

Expert opinion valuation method to quantify digital water metering benefits

Ian Monks^{1,2}, Rodney A. Stewart^{1,2} *, Oz Sahin^{1,2}, Robert Keller^{3,4} and Samantha Low Choy⁵

¹ School of Engineering and Built Environment, Griffith University, 4222 Gold Coast, QLD, Australia, ian.monks@griffithuni.edu.au (I.M.), o.sahin@griffith.edu.au (O.S.)

² Cities Research Institute, Griffith University, 4222 Gold Coast, QLD, Australia

³ Civil Engineering Department, Monash University, 3800 Clayton, VIC, Australia, rjkeller@optusnet.com.au (R.K.)

⁴ R. J. Keller & Associates, 3150 Edithvale, VIC, Australia

⁵ Arts, Education and Law Group/Researcher Education & Development/ Environmental Futures Research Institute, Griffith University, 4122 Mt Gravatt, QLD, Australia, s.low-choy@griffith.edu.au (S.L-C.)

* Correspondence: r.stewart@griffith.edu.au

Received: date; Accepted: date; Published: date

1. Introduction

This document is provided as a supplement to the paper, Expert opinion valuation method to quantify digital water metering benefits [1]. It provides

Section 2

For each Benefit,

- the question asked in the Experts Survey
- the background information provided
- a detailed summary of the experts' answers to the questions, and
- the scoring outcome for the Level of Agreement and the Extent of Benefit.

Section 3

Summary table of scores for the Agreement Level theme and Benefit Value theme for each benefit

Section 4

- participant profiles

Within this detailed summary the participants who provided each comment are identified by their expert number, for example, E70. The profiles of each participant is included in Section 3.

Benefits have been listed in question order and relate to Section 4.2 of the main paper.

Each question is identified by a simple sequence number and the question number within the Experts' Survey (eg. D11) where the first two characters represents the benefits block (ie, D1, D2, ... , P1) and the last number represents the sequence number within the block (1 up to 9).

2. Expert Opinions

2.1 Introduction

The following sections provide a detailed analysis of the range of opinions expressed by the experts. Individual experts whose comments are included are identified by coded reference. The profile of the experts is included in Section 3.

2.2 Business benefit questions – Detail

2.2.1 Operational Cost Savings: Meter Reading

Question1 (Q1):D11. From your experience/knowledge will water businesses benefit from a reduction in meter reading charges/billing costs and to what extent? BACKGROUND: Manually read meters require meter readers to walk or drive the reading route stop at each meter location find the meter, open the dial cover, read the meter and enter the reading to a handheld device. They complete the reading route by uploading the data file values into a database. Electronic reading can enable the reading to be taken across a communications network eliminating the meter reader cost (but replaced by a lower communications cost).

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
17	0	1	2	1	13	0
Extent of Benefit:						
	Negligible	Marginal	Reduce	Significant	Substantial	
	0	0	4	5	3	

Of the 17 responses to the proposition that digital metering would reduce the charges incurred by water utilities for meter reading and billing costs, 13 (76%) agreed, 1 somewhat agreed, 1 provided low level agreement while only 1 disagreed. One independent expert pointed out that “Meter reading cost in cities can be quite low per property but in regional areas the cost of meter reading is quite high due to the distances between properties.” The one Don’t Agree response was from a metropolitan water utility person who stated that “meter reading is still a very cheap option to obtain billing information” (E70). But the seven other metropolitan water utility staff dissented from this view and responded that the saving would range between real and substantial (E17, E26, E38, E43, E81, E89, E90). The seven responses from regional water utilities agreed (E22, E31, E40, E58) with some also pointing out the new cost of electronic collection offset much of the saving (E33, E59) but one added that digital metering generated 2500 times the amount of data (E51).

Q2: D12. From your experience/knowledge will water businesses benefit from a reduction in special meter reads and to what extent? BACKGROUND: When customers leave properties the water meter needs to be read to enable the leaving customer to be billed and the arriving customer to start from zero. By taking the electronic reading of the meter at a nominated date and time can eliminate meter readers having to visit the property.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
17	0	0	0	2	15	0
Extent of Benefit:						
	Negligible	Marginal	Reduce	Significant	Substantial	
	0	2	11	3	1	

All respondents thought that digital water meters would generate a savings by avoiding the manual reading. Two respondents, one from a regional water utility and one from a metropolitan water utility, both felt that the savings would be marginal (E58, E70). But others pointed to the

opportunity to complete the read remotely (from the office), enable field staff to focus on core tasks and have more timely and reliable data.

Q3: D13. From your experience/knowledge will water businesses benefit from a reduction in estimated bills and to what extent? BACKGROUND: Meters that cannot be read due to access issues are estimated. Often these estimates are inaccurate and cause customers to raise complaints. Collecting the data electronically could eliminate the estimated reads.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
17	0	0	0	0	16	1
Extent of Benefit:						
	Negligible	Marginal	Reduce	Significant	Substantial	
		1	8	2	6	

One expert wrote that their metropolitan water utility had a large number of properties that they could not access the meter due to them being locked, hard to find, buried and various other reasons (E17). This results in the bill being estimated and inaccurate billing with a flow on effect of phone calls, complaints, site investigations and re-billing with all of the associated additional costs. Another pointed out that bill estimation was increasingly being seen as an unacceptable practice (E27). Most others agreed with these opinions and the benefit for most was high to very high with only one describing the benefit as “small”.

Q4: D14. From your experience/knowledge will water businesses benefit from a reduction in Occupational Health and Safety (OHS) incidence costs and to what extent? BACKGROUND: It is possible that with meter readers no longer walking the reading routes they will avoid issues such as dogs, pits, bushes etc or stop/start driving between reads in rural areas and so the incidence of OHS cases could be expected to drop.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
17	0	0	0	1	14	2
Extent of Benefit:						
	Negligible	Marginal	Reduce	Significant	Substantial	
			9	3	5	

One expert described meter reading as “a huge OHS issue and risk” and that reducing the number of incidents also reduces the insurance costs (E72). There are always the ever present threats by walking the streets from potential dangerous human attack (E22) and being hit by cars, dog bites (E22, E31), time wasting waiting for dog to be controlled (E58), branches and holes on customer properties (E22), trip hazards (E31), spiders (E58), snake bites (E31, E58), back injuries (E27), abuse by home owners (E31), and accusations of meter readers breaking property (E33). A downside of reduced visits to properties was an increased risk when a site visit was required due to lack of hazard information recorded against properties (E17, E26). The extent of the benefit was seen as very high.

Q5: D15. From your experience/knowledge will water businesses benefit from a reduction in vehicle energy costs (GHG emissions) and to what extent? BACKGROUND: It is possible that with meter readers no longer driving to their reading routes and an almost complete elimination of special reads, vehicle energy costs and their input to the Greenhouse Gas emissions could be reduced.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
17	2	0	1	1	13	0
Extent of Benefit:						
		Negligible	Marginal	Reduce	Significant	Substantial
			1	7	2	5

Many responses to this proposed benefit referred to the amount of driving done by their meter readers (E22) or the size of the service area (E33) while others said this was part of outsourced meter reading to contractors (E17, E38, E43, E72). An interesting observation was the potential for the benefit to be considered towards meeting national emissions targets if accounted for properly.

The extent of the benefit was considered negligible unless rolled-out across the entire meter fleet (E40). Others felt that the benefit was very high in line with reduction in meter reading costs and OHS incident reduction.

Q6: D16. From your experience/knowledge will water businesses benefit from a reduction in billing and collection costs with monthly electronic billing and collection and to what extent? BACKGROUND: It has been suggested that water businesses may be able to offer monthly billing to customers using the automated reading taken at a nominated day and time within a month of readings. This would likely treble the postal charges. eBilling could significantly reduce the extra "mailing" cost. Further coupling of eBilling with direct debit could improve the potential for on-time payment and reduction in reminders and other debt recovery expenses.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
17	3	2	0	3	9	0
Extent of Benefit:						
		Negligible	Marginal	Reduce	Significant	Substantial
			1	0	10	1
						0

The attraction of monthly billing is the associated move to direct debit and the improvement in cash flow for the water utility (E26, E27, E89) and debt collection (E17). The additional cost of mailing out bills monthly rather than quarterly and the increased payment channel costs needs to be countered by compulsory eBilling and direct debit (E43). One person who disagreed pointed to the high cost of their water utility's current billing process (E40) while another nominated that paper bills were still preferred and required by older customers, in particular, and not necessary if leak alarming was provided (E58).

The extent of the benefit was consider a reduction in costs with one person considering the reduction significant. The person considering the extent of the benefit as negligible thought there may be an increase in bill related calls which would offset the benefit.

2.2.2 Operational Cost Savings: Financial Management

Q7: E11. From your experience/knowledge will water businesses benefit from digital water meters through improved revenue forecasting/recovery and to what extent? BACKGROUND: If customer usage is being tracked hourly for all customers the opportunity may exist to write periodic reports to accurately capture revenue earned and project that through to period-end amounts.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	0	1	2	1	3	1
Extent of Benefit:						
	Negligible	Marginal	Reduce	Significant	Substantial	
	0	3	4	0	0	

One person did not agree that improved revenue forecasting and recovery could benefit from digital metering stating that interval data is not used for this as it relies on population and weather (E89). Of the answers with only a low agreement it was indicated that they may analyse usage more frequently but they felt quarterly data worked well because of the influence of weather and the need for trending (E22, E58). Yet others had a very opposite view. They pointed out that water utilities will be able to know at the same resolution as data is captured how their revenue is generated (e.g. day of year, weekend-weekday comparisons, seasons, etc.), gain a better understanding of user behaviours, create more accurate revenue accruals rather than rely on bulk-water transfer data and reconciled after receipts, improve demand forecasting and year-end projections taking into account customer payment history (E19, E27, E38, E59, E61).

The extent of the saving was marginal among those with only a low agreement and somewhat agreement with one nominating a cost saving of just 0.1 fulltime equivalent person (FTE) in benefits. Among those more positive about the benefit, they believed real benefits would be achieved.

Q8: E12. From your experience/knowledge will water businesses benefit from digital water meters through improved cash flow/reduced working capital from monthly billing and to what extent? BACKGROUND: It is suggested that monthly rather than quarterly billing increases cash flow and reduces the working capital requirements of water businesses.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	1	1	0	1	5	0
Extent of Benefit:						
	Negligible	Marginal	Reduce	Significant	Substantial	
	0	1	4	1	0	

The benefit was generally accepted (E22, E27, E38, E59, E61, E89) while the person who did not agree (E58) stating that quarterly billing “worked well”.

The extent of the benefit was considered significant by one person on the basis that many customers would opt for monthly billing resulting in considerably improved cash flow (E22), while others saw a benefit in revenue collections and, an ability to identify customer payment issues earlier (E27, E59, E61, E89). One saw the benefit as a mere timing benefit producing a one-off benefit (E38).

Q9: D21. From your experience/knowledge will water businesses benefit from reduced residential non-revenue water data errors/losses and to what extent? BACKGROUND: Billing errors can be caused by lost, damaged and stolen meters, incorrect meter readings, poorly fitted meter installations and mismatching meter/customer, and other incorrect metering details such as units and multiplier lead to non-revenue water. Meter errors become compounded as the reads are used for calculating sewer charges. It is possible that automated reading could eliminate some of these errors or assist in quickly identifying anomalies and resolving the issues.

Number of Responses	Don't	0:Don't	1:Low Agree		2:Somewhat Agree		3:Agree	4:Strong Agree
	Know	Agree						
19	1	0	0		3		14	1
Extent of Benefit:								
			Negligible	Marginal	Reduce	Significant	Substantial	
				3	8	6	1	

One person who felt the number of misreads would be decreased significant did not feel that it would assist with lost, damaged or stolen meters (E39). Others agreed with the proposition that human error would be eliminated, tampered and stolen meters, water theft and other meter reading anomalies could be identified earlier through analysis and fault and tamper alerts, assisting with non-revenue water reduction (E14, E17, E22, E26, E27, E31, E33, E36, E51, E58, E59, E70, E72, E80, E81, E89). One person nominated that, for their metropolitan water utility, the manual meter reading error rate was only 0.05% (E70).

The extent of the benefit drew a wide range of responses from substantial to marginal with no clear division between metropolitan and regional water utilities.

Q10: D22. From your experience/knowledge will water businesses benefit from reduced non-residential customers' non-revenue water data errors/losses and to what extent? BACKGROUND: For non-residential customers as well as those errors that affect residential customers, changes in property use can result in inappropriate sized meter for the changed demand and peak flows resulting in under-recording or excessive wear on mechanical parts. It is possible that automated reading could eliminate some of these errors or assist in quickly resolving the issues.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
19	0	0	0	2	17	0
Extent of Benefit:						
		Negligible	Marginal	Reduce	Significant	Substantial
			3	11	3	2

Many responses to this benefit for non-residential customers nominated the same issues as for residential but with additional comments such as identifying the highest users for potential issues (E31), better understanding of commercial customers (E39) and earlier identification with a flow on effect of less impact of water-offs on the business (E17).

Q11: E19. From your experience/knowledge will digital water metering reduce insurance claim incidents and costs from bursts and leaks and to what extent? BACKGROUND: Water companies may be able to reduce the insurance costs (premiums and excess payments for claims) through data from digital meters enabling earlier detection and preventative or earlier action on issues that lead to bursts and leaks and so avoid the full effects of water damage caused by main breaks.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	1	0	0	2	5	0
Extent of Benefit: Negligible Marginal Reduce Significant Substantial						
				1	4	2

Two people considered this a significant benefit. One thought combining digital metering data with predictive machine learning should lead to early detection or preventative behaviour (E61) and the other thought that leakage management programs will significantly reduce the affect that hidden leaks have on building structures (e.g. underground break causes change in soil conditions which causes cracking in house) (E27). Others stressed the need for an integrated approach using bulk meters and digital metering data to identify smaller, longer term leaks that cause damage (E58, E59, E89). Two people only somewhat agreed with the benefit. One of them considered it a marginal benefit (E22) while the other considered it not significant or material (E38).

2.2.3 Operational Cost Savings: Utility Costs

Q12: G11. From your experience/knowledge will water business be able to gain a reduction in the wholesale cost of water and to what extent? BACKGROUND: Digital metering with associated data portal/communications may lead to greater customer awareness of their usage and in turn reduced customer demand and non-revenue water from leaks and bursts. The outcome from this water conservation could be reduced volume and cost of water from the wholesaler.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
9	0	1	0	0	7	1
Extent of Benefit: Negligible Marginal Reduce Significant Substantial						
				1	8	

One person from a regional water utility did not agree that there would be a reduction in the wholesale cost of water (E22) while three experts from other regional water utilities did (E51, E58, E59) as did the experts from the metropolitan water utilities (E15, E26, E36, E90) and an independent expert (E27). They reasoned that less bulk water would need to be purchased as a result of reduced usage by residential customers, and through leak reduction and other NRW responses. But the reduction was considered to vary from utility to utility and depend on their circumstances and their engagement with customers on demand reduction initiatives (E90).

Q13: G12. From your experience/knowledge will water business be able to gain a reduction in water leaks and other NRW causes (eg. bursts) and to what extent? BACKGROUND: With greater electronic coverage of the network and short interval data collection from bulk meters and digital water meters at properties water companies may be able to establish District Metered Areas and calculate water balances to help identify leaks which if undetected might otherwise have become bursts.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
9	0	1	0	1	7	0
Extent of Benefit: Negligible Marginal Reduce Significant Substantial						
				6	2	

The person who did not agree that this was a benefit was looking for a solution for leak prevention (E51). The other people answering the question thought real or nearly real time mass balancing is a key component to NRW reduction (E59) and that digital water meters could assist in finding the leaks and bursts faster (E26), reducing the incidence of bursts (E22), identifying theft (E27) and identifying unmetered/unauthorised use (E15). One person noted that digital water meter data will assist in the responsiveness to real NRW events with water utilities being able to prioritise them

216 based on a water loss rate and intervene where the initial assessment may under estimate the water
217 rate loss because of the water going straight into a drain or is out of sight, and the data would also
218 reduce time wasted looking for suspected leaks that are actually legitimate usage (E36).

219 The extent of the water saving benefit was considered real by eight persons with two of them
220 considering the savings significant.

221

Q14: G13. From your experience/knowledge will water business be able to better manage peak water demand and to what extent? BACKGROUND: Hourly data capture could provide valuable information on diurnal and peak consumption patterns enabling better peak demand management.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
9	1	1	1	0	6	0
Extent of Benefit:						
	Negligible	Marginal	Reduce	Significant	Substantial	
			6	1		

The one expert who did not agree with this benefit stated that bulk water meters do this now (E22). The person with a low level of agreement thought that it may be possible to better manage peak water demand via customer communications and by targeting the customers who are having the highest impact on peak demand but that it would certainly assist during periods of water restrictions (E15).

A person from a regional water utility considered this the largest benefit because “most modelling is based on stacked assumptions about water consumption” and that digital metering data would provide more accurate insight into peak demand (E15). The other five agreed that more information would lead to less estimation and better management, and, the potential for shifting customer water demand, better allocation of water to where it is needed and design of infrastructure requirements based on true data (E26, E27, E51, E58, E59, E90).

Q15: G14. From your experience/knowledge will water business be able to gain a reduction in water pumping cost (GHG emissions) and to what extent? BACKGROUND: Digital water metering may lead to a reduction in demand and so reduce the need for water pumping around the network.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
9	0	1	0	0	8	0
Extent of Benefit:						
	Negligible	Marginal	Reduce	Significant	Substantial	
		2	6			

The person who did not agree with the benefit said that their water utility only moved water to pressure tanks once (E22).

The other eight believed that the reduction in water volume would have a flow on impact of lower pumping costs but many pointed out that the extent of the benefit depended on the system configuration of the network while others noted that much of their system was gravity fed (E26). The lower pumping activity in turn was seen to reduce greenhouse gas (GHG) emissions and their electricity costs through an optimised pumping regime (E15).

Q16: D23. From your experience/knowledge, will water businesses benefit from a reduction in water theft, and to what extent? BACKGROUND: Hourly demand data readings from customer meters coupled with DMA water balance data could reveal anomalies through unusual patterns that might indicate meter damage or possible water theft.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
19	1	0	3	0	15	0
Extent of Benefit:						
		Negligible	Marginal	Reduce	Significant	Substantial
			5	12	1	

Water theft cases reported through the answers include meter removal, turned backwards and bypass (E58), change-over during reading cycle (E89), removal during construction or in response to water utility flow restriction (E17) and temporary bypass/removal for swimming pool filling and water-storing systems at the property (E59). For commercial/industrial users digital water metering can reveal theft whilst fire testing and system anomalies such as dividing valves being open between systems could be revealed (E91).

The extent of the issue was considered minor by five people with one regional water utility reporting just “2 or 3 cases” in the last 3 years (E59). Four others agreed that the benefit would be minor (E22, E26, E89, E91). One person (E36) thought that their water utility would benefit greatly from being alerted to meter tampering. Twelve thought the benefit would provide a real benefit. Two people noted that theft of the meter could also be picked up very quickly (E14, E26, E72). And, one noted that a disadvantage of not having meter readers was the loss of “eyes on our assets” (E51).

Q17: D24. From your experience/knowledge will water businesses benefit from a reduction in labour costs associated with leak detection and to what extent? BACKGROUND: With more data and at hourly intervals from property meters the labour effort required to detect, localise and find leaks could be reduced.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
19	2	1	4	2	9	1
Extent of Benefit:						
		Negligible	Marginal	Reduce	Significant	Substantial
				15	2	

Strong agreement came from one person who noted that a lot of effort was spent employing leak finding contractors and that with the data from digital meters, existing software would be able to provide very accurate locations and the number and size of leaks (E27). Another person who thought that water utilities would benefit greatly noted that leak alerting on the customer side would eliminate the work effort to send a crew to assess what would have been a customer raised alert (E36). Many others noted the opportunity for the effort to be more targeted or to narrow the search area and find the cause more quickly. Another noted the need to analyse the entire labour chain from “old model” to “new model” as more analysts would be needed to analyse the data (E14).

2.2.4 Operational Cost Savings: Meters

Q18: D31. From your experience/knowledge will water businesses benefit from deferred meter replacement (thru water conservation, targeted replacement) and to what extent? BACKGROUND: Meter replacement has usually been based on age or nominal volume of water through the meter. The age limit used is generally between 10 and 15 years but studies have found most meters are still operating within compliance limits at these ages. Using data analytics it is suggested that compliant meters can be identified and retained while non-compliant meters can be removed.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
	16	2	7	0	0	7
Extent of Benefit:		Negligible	Marginal	Reduce	Significant	Substantial
				4	3	

286 The earlier identification of meter failings lead to the benefit being rated as significant among
287 some responses.

288 2.2.5 Operational Cost Savings: Tariffs

289 Q19: E13. From your experience/knowledge will water businesses benefit from digital water
290 meters through more flexible tariffs by industry and to what extent? BACKGROUND: With meters
291 being read hourly it may be possible and worthwhile to offer tariffs that are more flexible so as to be
292 time of day and day of week dependent. This might be used in specific industries and to residential
293 users.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	1	0	3	0	4	0
Extent of Benefit:		Negligible	Marginal	Reduce	Significant	Substantial

Q20: E14. From your experience/knowledge will water businesses benefit from digital water meters through load shifting (leveling) and to what extent? BACKGROUND: It is suggested that digital water metering might enable tariffs to be altered for the specific purpose of levelling demand from the typical two peak diurnal curves encouraging more off-peak usage.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
	8	1	0	1	0	6
Extent of Benefit:		Negligible	Marginal	Reduce	Significant	Substantial
				6		1

Most people answering this question referred back to the previous new tariff opportunity where peak and off-peak tariffs were expected to enable a reduction in peak demand. The potential to use digital metering data to inform strategies targeting peak-time demand management in certain DMAs was acknowledged, and, the comment was made that the technique could produce a substantial benefit through the deferral of infrastructure upgrades and pumping costs especially in densely populated urban areas (E27). Three people suggested that the electricity industry be examined for the take-up of peak/off-peak tariffs and the impact on demand (E19, E27, E59). But such changes were considered a longer term option (E19, E22).

Q21: E17. From your experience/knowledge will water businesses benefit from digital water meters through improved customer service/satisfaction through modified tariffs and to what extent? BACKGROUND: Digital water metering might allow tariffs to be modified to be based on time of day and day of week and so give customers greater choice and control over their costs.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	0	1	0	4	3	0
Extent of Benefit: Negligible Marginal Reduce Significant Substantial						
2 6						

The person who disagreed with this benefit said that customer service or satisfaction would not benefit by modifying tariffs (E22). Others were a little more supportive with one comment that it would only happen if tariff changes lead to a reduction in costs for customers and that would require a corresponding decrease in operating costs of the water utility (E89). And, it was not known if customers would embrace or be satisfied with alternate tariffs (E27) as no modelling or customer testing had been undertaken by their utility (19, E38). But a first implementation might consider rewarding good consumers and developing their level of engagement and satisfaction level with their utility (E27).

2.2.6 Capital Cost Savings: Planning

Q22: H11. From your experience/knowledge will water business be able to improve network planning and to what extent? BACKGROUND: The increase in demand data available from digital water metering coupled with future land development plans may enable improvements to hydraulic modelling with more accurate development timing.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	0	0	0	1	7	0
Extent of Benefit: Negligible Marginal Improve Significant Substantial						
8						

While all eight experts who answered this question were agreed with the benefit the least supportive (E79) commented that the assumption made worldwide and used in water modelling is that consumers of the same types have statistically the same demand pattern. And, that the flow balance calculated shape of demand and the actual one at each property is not significant enough to have any relevant hydraulic impact. They concluded that knowing the individual demand pattern is of no interest from a water modelling perspective. Others commented that they would be able to better understand customer demand profiles across a range of segments leading to targeting customer segments impacting the network design the most (E15), improve demand projections (E24), avoid the

stacking of assumptions when planning networks and enable lowering of safety factors and assumptions by using real data (E51), and, the real data can be used for more informed demand management and forecasting purposes including network rehabilitation and upgrading (E58, E59). One expert pointed out the need for significant data capture and analysis first to enable the improved planning to occur (E22).

The extent of the improvement was unknown and one person commented that to measure the improvement would require the development of a water model using two datasets (E51).

Q23: H12. From your experience/knowledge will water business be able to defer network augmentation and to what extent? BACKGROUND: Actions arising from digital metering such as reduction in demand through network non-revenue water, in-property leaks and more awareness of water use could enable the deferral of network augmentation works including pipe upgrades, pumping upgrades and waste water processing plants.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	0	0	1	1	6	0
Extent of Benefit:						
	Negligible	Marginal	Defer	Significant	Substantial	
		2	5	1		

The benefit of deferring major supply augmentations such as the next desalination plant was considered the “big prize” but required customer demand reduction measures to be successful and remain over the longer term (E15). The availability of real data was expected to reduce the risk associated with infrastructure capacity planning with more economical and adequate design of reservoir based on actual demand, emergency and fire storage rather than 24 or 48 hours of storage (E59). While better data is assumed to enable the deferral of augmentations, it was pointed out that some system components might be revealed as being under-sized (E51). The two people who supported the benefit the least referred to the impacts of climate change and the characteristics of supply zones (E24), and, that network non-revenue water and in-property leaks would have a marginal impact on timing of network augmentations (E79).

2.2.7 Capital Cost Savings: Risk

Q24: E18. From your experience/knowledge will water businesses benefit from digital water meters through a reduction in risk premium and working capital costs and to what extent? BACKGROUND: Working capital costs are required to cover near term expenses. More accurate timing of capital works based on digital metering data to eliminate non-revenue water and enable better forecasting might enable a reduction in both the risk premium employed and the working capital requirements.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	0	2	0	2	4	0
Extent of Benefit:						
	Negligible	Marginal	Reduce	Significant	Substantial	
			5	1		

Two experts both from metropolitan water utilities thought the reduction in risk premium and working cash flow to be unlikely (E61, E89). Four were well supportive of the benefit (E22, E27, E58, E59) and the two who somewhat agreed (E19, E38) considered it to have minimal impact and a largely

one-off impact, respectively. The other four thought that the benefit would come from increased cash flow (E22), reduction or elimination of the over-sizing or under-sizing of major system components (E59) and more precise linking of water related expenditure and revenue to water supply zones and sub-areas down to individual customers (E27). One person noted that in their utility they ran for 11 months of the year at 2ML/d and for the other 4 weeks of the year at 5ML/d, and so expected to be able to operate more efficiently (E58).

Q25: E15. From your experience/knowledge will water businesses benefit from digital water meters through increased value of assets (service connections) and to what extent? BACKGROUND: Water companies do not normally treat as assets the main to property service connection even though they are responsible for the asset to and including the meter. The accurate location of the meter might be established as part of the digital metering rollout and enable these service connections to be recorded accurately as assets and valued.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	0	3	0	1	4	0
Extent of Benefit:		Negligible	Marginal	Improve	Significant	Substantial
		1		4		

Three experts thought that this was not a benefit of digital water metering (E22, E38, E61). Two considered it a benefit and stated that their water utility had already recorded the service connection as an asset (E19m E58). While another agreed but considered it of negligible value (E89) the last two considered that it would make for a more accurate assets register (E59) and would be part of a cities IoT agenda and enable better life-cycle management of the smart meter (E27).

2.2.8 New Knowledge: Customer Segments

Q26: J11. From your experience/knowledge will water business gain new knowledge of each non-residential customer's property use and to what extent? BACKGROUND: Compared to residential customers there is, generally, little knowledge about demand profiles of commercial, industrial and other non-residential customers. While doing a rollout of digital meters the opportunity exists to record the property use (business type) to help facilitate the data analytics and benchmarking of non-residential customers. While normal digital metering may be set at hourly reading intervals statistical sampling within business types of even higher frequency readings for short durations could be undertaken to establish demand patterns and end-use studies.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
11	0	0	0	1	8	2
Extent of Benefit:		Negligible	Marginal	Gain	Significant	Substantial
				10	1	

Strong agreement came from two people (E13, E15) who pointed out that non-residential demand patterns are different to residential and different between segments and even within segments, and, that very little is known about them other than for the bigger industrial users. For the larger industrial customers, two experts commented on wanting to undertake data collection at sub-hourly intervals for peak factor understanding and demand distribution (E51, E59). At one utility, adhoc data logging had been undertaken to assist customers with water efficiency and the data was later used for infrastructure planning and the potential for recycled water use. Their views were repeated by the

others but with less enthusiasm (E19, E22, E26, E27, E51, E59, E66, E71) and with one commenting that they could do this (gain new knowledge) if they chose to (E19).

Q27: J12. From your experience/knowledge will water business gain from new knowledge of tourism impacts for tourist regions (seasonal/event) and to what extent? BACKGROUND: Tourist precincts have individual water use patterns that change by season and local events. It is suggested that by capturing and using hourly meter reading data, these patterns might be better understood and water use planned for in the future.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
11	1	0	2	0	8	0
Extent of Benefit: Negligible Marginal Gain Significant Substantial						
1 9						

Two people from metropolitan water utilities thought the benefit was not a major issue for them but that there may be a benefit (E15, E66). Another metropolitan water utility expert thought that it could provide some additional useful knowledge (E19). But three other experts from metropolitan water utilities (E24, E26, E71) agreed with the benefit with one saying that seasonal patterns is very important to a city like Melbourne while others (regional water utilities and independent expert) pointed to a current lack of data and the benefit of understanding seasonal network behaviour and capacity requirements (E22, E27, E59).

Q28: J13. From your experience/knowledge will water business be able to understand time-of-day use by customer segment and to what extent? BACKGROUND: Hourly readings from digital water meters could provide an opportunity to develop demand patterns for each customer segment. This could be valuable when undertaking planning, meter sizing and benchmarking studies.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
11	0	0	1	0	10	0
Extent of Benefit: Negligible Marginal Understand Significant Substantial						
10 1						

All experts agreed with this benefit. One described it as a “big benefit” with daily diurnal demand helping to understand how different customer types and segments use water on different days of the week and how demand forecasting will be substantially more efficient (E27). Others pointed out the opportunity to develop design standards for each consumer category (E59), the opportunity for time-series clustering of customers using a bottom-up approach instead of most industry models being top-down (E51) and the ability to better inform design of their system components (E59, E51, E71). Some pointed out the need for data collection to support customer type segmentation and demand data over multiple years to understand the climatic factors and other external influences on demand (E15, E66, E71).

2.2.9 New Knowledge: New algorithms

Q29: D32. From your experience/knowledge will water businesses be able to use data from digital water meters to develop meter over-sizing identifiers and to what extent would they benefit? BACKGROUND Over-sized meters cause usage to be under recorded and the result is non-revenue

433 water. Benchmarking non-residential customers could enable customers that have over-sized meters
 434 to be identified. Their meter could then be replaced with a more suitable sized meter.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
16	3	0	1	1	11	0
Extent of Benefit:		Negligible	Marginal	Gain	Significant	Substantial
			2	9	2	

435 The expert who scored this as a low agreement thought it would be difficult to replace meters
 436 with different sized meters but replacing the type of meter more suited to the higher or lower flow
 437 would increase meter accuracy (E81). Others were supportive of the benefit noting that it would be
 438 true for under-sizing as well as over-sizing since a change of business type at properties, such as a
 439 shop becoming a restaurant, was an issue (E17), and being able to quickly identify incorrect sized
 440 meters was a real benefit (E25, E26, E41, E90). Others thought that digital meters should not be
 441 mechanical (E41, E70), that the benefit might be delayed until the next meter replacement was due
 442 (E26) and that this would be a better customer experience rather than a revenue benefit (E40).

443 Q30: H13. From your experience/knowledge will engineering planners of water business be able
 444 to reduce uncertainty and risk margin used in planning and to what extent? BACKGROUND: The
 445 access to vastly increased water demand data recorded by digital water meters at relatively short
 446 intervals could enable planners to more precisely know demand in different areas of the network
 447 under various circumstances and conditions. This could reduce the uncertainty in planning the
 448 operation and augmentation of the network. The risk margin might be reduced.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	0	1	0	0	7	0
Extent of Benefit:		Negligible	Marginal	Reduce	Significant	Substantial
			1	5	1	

449 The expert who disagreed with this benefit thought that the information, except for significant
 450 users, can be gained if a good flow meter coverage exists in the system. That is, metered zones defined
 451 per homogenous demand type and size taking into account operational requirements (fire flow system
 452 redundancies and meter accuracy requirements for example) (E79). Others thought that this was of
 453 particular benefit for infill development requirements (E24), that demand assumptions were
 454 constantly changing as lot sizes reduce and household composition changes (E15) and, that
 455 traditionally planning used theoretical data due to the lack of real data, but the availability of data
 456 from digital meters changed that and uncertainty is reduced significantly (E27, E59). But it was also
 457 noted that it is a conservative industry (E22), that reducing risk margin depends on the organisation's
 458 appetite for risk (E51) and that "planners always like margin of safety for unexpected events" (E58).

459 Q31: G15. From your experience/knowledge will water business be able to gain an improved
 460 forecasting of sewer flows and to what extent? BACKGROUND: With hourly measured water usage
 461 through digital metering at each property the sewer flows could be better forecast by time of day.
 462 These forecasts could be fed into waste water modelling tools. The impact of any water tanks on the
 463 properties and internal use of the harvested water may be able to be built into the m

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
9	1	0	0	0	8	0
Extent of Benefit:		Negligible	Marginal	Improve	Significant	Substantial
8						

464 The eight experts offering opinions all supported the benefit. One thought it beneficial to those
 465 that operated treatment plants (E15), provide information on garden and non-garden demand and
 466 enable prediction of sewer flows (E26, E27), inflow infiltration to the sewer (E59) and more efficient
 467 use of infrastructure (E58).

468 The extent of the benefit was not estimated other than improved analysis.

469 Q32: E16. From your experience/knowledge will water businesses benefit from digital water
 470 meters through improved demand forecasting and revenue projection, and to what extent?
 471 BACKGROUND: Capturing hourly demand from digital water meters and using a range of statistical
 472 approaches may allow the water companies to better understand the usage patterns of water its
 473 customer base and to forecast future water usage and to project revenue.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	0	1	0	1	6	0
Extent of Benefit:		Negligible	Marginal	Improve	Significant	Substantial
1 6						

474 One person did not agree saying that "interval data is not used for this as it relies on population
 475 and weather (E89).

476 While agreeing with the benefit one thought the benefit would be marginal (E19) and another
 477 only could only somewhat agree (E22). Others supported the benefit stating that digital meters would
 478 provide more information on customer usage patterns (E38, E59, E61) which help inform estimates
 479 and pricing options (E38), and enable utilities to be more precise with their accounting (E27). It was
 480 also noted that over decades utilities will have and extensive high resolution dataset that can be used
 481 in a range of forecasting scenarios (E27).

482 The extent of the benefit was not estimated by most but by agreement with the benefit has been
 483 rated as "Improve".

484 Q33: J14. From your experience/knowledge will water business be able to develop diurnal curves
 485 for non-residential customers by customer type (micro segmentation) and to what extent?
 486 BACKGROUND: Based on the ANZSIC (Australian and New Zealand Standard Industrial
 487 Classification) and AVPCC (Australian Valuation Property Classification Code) code there is an
 488 extensive range of business types. Some could be grouped into common demand patterns (eg.
 489 Commercial office based businesses). Digital metering could provide an opportunity to establish
 490 diurnal curves for different business types and for sub-business types (eg supermarkets with limited
 491 hours and those open 24x7).

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
11	0	0	2	0	9	0
Extent of Benefit: Negligible Marginal Improve Significant Substantial						
11						

The experts all agreed with this benefit although two provided only low level of agreement (E22, E66) with one from a regional water utility saying the benefit was well down on their priority list (E22) while the other from a metropolitan water utility pointed to the need to match the customer to ANZSIC/AVPCC information to be effective or use statistical clustering techniques to make presumptive assumptions (E66). Others were supportive (E13, E15, E19, E24, E26, E27, E51, E59, E71). Two went further. One said the challenge was more in understanding the business segment rather than the water use data and that the coding systems were not perfect (E13). The second person said that there was quite a poor understanding of diurnal demand and contributing factors to non-residential demand and that having the data would enable “constructive engagements” with commercial customers to “unpack” their end-uses that cause spikes in demand (E27).

No estimation of the extent of the benefit was recorded but by agreement with the benefit has been rated as “Improve”.

Q34: J15. From your experience/knowledge will water business be able to develop diurnal curves for high-rise buildings and multi-unit properties and to what extent? BACKGROUND: High-rise and multi-unit developments are special customer groupings and may have different demand profiles based on the numbers of residential units and the commercial businesses within the complex and the common areas that are not sub-metered. Data from digital water metering of properties within the complexes may be able to be used to develop curves for high-rise and multi-unit properties.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
11	0	0	1	0	10	0
Extent of Benefit: Negligible Marginal Improve Significant Substantial						
9 1 1						

Again an expert from a regional water utility only provided a low level of agreement saying that it was well down on their priorities (E22). Two other experts from regional water utilities were supportive of the benefit and nominated different segments that diurnal curves could be developed for (E59) and the use of machine learning techniques as a method of finding like segments (E51). The other experts supported the benefit (E15, E24) with two considering it to have rich data (E19) and substantial benefit when sub-metering is used (E27). Another person took a similar supportive view saying “particularly so when the main meter is included in the analysis” (E66). Others mentioned that individual units are not metered in some of their areas but that much more information would be available (E26, E71) and that individual building hydraulics needed to be understood as many buildings had header tanks that could result in apparent spikes in demand (E13).

Q35: J16. From your experience/knowledge will water business be able to develop reverse modelling of household characteristics via the demand pattern and to what extent? BACKGROUND: It is suggested that household size, irrigation use, presence of water tank and evaporative cooler use might be able to be modelled using demand patterns gained from hourly usage data across seasons using reverse modelling from previous end-use studies.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
11	3	0	1	0	7	0
Extent of Benefit: Negligible Marginal Develop Significant Substantial						
				7	1	

One person thought that this benefit may be possible (E19) while the other seven considered it a real benefit with one stating that their water utility was keen to reverse model household characteristics as water tanks and evaporative coolers were emerging as a big issue and they did not understand irrigation well (E22). Another suggested that they would be able to identify many characteristics from their diurnal pattern (number of people, existence of a garden, young kids, their level of water efficiency, etc) (E15). It was suggested that segmentation mathematics would allow for a better understanding of homes and their usage even with hourly data (E27). Data from existing end-use studies was seen as a being useful to make reverse modelling estimates but that the results would be subject to considerable uncertainty (E66). But privacy sensitivity was raised as an issue and hourly resolution was seen by one water utility as preventing the data being decomposed to identify types of consumption (E51).

2.3 Shared benefit questions – Detail

2.3.1 Customer Interaction: Complaints

Q36: L11. From your experience/knowledge will digital water metering lead to reduced customer billing complaints and to what extent? BACKGROUND: Billing complaints such as high-bills, estimated reads and mis-reads could be reduced if customers are provided with access to greater information about their water usage. In particular, if they are alerted to leaks early and if they could access an online portal for hourly or daily usage records from digital water meters.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
17	1	3	0	0	13	0
Extent of Benefit: Negligible Marginal Reduce Significant Substantial						
				8	3	2

Three people did not see that there would be a reduction in customer billing complaints (E35, E68, E89) but they did believe that the resolution of the complaint would be more straightforward to resolve (E35), make for more positive conversation (E89) and, if real time alerts for spikes are sent, the quarterly bill shock cases would be greatly reduced (E68). Of the thirteen who did agree with the benefit, two believed the reduction would be substantial as the high water consumption complaints were expected to be eliminated and put more information on their consumption into customers' hands, improving their knowledge and lead to more efficient behaviours (E40, E49). One person noted the positive impact of the availability of usage data on case handling in the electricity sector (E82), and reducing the use of bill estimation, the incidence of miss-reads, early detection of high usage through customer self-service and leak alerting were all seen as leading to a significant reduction in billing complaints (E33, E64). Some experts believe that billing complaints might increase initially especially if old slowing meters were replaced and the new meter was now recording correctly a higher usage (E20, E22). One person thought that there may also be new complaint types about the digital meters themselves including about missing data and accuracy (E59) and also about the digital meter rollout and installation (E20).

The extent of the benefit was nominated by one person as 50% reduction in billing complaints (E55) while two considered the benefit to be substantial, three considered the benefit as significant and the other eight though the benefit to be real.

Q37: L12. From your experience/knowledge will digital water metering lead to reduced external costs of Ombudsman (eg. EWOV) referred complaints and to what extent? BACKGROUND: Water Ombudsman (for example the Victorian Ombudsman) charges water companies a fixed annual fee based on the companies number of customers and a processing fee per complaint based on the effort to resolve the issue. Digital water metering may reduce the number of complaints referred to the Ombudsman and so could in turn reduce the costs to the water company.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
17	2	3	1	0	10	1
Extent of Benefit:						
	Negligible	Marginal	Reduce	Significant	Substantial	
		2	8	0	2	

Three experts did not agree with the benefit of reduced external cost of Ombudsman handled complaints because the Ombudsman would need to recover their costs (E92), and they expected an increase at least in the short to medium term as happened in the electricity industry (E20, E35). At the same time two took the opposite view and said the benefit would be substantial as the number of complaints was expected to “reduce dramatically” (E59) and in response to the use of a proactive approach of early alerting customers to high usage (E27). One person noted that customers currently go straight to the Ombudsman with their complaint but that was expected to change when customers are alerted to leaks and high usage by the water utility or become aware of usage spikes through a self-service portal (E49). The improved staff access to usage data was seen as a catalyst for early resolution of complaints even if the Ombudsman becomes involved (E22, E64, E68, E82, E89). One person cautioned that complaints might increase if there was a widespread technical problem resulting in extreme customer dissatisfaction (E27). And another thought that the Ombudsman should back up the data from the digital meter and not expect money to be taken off the customer’s bill (E17).

Q38: L13. From your experience/knowledge will digital water metering lead to **reduced internal costs of Ombudsman (eg. EWOV) referred complaints** and to what extent? BACKGROUND: Considerable water company staff time and therefore costs may be incurred when complaints are referred to the Ombudsman. Many billing complaints centre around billing issues are unresolved and referred to the Ombudsman. Billing complaints may be reduced through digital metering eliminating such issues as reading errors estimated reads and concealed leak high-bills and could be expected to reduce the billing complaints presented to the Ombudsman and therefore internal costs.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
17	2	0	0	2	13	0
Extent of Benefit:						
	Negligible	Marginal	Reduce	Significant	Substantial	
		2	11	2		

Interestingly the profile of responses to this internal cost of Ombudsman complaints did not match the external costs benefit. All fifteen experts who answered the question agreed that their water utility would have reduced internal costs. It was expected that many complaints would not get to the Ombudsman and so save money (E59, E82), there would be fewer complaints (E17, E92), staff would

have access to more accurate data (E64) and possibly stressful field investigation trips would be reduced (E20, E27, E68).

Q39: L14. From your experience/knowledge will digital water metering lead to improved outcomes from billing disputes and to what extent? BACKGROUND: With more data to draw on from digital water metering and customer self-service through a portal it is suggested that billing disputes could be avoided and if they do occur they could be resolved more quickly and amicably.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
17	0	0	1	1	15	0
Extent of Benefit:						
	Negligible	Marginal	Improve	Significant	Substantial	
			13	3	1	

All seventeen experts agreed to some degree with this benefit. Disputes over meter reading were expected, by one metropolitan water utility expert, to reduce dramatically because of internal access to the data allowing more timely responses to billing disputes and directing customers to read the data through a self-service portal (E17). Three experts shared the view that the improvement in outcomes would be significant due to the increased amount of data confirming the customer's usage (E20, E27, E40). One person thought customers may be less likely to dispute high accounts as they are made aware of issues when they arise (E49) and another considered that there would only be the potential for an improvement (E33). Of the other experts many pointed to the increased availability of data to enable better outcomes for the water company (E22, E64, E81, E82, E89, E92) and a reduction in estimated reads to reduce the number of complaints (E68). It was felt that disputes would only be reduced if customers are able to correlate the data with their water use actions and make sense of them suggesting the need for significant customer education during the rollout (E35).

2.3.2 Customer Interaction: Customer Assistance Programs

Q40: L15. From your experience/knowledge will digital water metering lead to reduced HULA (High Usage Leak Allowance) costs from concealed leaks and to what extent? BACKGROUND: Quarterly billing means that concealed leaks at properties can run for long periods before the customer becomes aware of the issue through a high usage and bill. Water companies' customer assistance programs for concealed leaks may be limited to the time when the customer contacts the water company about their high usage/bill. Earlier alerting of customers to possible leaks at their property (based on data from digital water metering) could significantly reduce the water company's assistance cost (through their HULA program).

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
17	0	0	0	0	16	1
Extent of Benefit:						
	Negligible	Marginal	Reduce	Significant	Substantial	
			8	6	3	

This benefit received universal and solid agreement from the experts and over half (9 of 17) indicated that the extent of the benefit would be substantial or significant. One person summed up a lot of the comments when they said that most water utilities have large HULA budgets and that digital metering would allow them to assist customers in a proactive way rather than being reactive (E49). While one person cautioned that alerting customers to leaks did not mean the leak would be fixed (E64) others nominated that the period of liability would be limited by the date that the customer was

alerted (E17, E20, E22, E27, E68). One person referred to a commercial initiative (the Schools Water Efficiency program) where data loggers identified leaks but no allowance was provided and they reported that the response from the schools was good (E17). This raises the possibility of not having any allowance program and, instead, putting the money into support programs, including educating customers to reduce the impact while waiting for the repair, where capacity to pay for the repair is an issue (E35, E68). Savings from the benefit are expected beyond the allowance amounts with additional savings from internal labour costs for field investigations (E65) and phone calls and follow-ups (E17).

Two of the experts nominated savings of 80% (E27, E55) and others used phrases such as “reduce significantly” (E35, E89) and “reduce dramatically” (E22, E81) in their answers.

Q41: L16. From your experience/knowledge will digital water metering lead to reduced plumbing assistance costs and to what extent? BACKGROUND: Some water companies run plumbing assistance programs to provide disadvantaged customers with access to funds to repair and replace water appliances. Early detection of issues based on digital water metering data may reduce the extent of the problem and therefore the assistance expense per customer allowing more customers to be assisted within program budgets.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
17	2	5	1	2	7	0
Extent of Benefit:						
		Negligible	Marginal	Reduce	Significant	Substantial
			1	5	4	

Unlike the benefit to HULA program budgets, the benefit of reduced plumbing assistance programs was mixed with five not agreeing with the benefit, three with only muted support and seven nominating a real benefit. Of those that disagreed, two thought the plumbing assistance program costs might need to increase due to more issues being identified (E89) and when capacity to pay was a factor in completing the repair (E35). Those that supported the benefit thought there would be less credit problems from customers unable to pay high bills from leaks (E22, E82) and earlier identification should reduce the size of the problem (E20, E59, E64, E68). The others thought the assistance costs to be minor or unchanged because most plumbing assistance programs related to leaking hot water systems or broken toilets (E92), many more but smaller problems would be identified and assistance would need to be confined to certain cases (E27), the program at their water utility had a very small allocation (E33) and that the audits that their water utility provides would still be required to help customers not able to interpret data (E17).

A further benefit in this category, **reduced Government assistance grants**, was not included in the survey.

2.3.3 Customer Interaction: Credit Management

Q42: P11. From your experience/knowledge will digital water metering lead to reduced supply restriction case costs and to what extent? BACKGROUND: When payment is withheld by a customer the water company may eventually restrict the flow into the property in order to reduce their potential ongoing losses. This requires a crew to attend the property to effect the restriction and then again once the non-payment issue is resolved. Digital metering with leak alerting, online access to usage data and bill prediction may reduce the issues that lead to disputes and to the restriction of service cases and therefore costs.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
6	0	0	1	1	4	0
Extent of Benefit: Negligible Marginal Reduce Significant Substantial						
1 4 1						

The six experts who answered this question all agreed with this benefit but one thought it as small (E89), fewer estimated bills and more correct bills would result in customers more likely to pay (E63) and in fewer cases and lower amounts (E22). Another expert noted that the customer would have less legal recourse as the water utility would have the chain of evidence and the lack of action on the customers' part and pointed out that digital metering puts the onus on the customer to action problems quicker as they have little excuse for not knowing of issues (E27).

Q43: P12. From your experience/knowledge will digital water metering lead to reduced debt recovery/legal action case costs and to what extent? BACKGROUND: When payment is withheld by a customer the water company may undertake debt recovery processes including taking legal action in order to recover their losses. Digital metering with leak alerting, online access to usage data and bill prediction, may reduce the issues that lead to disputes and, to the cost recovery and legal action cases and, therefore, costs.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
6	0	0	1	0	5	0
Extent of Benefit: Negligible Marginal Reduce Significant Substantial						
1 5						

The responses to this benefit were similar to the previous question on water utilities restricting flows with the additional comment that the digital data could be used in legal disputes (E59) and that the debt recovery process could be accelerated with detailed evidence and customers unlikely to have an argument to delay making payment (E27).

2.3.4 Customer Interaction: Customer Interactions

Q44: L17. From your experience/knowledge will digital water metering lead to reduced contact centre calls and to what extent? BACKGROUND: Customers with an online account portal in which they can see their water usage are more likely to visit that site to resolve their billing enquiry as they have 24x7 access to the portal to avoid having to wait until business hours to call and then getting caught in telephone wait queues and telephone IVR systems.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
17	1	5	1	0	7	3
Extent of Benefit: Negligible Marginal Reduce Significant Substantial						
11						

The benefit of reducing contact centre calls attracted spilt response with five not agreeing and 11 agreeing, three strongly. Those that disagreed suggested that calls may actually increase (E40, E89) or that the calls would be different and more positive rather than complaints (E49, E68). Of those that agreed that calls would reduce some also felt that calls might increase initially (E17, E20, E22, E64) and

that the calls would be about using the new portal system, general concerns about digital meters and customers seeking information about something in the data that they want explained (E17, E20, E64). The provision of a portal to enable customer self-service was seen as important (E35, E59, E64, E82, E92). Whether or not customers would use the self-service portal was questioned by one expert who pointed out that most electricity users don't use the service (E82).

Q45: M11. From your experience/knowledge will digital water metering lead to enhanced communications and to what extent? BACKGROUND: With more data of a customer's usage available, water companies might be able to provide more detailed information on bills and through an account portal.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
16	0	0	1	1	13	1
Extent of Benefit:						
Negligible				Marginal	Enhance	Significant
					15	1
						Substantial

The experts all agreed with this benefit. The two who provided muted support thought that it was possible through an account portal (E33) and that in large organisations bill information may not get to people outside Accounts Payable and in commercial situations the management arrangement may hinder or block information getting to the right people (E76). However others provided comments such as "better communication with less effort" (E59), "more available information to pass on" (E49), "comms will become tailored to the customer" (E92), and, "digital meter data would be the foundation for personalised customer experiences" (E22). Others referred to water utilities being able to be more proactive (E68, E37) and providing more targeted communications to the customers' usage and needs (E19, E26, E64). One expert noted that water utilities need to make people comfortable with digital meters through engagement and, after that, conversations would be enhanced as both parties shared information empowering each other to understand what each is talking about (E40). Another said that water was a "low involvement product" and the additional data helped as a point of engagement about something customers care about and want help with managing their bills and leakage (E18).

2.3.5 Customer Interaction: Goodwill

G46: F11. From your experience/knowledge will water business gain an improvement of value of goodwill from information sharing with their customers and to what extent? BACKGROUND: Customers may appreciate being alerted to possible leaks and to have access to more detailed water usage information from their water company on which they can make better decisions.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
26	1	0	0	4	19	2
Extent of Benefit:						
Negligible				Marginal	Improve	Significant
					21	4
						Substantial

This benefit question attracted a large number of responses possibly as a result of being in a block of goodwill questions open to all experts. Two experts strongly agreed with one describing the opportunity for water utilities to provide a holistic approach to what would have otherwise been a very negative experience (E68), and the other simply saying customers would definitely value the information sharing and water utility services more (E22). The four less certain experts mentioned

customer disinterest unless they had a billing issue (E15), goodwill would only come if the data made sense and was easy to digest (E35), that customers might be suspicious of Governments collecting more data and that water utilities needed to be careful how they shared the data (E14), and, a previous study of in-home displays found that initial interest in the data lead to changes in customer water usage but declined after a two month period (E91). Experts expected that water utilities sharing information would provide a higher level of confidence for the customer in discussions with their supplier (E76), that the majority of customers are very grateful when alerted to leaks but then there are customers who blame share and want a reduction in their water bill (E31), that transparency and information sharing could improve the relationship between customer and utility (E59). And, another expected that their water utilities relationship with customers would strengthen, especially if the benefits of the digital meters are socialised when the meters are introduced (E25). Another shared this view and pointed out that customers naturally distrust digital meters and that distrust would need to be overcome (E40). The past negative impact of the electricity smart meter rollout was raised when an expert questioned if electricity customers had benefited from the increased information available due to electricity smart meters (E70) ? But the needs of different customers was the subject of one answer. It was pointed out by one expert who agreed with the benefit said that some customers, particularly large users, were frustrated by the lack of detailed information from their water utility to use for analysis in order to optimise their water usage, and, while some might install data loggers themselves, most expect water utilities to provide this data (E90).

Q47: F12. From your experience/knowledge will water business gain an improvement of value of goodwill from new products and services and to what extent? BACKGROUND: Customers may appreciate a range of quality and flexible products and services and gain some economic value from them.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
26	10	1	1	2	12	0
Extent of Benefit: Negligible Marginal Improve Significant Substantial						
			1	14		

Many of the experts did not choose to offer an opinion on this benefit. The one expert who did not agree with the benefit said that their water utility had not considered new products and services and that research by the Intelligent Water Network (IWN) showed that customers were not interested in new services (E51). But twelve agreed with the benefit and another three offered muted agreement. Eleven that agreed were from metropolitan water utilities (metros) and four from regional water utilities. Among the metro experts it was believed that customers valued a modern and flexible service and that digital water metering provided scope for this (E35), that it was a level of service customers already have access to from other businesses such as electricity, gas, banking, insurance and retail (E64), the provision of self-service portals and in-home displays was seen as part of this (E68, E81) and tailoring or individualising products and services was a common response (E15, E17, E64). A warning was issued that if the services were seen as a "selling channel" customer satisfaction may drop (E89). Consistency of approaches and clear product ranges across water utilities was recommended (E24). Among the experts from regional utilities, it was thought that customers would appreciate real time information on other products (E49), that customers would like to learn more about their consumption and "spin-off" benefits such as flexible bill payments and leak detection that put customers in control (E14), and the better service and assistance to save water would be appreciated (E59). One warned that customers would see new products and services as revenue raising if offered too soon after the rollout and that proving the benefit was required to achieve customer goodwill (E40).

Q48: F13. From your experience/knowledge will water business gain an improvement of value of goodwill from customer recognition of operational efficiency and capital management and to what extent? BACKGROUND: Customers may appreciate that their water company is improving its efficiency, investing prudently and utilising contemporary technologies.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
26	5	4	5	1	11	0
Extent of Benefit:						
	Negligible	Marginal	Improve	Significant	Substantial	
		3	13	1		

Of the 26 responses to the question of goodwill benefit from digital metering operational efficiency and capital management, five did not offer an opinion, four did not agree, six offered muted agreement and eleven were supportive that it was a real benefit. Two of the four who did not agree believed customers expected these improvements as a part of ongoing business development (E15, E35) and the other two simply said "no" or "probably not" (E22, E89). Two who offered muted support also thought that some customers expected water businesses to move in this direction and others would appreciate the changes (E64, E68). Two experts thought that customers would only appreciate these changes if it translated to keeping bills low (E51, E66). Another thought that the appreciation would be among the major (Government) stakeholders rather than customers (E40).

Among the experts that supported the benefit some believed that customers had already advised that they would value utilities investing in the future and technology to improve efficiency (E49, E80, E81), but cheaper cost of water was seen as the trigger for improved goodwill (E24, E25, E31, E59, E81). Other comments included the need to socialise how the savings result in direct savings on water bills (E25), individualised and segment analysis of usage in an accurate and time segments would improve confidence in the water utility (E76) and one expert pointed out that only 30% of customers at their water utility were interested in digital meters and the benefits and might be willing to pay for it while others thought that the cost should be borne by the water utility (E90).

Q49: F14. From your experience/knowledge will water business gain an improvement of value of goodwill from more flexible tariffs and to what extent? BACKGROUND: New tariff options offered by water companies may increase customer choice which customers will appreciate and possibly gain benefit from.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
26	7	2	2	4	11	0
Extent of Benefit:						
	Negligible	Marginal	Improve	Significant	Substantial	
		1	15	1		

While seven experts chose to not offer an opinion, two said they did not agree one noting that feedback from customers showed that they did not want more flexibility in tariffs and that the experience from the electricity lead to higher bills (E51) while the other pointed to different tariffs creating winners and losers among customers as the company looks to collect a set amount of money but acknowledged the potential for water conservation (E15). This last person (E15) felt that it was often large families and those struggling to pay that were impacted by tariff changes, but another expert thought that large families are disadvantaged by the current 3-step tariff (unless in a hardship program) and that a range of tariff options may help (E17). Others thought that a small segment of

customers would benefit from flexible tariffs (E70), that tariffs could offer cheaper rates based on time of day usage (E59), and, that there was a potential to alter behaviour and reduce peak demand using new tariff structures (E17, E25, E81, E91). Most thought goodwill would be improved (E35, E40, E59, E61, E64, E76, E81) and one thought it would be a great outcome if behaviour patterns were changed and customer bills were reduced (E25). Some expressed some doubt with one declaring that customers were anti-Time of Use tariffs because of the “electricity debacle” (E22) and that any change needed to be made transparently (E35, E40).

2.3.6 Regulation/Compliance: Metering

Q50: D33. From your experience/knowledge will water businesses be able to use digital water meter data to improve meter sizing for non-residential customers and to what extent would they benefit? BACKGROUND: It is possible to log usage data at high frequency. For different customer types profiles might be developed from a sample of customers. It may then be possible to use simulated modelling based on these segment peers to work out the meters that best fit the operating characteristics of each business.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
16	2	0	1	1	12	0
Extent of Benefit:						
	Negligible	Marginal	Improve	Significant	Substantial	
		1	11	2		

Two experts thought this only somewhat possible (E22) and a small benefit but complex to implement (E89). Others agreed that this would be possible (E25, E31, E90) and a real benefit with one declaring use of digital meter data a “good way” to determine the correct meter size (E59) and, that digital meters would allow better understanding of customer usage patterns and this could be used for estimating new, similar meter size requirements (E40, E41, E81). Three experts considered in their answers the issue of existing properties and change to property use impacting meter performance (E17, E26, E58).

The extent of the benefit was rated significant by two experts mainly due to early identification of incorrect meter size for property use (E17, E26).

Q51: D34. From your experience/knowledge will water businesses be able to use digital water meter data for tighter meter performance/NMI compliance monitoring and to what extent would they benefit? BACKGROUND: Meters are required to operate within accuracy limits (+/-4%). Using data analytics it may be possible to effectively undertake in-situ testing from the desktop when data is collected frequently and at regular intervals.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
16	2	3	1	1	8	1
Extent of Benefit:						
	Negligible	Marginal	Improve	Significant	Substantial	
			9	2		

Of the three that did not agree with this benefit one said that their water utility did not follow population sample testing to the standard (E22), another said that the technology was yet to show this capability (E40) and the third did not believe that meter accuracy could be assessed from the desktop (E41). Two thought the meter could perform the test via on-board fault diagnosis (E26, E27) while

another thought that digital meters should not be mechanical but magnetic flow or ultrasonic instead (E70). Others said that if usage fell outside the normal range it could be identified quickly (E31, E72) and trend analysis should identify non-compliant meters (E59). Three experts believed this to be a huge benefit as it could cover the whole fleet (E33, E81) and eliminate the need to remove meters when customers disputed the meter's accuracy (E17, E81).

Q52: D35. From your experience/knowledge will water businesses be able to use digital water meter data to undertake meter failure analytics and to what extent would they benefit? BACKGROUND: It is speculated that changes in usage recorded over time or a gradual shift away from a customer's peers within a segment may be an indicator of declining performance and that data analytics could identify these failing meters.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
16	2	0	3	1	9	1
Extent of Benefit:						
		Negligible	Marginal	Improve	Significant	Substantial
			2	9	3	

Two experts believed the benefit to be marginal because there were low failure rates in meters under 10 to 15 years but that it may be useful if meter life was extended (E58) and, that there may be some benefit in identifying slowing meters (E89). Three experts considered the benefit significant. One thought that meter failures would be known much faster (E26). Another believed that, for their water utility, a huge portion of their non-revenue water was a result of failed meters on large customers where the failure was not identified earlier (E40). The third expert thought it would result in a good relationship with customers (E25). Of the other experts, one thought there would be more clarity on meter failure and provide faster feedback to suppliers on performance issues (E90), another thought it need to take into account socio-economic issues to account for consumer behaviour and household characteristic changes (E59), and an expert said that failed meters could be identified with property waste bin pickups showing that the property was not vacant (E31). Again, there was an expectation that on-board fault diagnostics should be possible and that the extensive data sent to the server would allow meaningful analysis for fault finding and exception reporting (E27).

Q53: D36. From your experience/knowledge will water businesses be able to use digital water meter data for meter silting detection (large meters) and to what extent would they benefit? BACKGROUND: It is speculated that a gradually decreasing trend in water consumption over time may provide an indicator of meter silting problem in large meters.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
16	11	0	0	1	4	0
Extent of Benefit:						
		Negligible	Marginal	Detect	Significant	Substantial
				5		

Eleven experts did not offer an opinion on this benefit. The other five agreed with one who only somewhat agreed (E90). One expert thought this only a benefit if the meters were mechanical (E70), another thought proper meter trend analysis was required (E59), another said that a long period of data would be required and there may be other external influences at work (E58), and two agreed with the benefit but without sufficient experience to offer further comment (E25, E90).

Q54: D37. From your experience/knowledge will water businesses be able to use digital water meter data to detect revenue losses caused by declining or failed meter accuracy after break in main and to what extent would they benefit? BACKGROUND: Meters that are located downstream of breaks in the network may have their accuracy compromised by grit and other sediment entering the pipe at the break despite flushing and other preventative actions.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
16	3	0	2	1	10	0
Extent of Benefit:						
	Negligible	Marginal	Detect	Significant	Substantial	
		1	10	2		

Two experts believed this was only a benefit for mechanical meters as static measurement meters were less susceptible to grit contamination (E41, E70). While there was general agreement with the benefit by other experts (E17, E25, E27, E33, E59, E89, E90), again it was stated by one expert that “smarts” within the meter would be required to enable on-board NMI compliance (E26), and one expert thought that network sensor technology and meter data together could be used to detect affected meters (E40). An expert from a mid-sized regional water utility described only having 100 main breaks a year on a service area for 40,000 customers and, that for each only between 10 to 30 houses might be affected so, with flushing to establish water turbidity below 1 NTU the likelihood of grit remaining was considered low (E68). Another expert described having seen large meters speed up with grit caught in the meters and smaller (20mm residential) meters stop due to grit damaging the piston and customer’s back flow prevention devices, and agreed with the potential of the benefit (E81).

2.3.7 Regulation/Compliance: Monitoring

Q55: P13. From your experience/knowledge will digital water metering enable automated regulation compliance monitoring and to what extent would water companies benefit? BACKGROUND: Water companies are sometimes required to impose water restrictions or implement bans on some water uses. These restrictions and bans are a water conservation measure and are intended to be equitable for all citizens - eg. Odds/Evens garden irrigation, winter ban on irrigation. Using the hourly data from digital water meters, data analytics may identify breaches which could then be investigated.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
6	2	2	0	0	2	0
Extent of Benefit:						
	Negligible	Marginal	Detect	Significant	Substantial	
				2		

Two experts did not offer an opinion on this benefit, two did not agree with it and two did agree. Of the two that agreed, one expert believed that digital water meter data would enable regulation compliance monitoring but that it would then require a “truck roll” and customer visit (E89) and the other cautioned that sometimes data analytics could not distinguish between legal and illegal use and gave the example of garden irrigation and filling the bath (E59). Of the two that disagreed with the benefit, one expert said that compliance monitoring was very easy but then said that, armed with new knowledge of the very many people who might be flouting the restriction, they may not choose to act but send targeted warnings instead and follow-up with enforcement if the bad behaviour continued (E27).

Q56: G16. From your experience/knowledge will water business be able to gain a reduction in audits required (through targeted SWM water quality testing) and to what extent? BACKGROUND: As part of the establishment of the AMR, separate water quality sensing devices or multi-purpose digital meters may be established to automate some water quality monitoring or corrective actions. For example, data analytics of complaints and actual hourly demand readings may help establish better chlorine dosing levels by time of day and day of week.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
9	3	0	1	0	5	0
Extent of Benefit:						
	Negligible	Marginal	Gain	Significant	Substantial	
		1	4	1		

While three experts did not provide an opinion, all six experts that answered this question agreed with the benefit. One expert cautioned that electronic water quality testing was in its infancy and that most digital water meters did not have the salient parameters on-board but the benefit was a potential spin-off of establishing an IoT network for digital meters (E51). One expert thought the benefit minimal as they expected lab testing to still be needed but it would lead to the early identification of issues and prevent incidents (E22) while another expert thought digital meters could assist with non-biological indicators (E15). But two experts thought that each customer's digital water meter could incorporate data logging to capture water quality parameters and be linked to the monitoring system with interpolation between sensors allowing water utilities to fully understand water quality changes across the water network (E27, E59).

2.4 Customer Benefit Questions – Detail

2.4.1 Customer Service: Usage Cost

Q57: K11. From your experience/knowledge will customers be able to reduce costs by being alerted to leaks at their property and to what extent? BACKGROUND: Early detection of leaks at properties and alerting the customer may be enabled by digital water metering and might significantly reduce the time that leaks run before repair and therefore reduce the cost impact on customers.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
27	0	0	1	0	21	5
Extent of Benefit:						
	Negligible	Marginal	Reduce	Significant	Substantial	
			15	10	2	

This benefit attracted the most responses and support with twenty-six experts agreeing or agreeing strongly with only one extending just muted support. Two considered the extent of the benefit to be substantial, ten rated it significant and the remaining seventeen considering it a real benefit to reduce customers' costs.

One ex-water utility expert now working in a sustainability role described how the water bill at one work site had jumped 10-fold, from \$8K/yr to \$80K/yr, with most people considering the cause water theft from hydrants. But after installing data loggers the cause was demonstrated to be a leak and after repairing the leak the usage returned to historic levels. The expert went on to describe how, not long after finding the leak, these data loggers identified a burst that had occurred in a disused area of the site. That burst was wasting water at of 1500L/min which could have resulted in a waste of 60ML of water in the next bill.

One person consider this leak alerting benefit to be the biggest benefit after more frequent billing (E22), another considered it the largest benefit (E81) another stated that waiting for the quarterly bill was inefficient (E58), and another stated that the large number of vulnerable customers at their water utility find themselves in financial difficulty due to undetected leaks (E49). Others comments included that early identification of leaks would reduce bill shock (E33), the alert would be up to 3 months earlier than current (E26), alerting will meet the stated need of customers to be made aware earlier (E17), for dwellings built on sandy soil an alert might be the first indication of a leak (E31), and, from a trial, customers on rural properties may not notice issues occurring out in their paddocks and were appreciative when advised of a possible leak (E74). One expert was more muted in their support of the benefit stating that when leaks are small the cost of repair may exceed the cost of water (E39).

Some nominated figures for customer costs or numbers of customers impacted by leaks: “residential leaks area common and large undetected leaks can cost customers \$100's of dollars” (E45), (in a regional water utility) the utility reduced around 260 concession application to just 86 in two years (E32), in a metropolitan utility trial, water savings totalled 7-10% (E90), another expert estimated water savings of 5-10% “with little effort” (E27), and, an expert at another regional water utility estimated that alerting would help 80% of their customers with concealed leaks on properties (E55).

Q58: K12. From your experience/knowledge will customers be able to reduce their water use through awareness and education and to what extent? BACKGROUND: Providing customers ready access to their water usage through an online portal could provide them with opportunities to modify their water demand.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
26	0	0	0	1	24	1
Extent of Benefit:						
		Negligible	Marginal	Reduce	Significant	Substantial
			2	20	3	1

This benefit attracted almost as much support as the leak alerting benefit. One of the experts who considered the extent of the benefit to be marginal expected the main benefit to be to commercial buildings and in most cases actual water users will not be affected by the information (E76), and another expert thought that most consumers would not care very much as the care factor only increases as bills rise (E81). But the expert who agreed the strongest believed that water utilities could be very targeted in their demand management information to customers and be able to quickly reduce per capita consumption from 170L/p/d in half the time of the past drought, and they considered knowledge of customers the main benefit of digital metering (E27). Of the three experts that considered the extent of the benefit to be significant one said that previous studies (Suez case study in Singapore) showed significant savings were achieved through the right behaviour change programs leveraging the data from digital meters (E18), another said that customer self-service monitoring of their real time usage, where they could identify leaks and receive advice as to how much the leak would contribute to their next bill if not fixed, could change their usage behaviour (E68), and, customers could identify where they could make water savings, and communications and education can be more tailored when based on this accurate data (E64).

Three experts that agreed with the benefit wondered if the novelty of accessing water usage portal might wear off over time and one considered alerting would probably work better (E33, E72, E74). Another expert agreed but believed that not all would or could use a self-service portal, especially the customers who are old and “not technology rich” (E58). One expert of a regional utility estimated that customers might reduce their water use by 50% with awareness and education (E55)

while another thought the figure for their metropolitan utility to be between 7% and 10% (E90). An expert of a water utility that provided customers with the myh2o water usage portal that allowed the customer to see their water use each day, their costs and receive high consumption and water leak alerts indicated that water savings from 300 L/p/d to 283 L/p/d (E32). Echoing this view, another expert pointed out that portals could provide water saving tips (E37). Similarly to these views, an expert at a metropolitan water utility said that unexplained high bills was a huge driver of calls to their call centre and enabling and educating customers to use a portal to access their data puts them in control and makes them aware of how much their appliances use, especially in summer (E17).

Q59: K13. From your experience/knowledge will customers be able to be more water efficient and reduce their bill through bill prediction and to what extent? BACKGROUND: Systems and processes that use forecasting techniques could be set up to provide customers to a portal that could include a bill prediction based on previous usage patterns and billing period-to-date from digital water metering.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
26	6	1	3	2	14	0
Extent of Benefit:						
		Negligible	Marginal	Reduce	Significant	Substantial
			3	15	1	

Six experts did not offer an opinion on whether customers could be more water efficient with bill prediction, one did not agree, five gave muted support and fourteen considered it a real benefit. The one expert who did not agree with the benefit felt that customers could do this already with standard meters and could not see how bill prediction based on digital meters could help further (E72). The five experts who offered muted agreement thought the bill prediction would help to a small extent (E18, E22), or help only a small number of customers (E89), and, would only be useful where the customer could identify recurring water saving changes (E68, E76). But one expert from a regional water utility nominated a saving of 60% through bill prediction (E55), another expert suggested that customers should be able to nominate a review point at a percentage of their normal use (E27), another person said that they personally used it for electricity and found it helpful, especially in winter where they were prepared to pay more to stay warm, and they thought that the same might apply to gardeners for irrigation (E58).

One expert cautioned that water was perceived to be a non-discretionary product so the impact might be less than for other utilities such as electricity (E19). But others thought it put customers in control, aids their budgeting and they could modify their usage or ask for help from the water utility earlier (E17, E31, E49, E59, E64). Two noted that such services required the customer to engage with the system for it to be effective (E26) and that when advertising material was sent out with the water bill about the myh2o portal at their water utility more customers would sign up and monitor their expenditure (E32).

Q60: K14. From your experience/knowledge will customers be able to be more water efficient and reduce costs through monthly billing and to what extent? BACKGROUND: Monthly billing would provide earlier feedback to customers on their recent usage to which they could react to control their use.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree	
26	5	1	2	5	13	0	
Extent of Benefit:			Negligible	Marginal	Reduce	Significant	Substantial
			2	2	15	1	

1001 One expert who did not agree with the benefit of more water efficiency and reduced costs
1002 through monthly billing did comment that when leak alerts were provided that that was where the
1003 savings would come from, that it depended on the diligence of the customer to saving costs or interest
1004 in sustainability, that it may appeal to big non-residential customers but believed that the majority of
1005 customers would not want monthly billing and that it should be discretionary if introduced (E72).

1006 Of the seven experts that offered only muted agreement one thought that the extent would be
1007 negligible as price elasticity and the variable component of the bill indicated that the vast majority of
1008 customers would not change their behaviour (E89), large water users tended to closely monitor all
1009 their resource usage already (E76), while monthly billing provided more regular feedback it alone
1010 would be unlikely to change behaviour (E26), and others used terms like “to some extent”, “could”
1011 and “maybe” (E22, E73, E76, E81). One expert cautioned about the increase in costs including postage
1012 and the change to call centre activity (E17) but another expert conceded that monthly bills are easier to
1013 pay (E81).

1014 Of the other thirteen that agreed with the benefit one nominated a saving of 70% which was for
1015 customers in a regional water utility (E55). And, contrary to the expert that did not think customers
1016 wanted monthly billing, one expert said that customers do ask for monthly billing as they find it easier
1017 to form a budget month to month rather than quarterly (E49). Two experts mentioned that monthly
1018 billing empowered customers to manage their water better (E27) and change their behaviour
1019 especially during heavy usage periods because the monthly billing was more timely (E64). One expert
1020 thought the impact would be marginal (E19), another thought it would influence some customers
1021 (E90), while others pointed to customers being able to do the same through a self-service portal (E18,
1022 E31, E37) and, one expert pointed out that customers could be vigilant now and cautioned that
1023 monthly billing would cost more (E71). Lastly, an expert with more than 20 years in the industry and
1024 experience with a digital meter rollout stated that customers who have continuous access to their
1025 usage tended to be more water wise (E59).

1026 Q61: L18. From your experience/knowledge will digital water metering lead to a reduction in
1027 insurance claims by customers and to what extent? BACKGROUND: Customers' insurance claims
1028 involving water use include water theft from behind the meter and damage to properties caused by
1029 concealed leaks. Digital metering could help to reduce these claims through early detection of
1030 anomalous water use patterns, access to data through a portal, bill prediction and customer set alerting
1031 rules.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree	
17	12	1	0	1	3	0	
Extent of Benefit:			Negligible	Marginal	Reduce	Significant	Substantial
					2		2

1032 The benefit was aimed at customers experiencing insurance claims from concealed leaks after the
1033 meter (as indicated by the background information) but five of the experts took it to be about claims

against the water utility. These have been moved to the “Don’t Know” column in the table above and so making twelve experts that did not offer an opinion on this benefit. One expert said that they did not agree with the benefit, one who somewhat agreed and three who agreed. The person that disagreed said “No, not to my knowledge” (E40). The other four all pointed to earlier identification of issues and the potential to reduce the impact of the issue, particularly from concealed leaks impacting internal walls, slabs and floor boards (E17, E27, E59, E68).

2.4.2 Customer Service: Complex property/multiunit usage reconciliation

Two benefits were identified after the start of the survey: faster and easier reconciliation of bills for properties with multiple accounts, and, identify plumbing irregularities in properties with complex plumbing. These were not put to the experts, however three experts, in answers to other benefit questions, thought that digital water meters would enable these benefits.

To the benefit of “reduced residential non-revenue water data errors/losses” (Question D21), E81 wrote that correct balancing across multi-unit property networks is one area of potential benefit.

To the benefit of “develop diurnal curves for high-rise buildings and multi-unit properties” (J15), E27 considered that, especially where there is digital sub-metering of high rises and interval data (say hourly) then body corporates will be able to understand usage of individual customers and common use such as for irrigation systems and pool filling.

To the benefit of D23: “a reduction in water theft” E91 wrote System anomalies like open dividing valves between systems could be revealed.

2.4.3 Customer Service: New Services

Q62: N11. From your experience/knowledge will digital water metering enable customer selection of their billing day and to what extent would customers and water businesses benefit? BACKGROUND: If digital water meters provide a reading each hour of each day it is suggested that customers could be provided with the opportunity to nominate the day of the month that their meter is read for billing purposes. This could help customers with their household/business budgeting and cash flow and offer the water company more certainty of payment.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	0	0	1	2	5	0
Extent of Benefit:						
		Negligible	Marginal	Enable	Significant	Substantial
				7	1	

One expert felt this a good benefit of digital metering as customers could time their billing to a particular day of the month and get a true bill for that day. The customer would be highly satisfied by this option and it would increase their goodwill towards the water utility (E27). Another expert thought that allowing customers to manage their billing day would be the main customer benefit of digital meters along with more frequent billing (E22). While one commented that along with customer selection of billing day utilities needed to consider the need for a steady revenue stream (E26) but three other experts took an opposite view saying happy customers pay on time (E59), billing day selection along with billing period and eBilling and direct debit were real benefits (E89), and there may be a measurable impact on the debt collection process (E19). Three other experts thought that billing day selection was a long way off if it was to happen at all (E26) and, that there were internal water utility cultural impediments, IT support to facilitate the change and possible regulatory approval (E14, E15).

Q63: N12. From your experience/knowledge will digital water metering enable information to be provided to customers on their evaporative cooler water use and to what extent would customers benefit? BACKGROUND: In southern states of Australia, evaporative coolers are used to cool homes as they are considered more cost effective. They are more energy efficient but have the additional cost of water used to cool the filters. Hourly meter readings could provide customers with an opportunity to monitor the water use efficiency of their evaporative coolers during hot periods, especially overnight when other appliances are not being used. High readings might signal parts failure or the need for servicing or the replacing of the appliance.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
7	1	0	0	2	4	0
Extent of Benefit: Negligible Marginal Enable Significant Substantial						
				5	1	

One expert nominated evaporative cooler use as an emerging issue and one bigger than many water utilities realise (E22). Two experts believed it depended on the reading interval period that water utilities used when setting up the digital meters and the analysis might be extended to other appliances (E14) and also be extended to demonstrate payback period on other cooling appliances (eg. refrigerated unit) or how different operating approaches might save them money (E15). The other three experts agreed with the benefit (E59) and said that as evaporative coolers were big users of water customers could be informed how their use of the cooler impacts their bill (E19) and how they might use their appliance more efficiently or upgrade to a more efficient unit (E27).

Q64: N13. From your experience/knowledge will digital water metering enable non-residential customer end-use data logging and analytics and to what extent would customers benefit? BACKGROUND: Considerable effort has been put into residential end-use analysis. Non-residential customers in high-water use industries may benefit from water companies offering a service involving similar data logging at high frequency. This could enable individual customer end-use analytics and ongoing tracking of water use for machinery and process performance analysis.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	0	0	0	0	8	0
Extent of Benefit: Negligible Marginal Enable Significant Substantial						
				8		

The opportunity to offer new services such as data logging and analytics for non-residential customers was embraced by most experts (E14, E15, E19, E26, E27) and that providing this service would enable significant night flow data to inform mass balancing of DMA's and non-revenue water analysis (E59). Two experts pointed to the service would require sub-metering within large water users to break-down where the water is being used (E22, E89). The need for this service was highlighted by E13 in response to the question (K11) about customers being alerted to leaks at their property, and by E17 when discussing the impact of the School Water Efficiency Program in response to the question (L15) on high usage allowances.

2.4.4 Customer Service: New Products

Q65: N14. From your experience/knowledge will digital water metering enable customised product offers to be made to customers and to what extent would they benefit? BACKGROUND:

With digital water metering generating so much more information about customer water use patterns and potential profiling, water companies may have opportunities to customise product offers to individual customers and customer segments. These might include plumbing services, rain water tanks, appliance servicing and appliance upgrades. Such targeted marketing programs based on water use patterns could be used to reduce marketing cost and boost sales outcomes.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	1	0	0	1	5	1
Extent of Benefit: Negligible Marginal Enable Significant Substantial						
7						

While all experts answering this question agreed, one thought that it possible “in the future” (E26). Other experts were more enthusiastic. One considered it only limited by the imagination of water companies stating that they knew 10% of customers craved more information many of whom would pay for it (E15). Some experts agreed but offered caution as the appetite of water utilities, regulators and customers was needed (E19), that there may be issues around “competitive neutrality” (E89) and, that there may be unintended consequences (both benefits and risks) to think through (E14).

Q66: M12. From your experience/knowledge will digital water metering enable water companies to provide a service to non-residential and residential customers for disaggregated/appliance end use and to what extent? BACKGROUND: High frequency digital metering studies has led to tools for disaggregating water usage into end-use even when multiple appliances are applied. Based on these studies the algorithms provide an opportunity for customer portals to also provide a disaggregated end-use analysis from hourly interval metered use data. This might be particularly useful to some non-residential users who would otherwise need to sub-meter their business to monitor the water efficiency of particular processes.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
16	6	3	2	2	3	0
Extent of Benefit: Negligible Marginal Enable Significant Substantial						
6 1						

While six experts chose not to comment on this benefit, another three did not agree with one considering it for end-use studies only (E22), another considering it a battery life issue but that it could be offered as an additional service or for short periods (E26) while the third expert thought privacy concerns and the value of information for residential customers would make it unlikely, but for non-residential it may be worth doing (E89). Four experts consider it possible but thought it only likely in an advanced rollout (E40), when logs were also kept (E59), when the uses on site are known (E13), and when linked to other software for the analysis (E76). Another expert was more enthusiastic but considered it dependent on the frequency of the data capture and whether the end-use algorithm used was capable of categorising data at that resolution (E19). Lastly, one expert suggested that high-water users within segment might be offered such a service including demand management services and efficiency audits to reduce consumption (E27).

2.4.5 Customer Service: Security

Q67: N15. From your experience/knowledge will digital water metering enable water businesses to offer customers vacant property water use monitoring and alerting and to what extent would they

benefit? BACKGROUND: Using data from digital water metering and with a leak alerting system in place, the functionality could be extended to allow the customer to set the trigger flows at zero so that any flow will send an alert to the customer. This service could also be charged for to defray costs. Controlled through a portal, such a service might be useful to customers on extended holidays away from home, holiday home owners and untenanted property owners. The frequency of the alert (eg. Maximum 1 alert per day) and the alert method could be limited to control costs of the service.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
8	0	0	0	3	5	0
Extent of Benefit:						
	Negligible	Marginal	Enable	Significant	Substantial	
		1	6	1		

While all of the experts agreed with this benefit their comments were varied. One expert believed it could prevent theft and reduce internal leakage (E59), another expert said this could be done now but digital meters made it much more efficient (E14), another expert said it would alert the water utility that the meter had been removed by the builder (E15), another thought this the same as on any property (E26), and another thought water usage a good surrogate for vacancy and occupancy and would generate goodwill if customers could set up certain alert conditions based on their occupancy or vacancy of the property (E27). But three thought it a small benefit (E89), not a high priority (E22) and that there may be security and privacy concerns associated with the service (E19).

A second security benefit, that digital water metering would lead to fewer visits to the property and therefore to increased security for home and business owners, was not put to the experts through the survey.

2.4.6 New Knowledge: Appliance usage/End-Use

Q68: M13. From your experience/knowledge will digital water metering lead to integration of smart meters with "smart" appliances and to what extent? BACKGROUND: It is speculated that the integration of smart water meters with other household appliances could be possible and assist water conservation by controlling use to optimal levels.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
16	7	1	1	2	5	0
Extent of Benefit:						
	Negligible	Marginal	Enable	Significant	Substantial	
				8		

One person did not agree with the benefit having concluded that they could not think of a cost effective scenario (E89) while another seven experts did not offer an opinion. Of those that agreed three experts thought it in the future once technology had advanced (E22, E26, E40) and another thought that legal requirements and privacy protections needed to be established (E64). Two experts thought that smart water appliances would be possible and digital water meters could enable their development leading to reduced water waste and to limit damage done to homes (E59, E68). The other two experts that offered opinions thought that "smart water appliances" another way to influence demand management and inform customers (E27) and, that commercial enterprises may need to research and consider whether such a product could be profitable and take a lead from the electricity industry (E19).

Q69: J17. From your experience/knowledge will water business be able to gain new knowledge of the impact of appliance efficiency on total demand and to what extent? BACKGROUND: Historical disaggregated end-use models might be able to be employed with digital metered properties to provide sufficient data to enable the efficiency of appliances to be measured. Long term trending of appliance efficiency and its impact on total demand might be able to be modelled from this data.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
11	2	4	1	0	4	0
Extent of Benefit:						
Negligible				Marginal	Gain	Significant
					4	1
						Substantial

Of the eleven responses to this benefit two experts did not offer an opinion and four did not agree with it, leaving only five to record a level of agreement. The four experts that disagreed thought that the level of granularity of the data was a factor and suggested that either specific end-use studies or short term logging at very high frequency (eg. Every 10 seconds for one week) to save battery life (E22, E26, E51, E71). Of those experts that agreed one thought that changes in appliance efficiency might be masked by general noise within the data (E66), that it depended on the types and frequency of data collected (E19, E24), that at a macro level and at fine resolution (1 – 5 minutes) a comprehensive water audit might be provided to a household and might include recommendations for which appliances might be replaced (E15), and, lastly, that the influence on demand management interventions, such interventions including education and rebate programs taken-up by customers, would be able to be evaluated and linked to changes in diurnal patterns and infrastructure deferrals (E27).

2.4.7 New Knowledge: Benchmarking

Q70: N16. From your experience/knowledge will digital water metering enable water businesses to offer benchmarking of water demand of evaporative coolers and to what extent would they benefit? BACKGROUND: In southern states of Australian evaporative coolers are used as energy efficient appliances during hot weather. Digital water meters being read hourly could provide data so that the water use of these appliances could be checked. Benchmarks for coolers of similar age, make and model might be able to be developed so that the efficiency of an individual customer's appliance could be compared to benchmarks of similar appliances.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
7	2	0	0	1	4	0
Extent of Benefit:						
Negligible				Marginal	Enable	Significant
						5
						Substantial

All five experts that answered the question provided similar answers that included evaporative coolers being large water using appliances, which contributed to peak hour demand and that little was known of their performance once installed (E15, E19, E22, E27, E59). Additional comments included that sub-metering would be more accurate (E59) and that benchmarking could be extended to all appliances and might provide a feedback loop for water efficiency labelling and so to consumers (E19).

Q71: J18. From your experience/knowledge will water business be able to develop benchmarks for customer segments and to what extent? BACKGROUND: Customers within segments may have similar usage patterns. Using data from simultaneous hourly digital metering there is a possibility that

1201 they could be benchmarked. The individual customers within segments could then be compared to the
1202 benchmarks.

Number of Responses	Don't Know	0:Don't Agree	1:Low Agree	2:Somewhat Agree	3:Agree	4:Strong Agree
11	0	0	1	2	8	0
Extent of Benefit:						
Negligible Marginal Enable Significant Substantial						
1 9 1						

1203 All experts who answered this question agreed with the benefit, although three of the eleven
1204 provided only muted support. These three considered it possible but did not elaborate (E71), that
1205 either it was way down on their priority list (E22) or that there were many factors to take into account
1206 (E59). One expert said that they knew that customers respond to comparison with others in their
1207 customer cohort but that also they wanted actionable insights that the data may enable to be offered
1208 (E15). It was suggested that many different segments and benchmarks might be created through
1209 clustering and the use of other external data (such as the ANZSIC codes) (E13, E19, E26, E27, E51, E66).
1210 One expert simply agreed with the benefit without elaboration (E24) while another cautioned that after
1211 creating benchmarks those beating the benchmark may regress back to the norm (E51).

3. Summary Scores

Column 1: Question identifying number, Col 2: Number of responses identified as Don't Know; Cols 3-6: Number of responses for Agreement Level themes; Col 7: Short description of benefit and survey question code (Block+Question number within block); Cols 8-12: Number of responses for Extent of benefit value themes; Col 13: Context of the benefit where Ch=Changes and Operational Costs, CW=Cost of water. Taxonomy Beneficiary, Category and Sub-category included as section headings.

Question Number	Don't know	Don't agree	Low agreement	Some what agree	Agree	Strong agreement	Benefit (question code & short description)	Negligible	Marginal	Reduce/ Improve/ gain	Significant	Substantial	Context ⁵
BUSINESS BENEFITS: Operational Cost Savings: Meter Reading													
1	0	1	2	1	13	0	D11 - Reduction in meter reading charges/billing costs	0	0	8	5	3	Ch
2	0	0	0	2	15	0	D12 - Reduction in special meter reads	0	2	11	3	1	Ch
3	0	0	0	0	16	1	D13 - Reduction in estimated bills	0	1	8	2	6	Ch
4	0	0	0	1	14	2	D14-Reduction in Occupational Health & Safety incidence costs	0	0	9	3	5	Ch
5	2	0	1	1	13	0	D15 –Reduction in vehicle energy costs (Green House Gas emissions)	0	1	7	2	5	Ch
6	3	2	0	3	9	0	D16 - Reduction in billing and collection costs with monthly electronic billing and collection	1	0	10	1	0	Ch
Operational Cost Savings: Financial Management													
7	0	1	2	1	3	1	E11 - Improved revenue forecasting/recovery	0	3	4	0	0	CW
8	1	1	0	1	5	0	E12 - Improved cash flow/reduced working capital from monthly billing	0	1	4	1	0	Ch
9	1	0	0	3	14	1	D21 - Reduced residential non-revenue water data errors/losses	0	3	9	5	1	Ch
10	0	0	0	2	17	0	D22 - Reduced non-residential customers' non-revenue water data errors/losses	0	3	11	3	2	Ch
11	1	0	0	2	5	0	E19 - Reduce insurance claim incidents and costs from bursts and leaks	0	1	4	2	0	Ch
Operational Cost Savings: Utility Costs													
12	0	1	0	0	7	1	G11 - Reduction in the wholesale cost of water	0	1	7	0	0	CW
13	0	1	0	1	7	0	G12 - Reduction in water leaks and other non-revenue water (NRW) causes (eg. bursts)	0	0	6	2	0	CW
14	1	1	1	0	6	0	G13 - Better manage peak water demand	0	0	6	1	0	CW
15	0	1	0	0	8	0	G14 - Reduction in water pumping cost (Green House Gas emissions)	0	2	6	0	0	CW
16	1	0	3	0	15	0	D23 - Reduction in water theft	0	5	12	1	0	CW
17	2	1	4	2	9	1	D24 - Reduction in labour costs associated with leak detection	0	0	14	2	0	Ch

Question Number	Don't know	Don't agree	Low agreement	Some what agree	Agree	Strong agreement	Benefit (question code & short description)	Negligible	Marginal	Reduce/ Improve/ gain	Significant	Substantial	Context ⁵
Operational Cost Savings: Meters													
18	2	7	0	0	7	0	D31 - Deferred meter replacement (thru water conservation, targeted replacement)	0	0	4	3	0	Ch
Operational Cost Savings: Tariffs													
19	1	0	3	0	4	0	E13 - More flexible tariffs by industry	0	0	7	0	0	CW
20	1	0	1	0	6	0	E14 - Load shifting (levelling)	0	0	6	0	1	Ch
21	0	1	0	4	3	0	E17 - Improved customer service/satisfaction through modified tariffs	0	2	5	0	0	CW
Capital Cost Savings: Planning													
22	0	0	0	1	7	0	H11 - Improve network planning	0	0	8	0	0	Ch
23	0	0	1	1	6	0	H12 - Defer network augmentation	0	2	5	1	0	Ch
Capital Cost Savings: Risk													
24	0	2	0	2	4	0	E18 - Reduction in risk premium and working capital costs	0	0	5	1	0	Ch
25	0	3	0	1	4	0	E15 - Increased value of assets (service connections)	1	0	4	0	0	Ch
New Knowledge: Customer Segments													
26	0	0	0	1	8	2	J11 - Gain new knowledge of each non-residential customer's property use	0	0	10	1	0	CW
27	1	0	2	0	8	0	J12 - Gain from new knowledge of tourism impacts for tourist regions (seasonal/event)	0	1	9	0	0	CW
28	0	0	1	0	10	0	J13 - Understand time-of-day use by customer segment	0	0	10	1	0	CW
New Knowledge: New Algorithms													
29	3	0	1	1	11	0	D32 - Develop meter over-sizing identifiers	0	2	9	2	0	CW
30	0	1	0	0	7	0	H13 -Reduce uncertainty and risk margin used in planning	0	1	5	1	0	Ch
31	1	0	0	0	8	0	G15 - Improved forecasting of sewer flows	0	0	8	0	0	CW
32	0	1	0	1	6	0	E16 - Improved demand forecasting and revenue projection	0	1	6	0	0	CW
33	0	0	2	0	9	0	J14 - Develop diurnal curves for non-residential customers by customer type (micro segmentation)	0	0	11	0	0	CW
34	0	0	1	0	10	0	J15 - Develop diurnal curves for high-rise buildings and multi-unit properties	0	0	9	1	1	CW
35	3	0	1	0	7	0	J16 - Develop reverse modelling of household characteristics via the demand pattern	0	0	7	1	0	CW
SHARED BENEFITS: Customer Interaction: Complaints													
36	1	3	0	0	13	0	L11 - Reduced customer billing complaints	0	0	8	3	2	Ch
37	2	3	1	0	10	1	L12- Reduced external costs of Water Ombudsman referred complaints	0	2	8	0	2	Ch

Question Number	Don't know	Don't agree	Low agreement	Some what agree	Agree	Strong agreement	Benefit (question code & short description)	Negligible	Marginal	Reduce/ Improve/ gain	Significant	Substantial	Context ⁵
38	2	0	0	2	13	0	L13 - Reduced internal costs of Water Ombudsman referred complaints	0	2	11	2	0	Ch
39	0	0	1	1	15	0	L14 - Improved outcomes from billing disputes	0	0	13	3	1	Ch
Customer Interaction: Customer Assistance Programs													
40	0	0	0	0	16	1	L15 - Reduced High Usage Leak Allowance (HULA) costs from concealed leaks	0	0	8	6	3	Ch
41	2	5	1	2	7	0	L16 - Reduced plumbing assistance costs	0	1	5	4	0	Ch
-	-	-	-	-	-	-	X3 - Reduced Government assistance grants ¹	1	2	12	3	2 ^{1.1}	Ch
Customer Interaction: Credit Management													
43	0	0	1	1	4	0	P11 - Reduced supply restriction case costs	0	1	4	1	0	Ch
44	0	0	1	0	5	0	P12 - Reduced debt recovery/legal action case costs	0	1	5	0	0	Ch
Customer Interaction: Customer Interactions													
45	1	5	1	0	7	3	L17 - Reduced contact centre calls	0	0	11	0	0	Ch
46	0	0	1	1	13	1	M11 - Enhanced communications	0	0	15	1	0	Ch
Customer Interaction: Goodwill													
47	1	0	0	4	19	2	F11 - An improvement of value of goodwill from information sharing with their customers	0	0	21	4	0	CW
48	10	1	1	2	12	0	F12 - An improvement of value of goodwill from new products and services	0	1	14	0	0	CW
49	5	4	5	1	11	0	F13 - An improvement of value of goodwill from customer recognition of operational efficiency and capital management	0	3	13	1	0	CW
50	7	2	2	4	11	0	F14 - An improvement of value of goodwill from more flexible tariffs	0	1	15	1	0	CW
Regulation/Compliance: Metering													
51	2	0	1	1	12	0	D33 - Improve meter sizing for non-residential customers	0	1	11	2	0	CW
52	2	3	1	1	8	1	D34 - Tighter meter performance/National Metering Institute (NMI) compliance monitoring	0	0	9	2	0	CW
53	2	0	3	1	9	1	D35 - Undertake meter failure analytics	0	2	9	3	0	CW
54	11	0	0	1	4	0	D36 - Meter silting detection (large meters)	0	0	5	0	0	CW
55	3	0	2	1	10	0	D37 - Detect revenue losses caused by declining or failed meter accuracy after break in main	0	1	10	2	0	CW
Regulation/Compliance: Monitoring													
56	2	2	0	0	2	0	P13 - Enable automated regulation compliance monitoring	0	0	2	0	0	Ch

Question Number	Don't know	Don't agree	Low agreement	Some what agree	Agree	Strong agreement	Benefit (question code & short description)	Negligible	Marginal	Reduce/ Improve/ gain	Significant	Substantial	Context ⁵
57	3	0	1	0	5	0	G16 - Reduction in audits required (through targeted Source Water Monitoring (SWM) water quality testing)	0	1	4	1	0	Ch
CUSTOMER BENEFITS: Customer Service: Usage Cost													
58	0	0	1	0	21	5	K11 - Reduce costs by being alerted to leaks at their property	0	0	15	10	2	CW
59	0	0	0	1	24	1	K12 - Reduce their water use through awareness and education	0	2	20	3	1	CW
60	6	1	3	2	14	0	K13 - Be more water efficient and reduce their bill through bill prediction	0	3	15	1	0	CW
61	5	1	2	5	13	0	K14 - Be more water efficient and reduce costs through monthly billing	2	2	15	1	0	CW
62	12	1	0	1	3	0	L18 - Reduction in insurance claims by customers	0	0	2	0	2	Ch
Customer Service: Complex Property/multiunit usage reconciliation													
-	-	-	-	-	-	-	X1 - Faster and easier reconciliation of bills for properties with multiple accounts ²	1	2	12	3	2 ^{2.1}	Ch
-	-	-	-	-	-	-	X2 - Identify plumbing irregularities in properties with complex plumbing ³	1	2	12	3	2 ^{3.1}	Ch
Customer Service: New Services													
65	0	0	1	2	5	0	N11 - Enable customer selection of their billing day	0	0	7	1	0	Ch
66	1	0	0	2	4	0	N12 - Enable information to be provided to customers on their evaporative cooler water use	0	0	5	1	0	CW
67	0	0	0	0	8	0	N13 - Enable non-residential customer end-use data logging and analytics	0	0	8	0	0	CW
Customer Service: New Products													
68	1	0	0	1	5	1	N14 - Enable customised product offers to be made to customers	0	0	7	0	0	Ch
69	6	3	2	2	3	0	M12 - Provide a service to non-residential and residential customers for disaggregated/appliance end use	0	0	6	1	0	Ch
Customer Service: Security													
71	0	0	0	3	5	0	N15 - Enable water businesses to offer customers vacant property water use monitoring and alerting	0	1	6	1	0	Ch
-	-	-	-	-	-	-	L19 - Increased security for home and business owners ⁴	1	2	12	3	2 ^{4.1}	Ch
New Knowledge: Appliance usage/End-use													
72	7	1	1	2	5	0	M13 - Integration of smart meters with "smart" appliances	0	0	8	0	0	CW
73	2	4	1	0	4	0	J17 - Gain new knowledge of the impact of appliance efficiency on total demand	0	0	4	1	0	CW
New Knowledge: Benchmarking													
74	2	0	0	1	4	0	N16 - Enable water businesses to offer benchmarking of water demand of	0	0	5	0	0	CW

Question Number	Don't know	Don't agree	Low agreement	Some what agree	Agree	Strong agreement	Benefit (question code & short description)	Negligible	Marginal	Reduce/ Improve/ gain	Significant	Substantial	Context ⁵
							evaporative coolers						
1217	0	0	1	2	8	0	J18 - Develop benchmarks for customer segments	0	1	9	1	0	CW
1218	^{1, 2, 3, 4} These benefits were included in the Literature Review paper but were not included in the structured interviews. They are included here for completeness.												
1219	^{1.1, 2.1, 3.1, 4.1} Benefit Values derived from average values of benefits for Charges/Operational Cost												
	⁵ Context is discussed in Section 2.2.2 and Section 4.5 of the main manuscript, CW=Cost of Water, Ch=Charges/Operational Costs												

1220

1221

1222 4. Expert Profiles

1223
1224

Table 1 Business area experience of industry experts.

Expert	a ¹	b	c	d	e	f	g	h	i	j	k	Utility type	Years in Industry	Experience of Digital Meters
E13 ²											Water Efficiency	Independent	11-20 years	Peripheral role ⁷
E14										•	R&D	Regional	0-2 years	Planning a trial(s) ⁶
E15	•	•	•	•			•		•			Metro	11-20 years	Completed or in-progress trial(s) ⁵
E17	•			•								Metro	11-20 years	Peripheral role ⁷
E18							•					Metro	11-20 years	Peripheral role ⁷
E19	•	•										Metro	6-10 years	Completed or in-progress trial(s) ⁵
E20	•											Metro	6-10 years	In progress rollout ⁴
E22				•							Water Effic'y, Asset Mgmt	Regional	11-20 years	In progress rollout ⁴
E24		•	•		•	•	•				Integrated Water Mgmt	Metro	more than 20 years	Peripheral role ⁷
E25		•										Metro	6-10 years	Peripheral role ⁷
E26											Management	Metro	6-10 years	Completed or in-progress trial(s) ⁵
E27	•	•	•	•					•	•		Independent	11-20 years	Completed or in-progress trial(s) ⁵
E31	•			•							Planning & Maintenance	Regional	6-10 years	Full rollout ³
E32	•											Regional	3-5 years	Full rollout ³
E33	•			•			•					Regional	3-5 years	Planning a trial(s) ⁶

Expert	a ¹	b	c	d	e	f	g	h	i	j	k	Utility type	Years in Industry	Experience of Digital Meters
E35	.					.						Metro	3-5 years	Planning a trial(s) ⁶
E36		.	.									Metro	more than 20 years	Peripheral role ⁷
E37	.	.										Regional	3-5 years	Peripheral role ⁷
E38					.							Metro	more than 20 years	Peripheral role ⁷
E39	.			.		.						Regional	6-10 years	Full rollout ³
E40	.											Regional	6-10 years	Planning a trial(s) ⁶
E41				.								Metro	0-2 years	Planning a trial(s) ⁶
E43	.			.								Metro	3-5 years	Planning a trial(s) ⁶
E45	.										Water Efficiency	Regional	6-10 years	Completed or in-progress trial(s) ⁵
E47	.			.								Regional	more than 20 years	Public information only ⁸
E48							.					Regional	11-20 years	Planning a trial(s) ⁶
E49	.											Regional	6-10 years	Public information only ⁸
E51	.						.				Data Science	Regional	11-20 years	In progress rollout ⁴
E55	.			.								Regional	6-10 years	No current knowledge ⁹
E58				Regional	more than 20 years	Completed or in-progress trial(s) ⁵
E59			Regional	more than 20 years	Full rollout ³
E61					.							Metro	3-5 years	Planning a trial(s) ⁶
E63	.					.						Metro	3-5 years	No current

Expert	a ¹	b	c	d	e	f	g	h	i	j	k	Utility type	Years in Industry	Experience of Digital Meters
														knowledge ⁹
E64	.											Metro	11-20 years	Public information only ⁸
E65	.											Metro	11-20 years	Peripheral role ⁷
E66		.										Metro	6-10 years	Peripheral role ⁷
E68	.										Water Efficiency	Metro	11-20 years	No current knowledge ⁹
E70	.			.								Metro	11-20 years	Planning a trial(s) ⁶
E71		.	.	.								Metro	11-20 years	Completed or in-progress trial(s) ⁵
E72	.			.			.				Contract/Stakeholder Mgmt	Independent	more than 20 years	Planning a trial(s) ⁶
E73	.										Communications & digital	Independent	11-20 years	Peripheral role ⁷
E74	.	.		.								Independent	more than 20 years	Completed or in-progress trial(s) ⁵
E76	.											Metro	more than 20 years	No current knowledge ⁹
E79		.	.									Metro	more than 20 years	Peripheral role ⁷
E80		.										Metro	11-20 years	Planning a trial(s) ⁶
E81	.			.								Metro	more than 20 years	Peripheral role ⁷
E82	.						.					Independent	11-20 years	Peripheral role ⁷
E86					Independent	11-20 years	Planning a trial(s) ⁶

Expert	a ¹	b	c	d	e	f	g	h	i	j	k	Utility type	Years in Industry	Experience of Digital Meters
E89					Metro	6-10 years	Completed or in-progress trial(s) ⁵
E90	.			.								Metro	3-5 years	Completed or in-progress trial(s) ⁵
E91		.	.									Metro	11-20 years	Completed or in-progress trial(s) ⁵
E92	.			.								Metro	6-10 years	Completed or in-progress trial(s) ⁵

¹ Legend: Business area experience of industry experts.

a. Customer Service b. Engineering Planning c. Engineering Operations d. Metering e. Finance

f. Legal / Regulation / Corporate Services g. Senior Management h. Human Resources

i. Information Technology j. Academic k. Other

² Expert identification numbering starts at 13 due to development and testing of the interview questions. Gaps in the numbering were created when participants started but do not complete the interview.

Experience Level with Digital Metering:

³ Full rollout of digital water metering

⁴ In progress rollout of digital water metering

⁵ Completed or in-progress trial(s) of digital water metering

⁶ Planning a trial(s) of digital water metering

⁷ Peripheral role in metering and/or digital metering area

⁸ Public information and presentations on digital water metering only

⁹ No current knowledge or experience/Water industry general knowledge only

1242

1243 **References**

- 1244 1. Monks, I., et al.,
- Expert opinion valuation method to quantify digital water metering benefits (in press)*
- . 2020.
-
- 1245

1246



© 2020 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).

1247