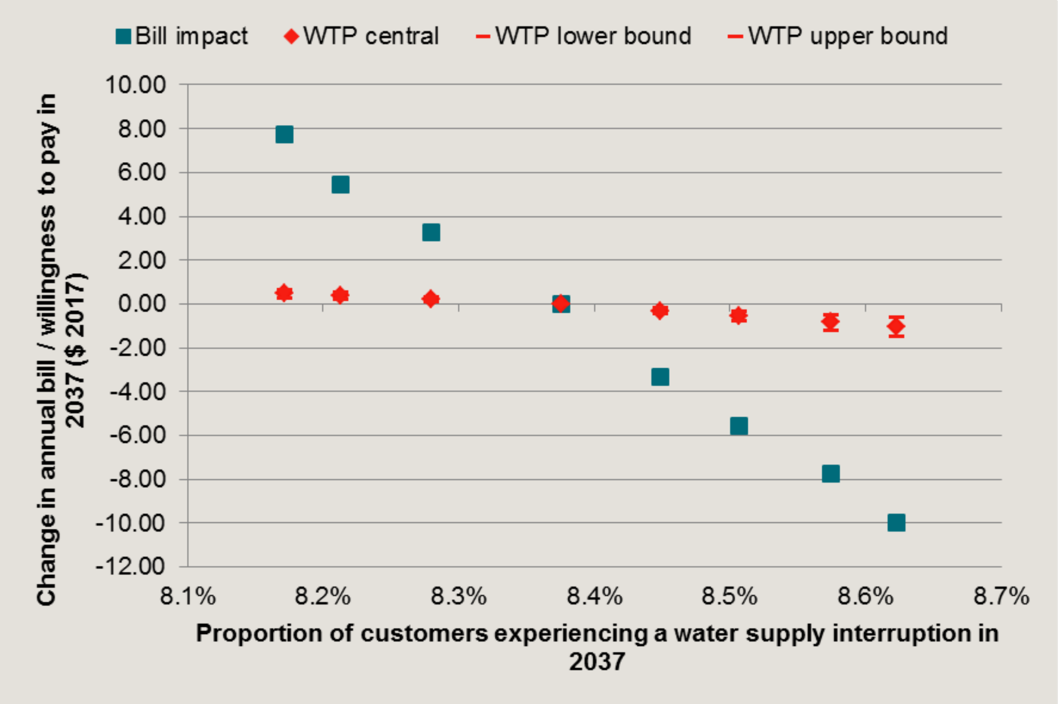
Customer impact

The bills and service levels experienced by customers vary over time in each of the options. Figure 2.8 illustrates the costs and benefits in terms of a single customer in 2037, by way of example. For the purpose of illustrating the trade-off customers are faced with, we base the bill impacts on an assumption that all costs are treated as operating costs. In practice, some costs may be treated as capital costs and recovered over several decades, with a return on capital charged on any unrecovered amounts such that the recovery is equal to the operating cost treatment in present value terms. Viewing bill impacts in a single year based on a capital cost treatment can be misleading as it obscures the link between costs and bills. In particular, it obscures the fact that the customer is locked into paying higher bills over many future years regardless of the expenditure in those years.

The figure clearly shows that the cost savings from undertaking fewer renewals are significantly greater than the minimum compensation required by the customer for the consequent service degradation. The bill increases that would result from increasing renewals are significantly greater than the maximum amount customers would be willing to pay for the service improvement that would be achieved.

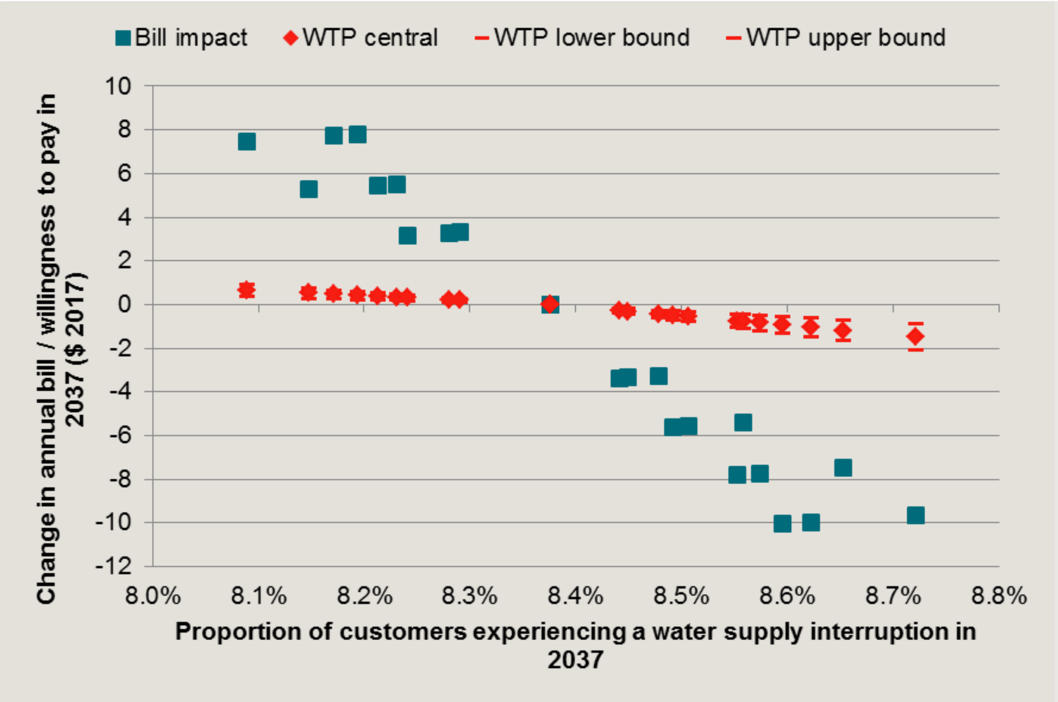
This conclusion holds even at the upper bounds of WTP and the effectiveness of expenditure at reducing interruptions. Figure 2.9 illustrates the same customer trade-off between cost and service, with the addition of the upper and lower bound assumptions for the impact of bill changes on interruption rates.

2.8 Bills and service levels for a residential customer in 2037



Data source: CIE analysis

2.9 Bills and service levels for a residential customer in 2037 incl. cost sensitivity



Data source: CIE analysis

Conclusion

- **This analysis clearly indicates there would be net benefits to the community from reducing expenditure on proactive water mains renewal**

Water mains renewals are much more expensive than mains repair, with the modelling indicating that the mains renewal cost per avoided customer interruption is around $8,500 in present value terms (the present value of expenditure on the base case is around $30 million and the present value of customer interruptions avoided relative to the 'Renewals $0' option is around 3,500). On average, customers are not willing to incur that cost to avoid a water supply interruption.

This analysis has been based on system-average performance and customer value. While it clearly indicates there would be community benefits from reducing water mains renewal expenditure, it may not be efficient to cease proactive water mains renewal altogether. There may be some areas with sufficient density of customers placing a high value on water supply reliability to derive net benefits from renewal. Icon Water has also indicated there may be equity concerns associated with reducing renewal expenditure, since the increase in unplanned interruptions over time would be borne by the customers currently experiencing the highest rate of interruptions.

3 Sewerage network analysis

The base and alternative options

The analysis considers six sewerage investment options, drawn from the work conducted by SEAMS. Each corresponds to a different level of expenditure on proactive sewer maintenance, ranging from no proactive investment up to expenditure of more than $300 million over the next 15 years aimed at improving service levels to the national average (see table 3.1).

The base option is maintaining a budget of around $8.6 million per year spent on CCTV, cleaning, local repair and renewals (the 'budget cap' option). The costs and benefits of the other options are measured relative to this baseline.

The alternative options are:

- no proactive investment
- reduced budget cap, which involves a 10 per cent reduction in expenditure on CCTV, cleaning and local repair relative to the budget cap option
- maintain service, which involves spending below the budget cap option early in the 20-year period and above the budget cap later in the period
- decrease performance, which involved undertaking only CCTV and cleaning to allow failure rates to deteriorate to Sydney Water's level by 2037
- improve performance, which involved undertaking significant expenditure, particularly on renewal, to improve failure rates to the national average by 2037.

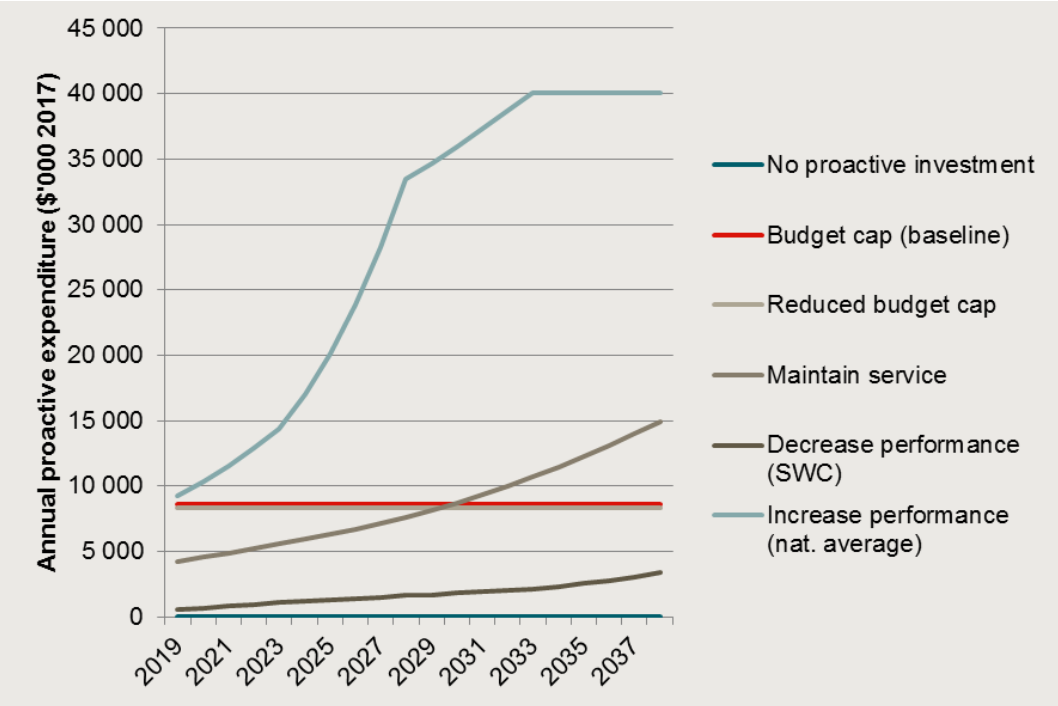
3.1 Sewerage proactive investment options

Option label	Proactive expenditure over 20 years	Activities
	$'000 real 2017	
No proactive investment	0	N/A
Budget cap (baseline)	172 825	CCTV, cleaning, local repair and renewals
Reduced budget cap	165 943	CCTV, cleaning, local repair and renewals
Maintain service	170 822	CCTV, cleaning, local repair and renewals
Decrease performance (SWC)	34 778	CCTV and cleaning
Increase performance (Nat. average)	568 104	CCTV, cleaning, local repair and renewals

Source: SEAMS 2017. *Scenario summaries*. Data reported to Icon Water, 24 February. CIE analysis.

The profiles of expenditure over time for each option are shown in figure 3.2. We assume for the purpose of this analysis that any real cost escalation will be offset by productivity improvement.

3.2 Proactive expenditure over time by option



Data source: SEAMS 2017. *Scenario summaries*. Data reported to Icon Water, 24 February. *Some of the figures towards the end of the 20-period for the 'increase performance' and 'maintain service' options were based on Icon Water advice.* CIE analysis.

For further detail on the activities undertaken in each option, including the length of mains subject to each activity over time, see the SEAMS report.

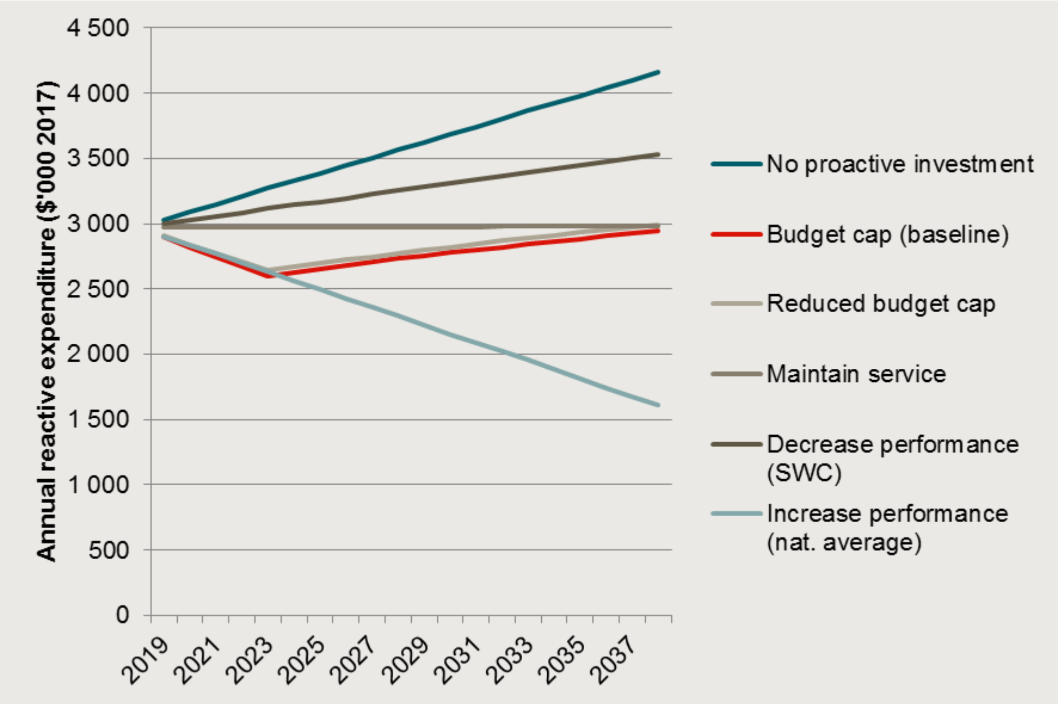
Changes from each option

There are two main benefits from expenditure on proactive sewer maintenance:

- a reduction in the number of blockages and collapses and the resulting sewage overflows
- a reduction in the reactive maintenance costs incurred in dealing with blockages and collapses.

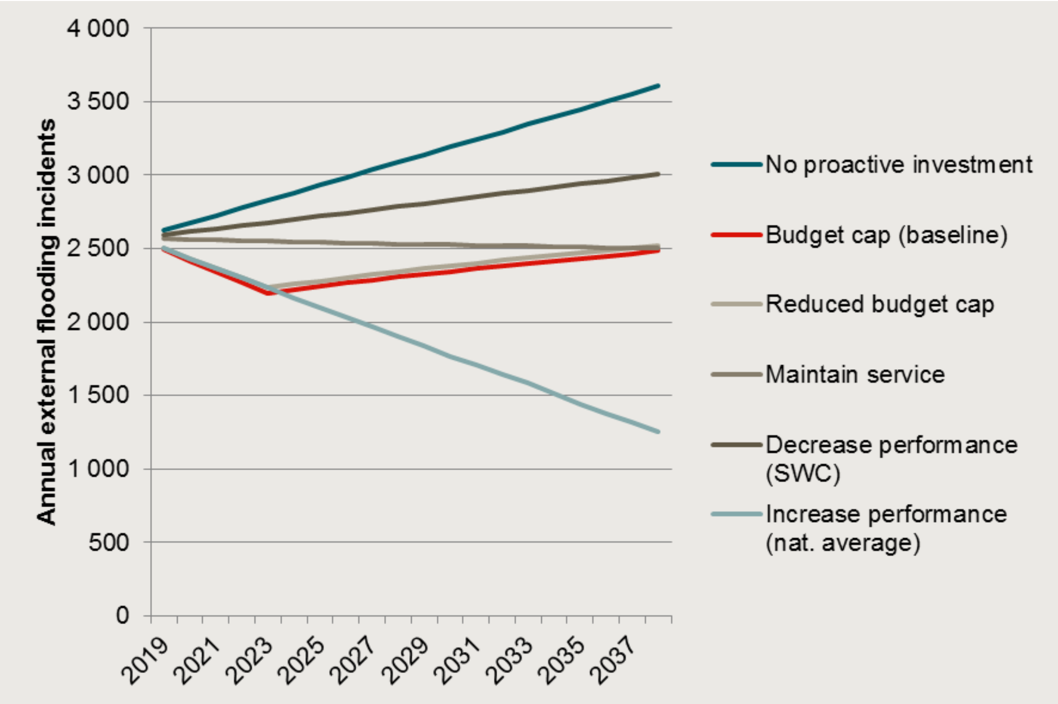
When the annual expenditure on mains renewals is increased, these two benefits increase gradually over time, as shown in figures 3.3 and 3.4. Figure 3.4 shows the impact on external overflows; that is, overflows from manholes or overflow relief gullies. In addition there is a proportionate impact on the number of internal overflows, which, by 2038, range from 14 to 34 per year across the options. The sensitivity of results to these estimates is tested later in the report (see page 28).

3.3 Estimated impact of proactive sewer maintenance on operating costs



Data source: SEAMS 2017. *Scenario summaries*. Data reported to Icon Water, 24 February. CIE analysis.

3.4 Estimated impact of proactive sewer maintenance on overflows



Data source: SEAMS 2017. *Scenario summaries*. Data reported to Icon Water, 24 February. CIE analysis.

We assume that around half of the external overflow incidents take place on customer properties, for example, from overflow relief gullies, and half take place from manholes on the street or in public land.

Valuing the changes

In contrast to the benefit of reduced operating costs, the benefit of reduced customer sewage overflows is not readily expressed in dollar terms. The value placed by customers on this benefit is the maximum amount they would be willing to pay to obtain it. We cannot readily observe this value in a market, since customers cannot choose their level of network reliability. We therefore estimate these benefits using Icon Water's stated preference research on customer willingness to pay (WTP). This research used a choice modelling survey to estimate consumer WTP or willingness to accept (WTA) compensation for changes in the number and nature of sewer overflows

The values used in the benefit-cost analysis are set out in table 3.5. These amounts are increased over the forecast period by one per cent per annum, which is equal to the ACT Treasury forecast real increase in wage price index.[2]

Values are disaggregated across:

- Type of overflow – internal, external on property or external in street
- Type of customer – residential or non-residential
- Type of change – improvement or degradation (for residential customers only).

The value placed on avoiding internal overflows was not estimated directly in the WTP research. We base our estimates on the costs incurred by Icon Water when compensating customers for internal overflows. These costs range from $400 for cleaning a wet area (e.g. bathroom) to the typical insurance excess of $25 000 or more for replacement of carpets and porous surfaces in multiple rooms.[3] We use a central estimate of $2 000 per internal overflow. While there is significant uncertainty over this value, it has little impact on the overall net benefit result because there are so few internal overflows under any of the options.

Residential values placed on avoiding external overflows are drawn from the 2016 study conducted by Icon Water in partnership with University of Waikato. Non-residential values are based on the 2003 study conducted by NERA and AC Nielsen and inflated in line with the consumer price index. The lower and upper bounds are used to test sensitivity of results later in this report. The bounds for the residential estimates are set at the 95 per cent confidence intervals on the estimates of WTP. The bounds on the non-residential estimates are set proportionately to the residential bounds, since the NERA and AC Nielsen study did not report confidence intervals, but used a similar sample size.

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2 ACT Treasury 2015-16 Budget Review and ACT Treasury 2016-17 Budget Outlook both forecast wage price index growth at 3.5 per cent and consumer price index growth at 2.5 per cent.

3 Ellen Green, Senior Stakeholder Relations Officer, Business Services Group, Icon Water, 2017. pers. comm. 7 March.

3.5 Values placed on changes in the number of sewer overflows

	Central	Lower bound	Upper bound
	$ (real 2017) per customer per year	$ (real 2017) per customer per year	$ (real 2017) per customer per year
Average WTP to avoid an internal overflow	2 000	400	25 000
Residential WTP for 100 basis point decrease in risk of external overflows on their property	16.16	12.07	20.24
Residential WTP for 100 basis point decrease in risk of external overflows in their street	5.88	3.43	8.33
Residential WTA compensation for 100 basis point increase in risk of external overflows on their property	85.97	44.41	127.52
Residential WTA compensation for 100 basis point increase in risk of external overflows in their street	31.29	12.28	50.30
Non-residential WTP to avoid an additional overflow per year	2 794	1 448	4 140

Source: Icon Water and University of Waikato 2016. Willingness to pay: customer preferences for balancing cost with risks of water supply interruptions and sewer overflows. NERA and AC Nielsen 2003. Willingness to pay research study. A Report for ACTEW Corporation and ActewAGL, September. CIE analysis.

The residential WTP estimates are measured in terms of changes in the probability of overflows. By way of example, the central estimate of $16.16 is the amount a customer is willing to pay each year, on average, for a decrease in the proportion of customers experiencing an overflow on their property each year (or equivalently the system average number of on-property overflows per customer per year) from, say, 2 per cent to 1 per cent. The study found that customers' WTA compensation for an increase in overflows was around five times greater than customers' WTP for a decrease in overflows.

The residential estimates were based on the stated preferences of only owner-occupier households, since those households are directly affected by changes in both service and price. This meant that older, better-educated individuals, with higher income, were over-represented in the sample relative to the Canberra population. The study found no statistically significant relationship between these characteristics and WTP, but some relationship at least with income would be expected in a larger sample. The WTP estimates could therefore be slightly higher than the true population average. We consider this matter when drawing conclusions.

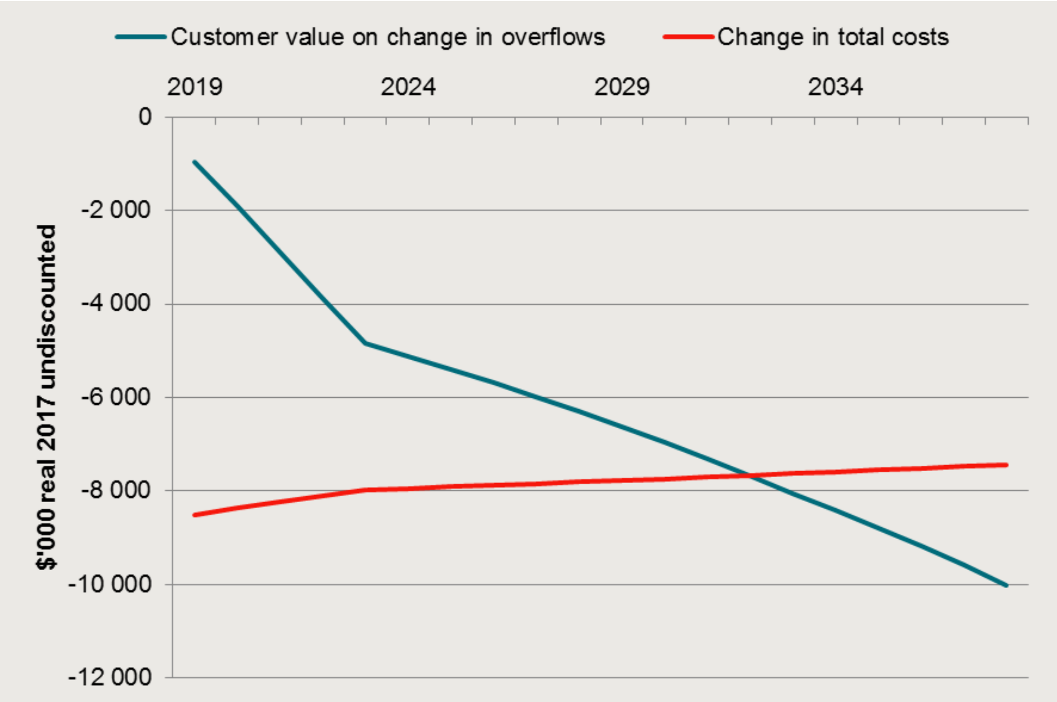
For further detail on the derivation of residential values, see the WTP research report by Icon Water and University of Waikato.

Present value of net benefits

The benefit-cost analysis compares the costs and benefits of each option over a period of 20 years. Costs and benefits occurring in the near future are valued more highly than those occurring further in the future in recognition of the opportunity cost of funds. The rate at which real costs and benefits are discounted to present values is 6 per cent per annum.

Figure 3.6 illustrates the costs and benefits over time for a single option – the 'no proactive investment' option – relative to the baseline option ('Budget cap'). It shows that the benefit of reduced spending outweighs the cost of increased sewer overflow rates in the early years of the period in question. However, as overflow rates worsen and reactive operating costs increase over time, net benefits become negative beyond 2030.

3.6 Costs and benefits of no proactive sewer maintenance relative to base over time



Data source: CIE analysis

The present value of net benefits of each option are set out in table 3.7. This analysis, based on central estimates, indicates that the best outcome for the community would be to decrease spending and allow performance to deteriorate to Sydney Water levels. However, sensitivity analysis is required to test the robustness of this result. Furthermore, there may be specific parts of the network where a higher level of reliability may be warranted due to a concentration of high-valuing customers, critical social infrastructure or environmental risks. Clearly, the least favoured option is the 'increase performance' option, which would result in a large net cost to the community.

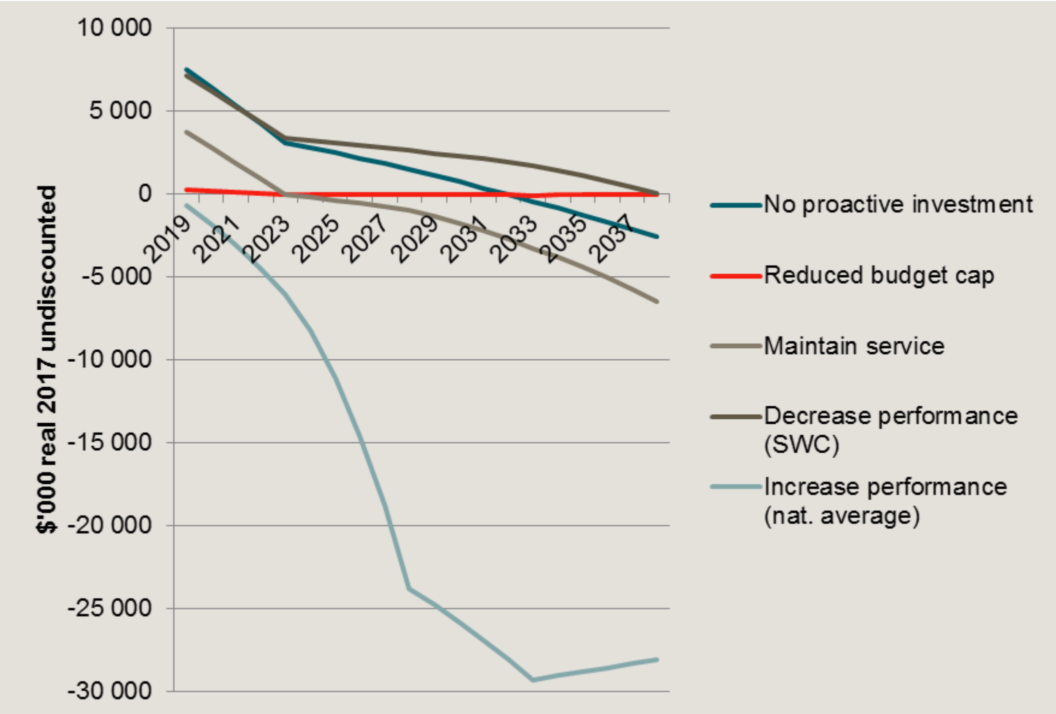
3.7 Present value of net benefits relative to base case

Option	Discounted net benefit
	$'000 real 2017
No proactive investment	26 557
Reduced budget cap	476
Maintain service	-6 822
Decrease performance (SWC)	36 450
Increase performance (Nat. average)	-163 296

Source: CIE analysis

The net benefits over time for each option are shown in figure 3.8. It indicates that the ‘increase performance’ option would impose a net cost on the community in every year. Options that involve reduced expenditure deliver initial net benefits before imposing net costs in later years.

3.8 Net benefits relative to base case over time



Data source: CIE analysis

Sensitivity analysis

The estimates of WTP are based on a survey completed by a subset of the population. If another subset of similar size were drawn from the population, the estimates of WTP may differ from those derived from the first subset. This sampling uncertainty is reflected in the lower and upper bounds on the estimates of customer values set out in table 3.5 on page 26.

Another parameter over which there is significant uncertainty is the number of customers affected by an overflow incident occurring in the street or on nearby public land. This number will vary from one overflow to the next depending on its location and proximity to stormwater drains. It also depends on respondent perceptions in the choice modelling survey of the maximum distance an overflow could be away from their property while still qualifying as “an overflow in their street or on nearby public land”. We analyse lower and upper bounds of one and five customers affected per overflow (relative to a central estimate of two customers per overflow).

Icon Water has advised that the modelling of the impact on overflows from specified expenditure levels is based on the reasonably reliable performance of the network over recent years. The results may vary with weather conditions. In particular, prolonged dry periods cause tree root incursion and cause Canberra’s clay soils to contract, and afterwards expand, resulting in pipe damage. To test sensitivity to different assumptions about the marginal cost of network reliability, we set a lower bound on the impact of expenditure on overflows at 23 per cent below the central estimates and an upper bound at 44 per cent above the central estimates. These figures are equal to the differences between the average frequency of sewer mains breaks and chokes over the past three years and the second highest and second lowest levels of breaks and chokes observed over the past seven years.

The impact of adopting the lower and upper bound assumptions for WTP, the number of customers affected by a street overflow and expenditure effectiveness on the discounted net benefits is shown in table 3.9.

3.9 Sensitivity of discounted net benefits

Option	Lower bound assumptions	Upper bound assumptions
	$’000 real 2017	$’000 real 2017
No proactive investment	70 275	-137 716
Reduced budget cap	2 584	-7 382
Maintain service	5 445	-52 801
Decrease performance (SWC)	63 079	-63 361
Increase performance (Nat. average)	-167 249	-148 857

Source: CIE analysis

It shows that, under the upper bound assumptions, no option performs better than the base case ‘budget cap’ option. This outcome holds even if the sensitivity analysis is limited only to WTP and the number of customers affected by a street overflow (and not expenditure effectiveness). It confirms that the main conclusion to be drawn from the analysis is that the ‘increase performance’ option would not be in the community interest. The differences between the net benefits of the remaining options are within the bounds of error in the WTP estimates (and even more so once bounds on expenditure effectiveness are considered).

Reducing the WTP estimates in order to account for any assumption that renters place a lower value on reliability than the owner-occupiers whose stated preferences were used to derive the estimates would only serve to increase the net costs of improving performance. Any reasonable adjustment for this issue would not be sufficient to allow us to conclude there would be net benefits from reducing proactive sewerage maintenance activities.

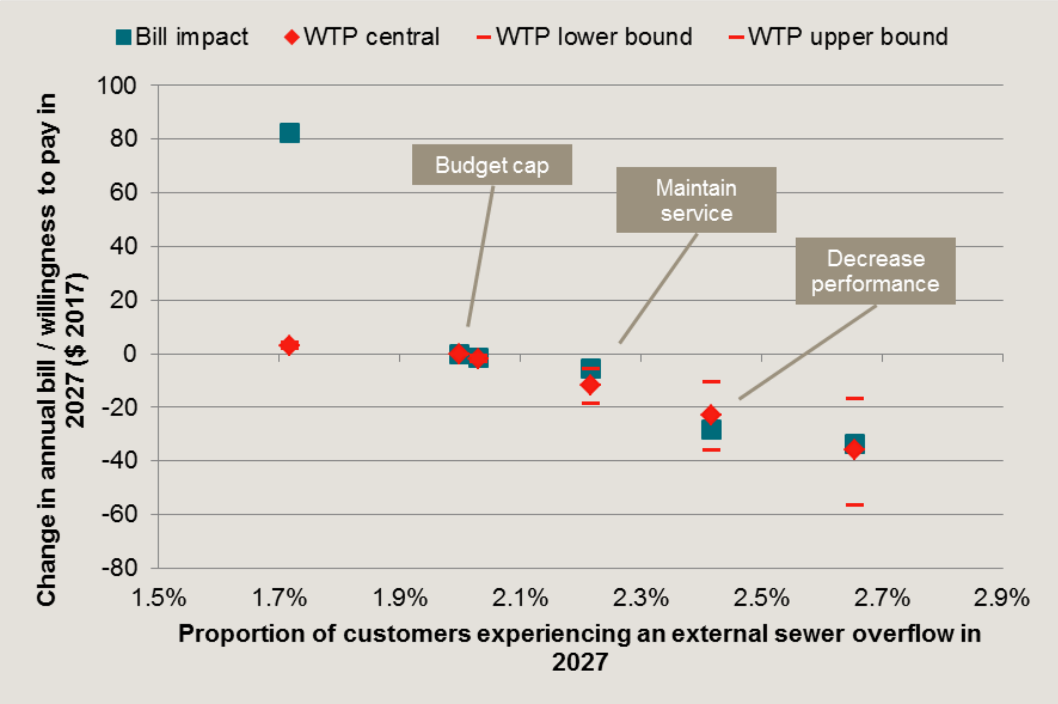
Customer impact

The bills and service levels experienced by customers vary over time in each of the options. Figure 3.10 illustrates the costs and benefits in terms of a single customer in 2037, by way of example. For the purpose of illustrating the trade-off customers are faced with, we base the bill impacts on an assumption that all costs are treated as operating costs. In practice, some costs may be treated as capital costs and recovered over several decades, with a return on capital charged on any unrecovered amounts such that the recovery is equal to the operating cost treatment in present value terms. Viewing bill impacts in a single year based on a capital cost treatment can be misleading as it obscures the link between costs and bills. In particular, it obscures the fact that the customer is locked into paying higher bills over many future years regardless of the expenditure in those years.

The bill impact from the 'increase performance' option is clearly greater than the maximum amount the customer would be willing to pay for the service improvement achieved under that option. The marginal costs and marginal benefits from degrading service are quite similar. While the bill savings from the 'decrease performance' option are marginally greater than the central estimate of the minimum amount the customer would be willing to accept by way of compensation, they are within the bounds of statistical error.

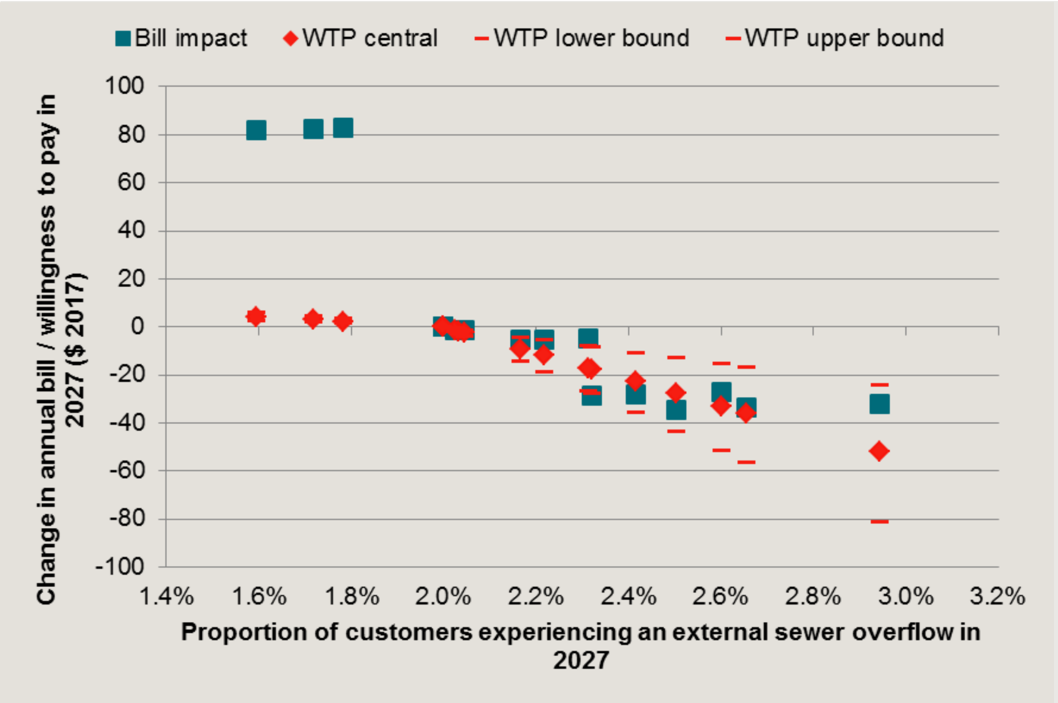
This conclusion holds when sensitivity around expenditure effectiveness is taken into account. Figure 3.11 illustrates the same customer trade-off between cost and service, with the addition of the upper and lower bound assumptions for the impact of bill changes on overflow rates. Even at the upper bounds of WTP and expenditure effectiveness, customers are not willing to pay the cost of service improvement. The additional sensitivity around expenditure effectiveness confirms we cannot determine whether customers would be willing to accept the service deterioration associated with a cost saving.

3.10 Bills and service levels for a residential customer in 2027



Data source: CIE analysis

3.11 Bills and service levels for a residential customer in 2027 incl. cost sensitivity



Data source: CIE analysis

Conclusion

- There would be a significant net cost to the community from increasing expenditure on sewerage network maintenance above the existing budget cap
- It is not clear whether the other sewerage network management options analysed would result in positive net benefits, since the results are within the bounds of statistical error
- This analysis suggests Icon Water should maintain or reduce, but not increase, its current level of expenditure on proactive sewerage maintenance

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