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Memorandum

DATE: September 25, 2017

TO: Nick Wetaski, Resort Municipality of Whistler (RMOW)

FROM: Ryan Lesyshen, M.Sc., P.Eng., Kerr Wood Leidal (KWL)

RE: **WATER METERING OPTIONS ASSESSMENT**
Our File 0029-271-300

1. Introduction

The Resort Municipality of Whistler (RMOW) has adopted water conservation measures as a core strategy for balancing water supplies and peak demands. Implementing a water metering program in combination with volume based pricing, may allow RMOW to achieve water savings.

This technical memorandum provides a cursory review of capital and operations costs associated with implementing a metering program and potential water savings that could be achieved. Two water metering options were reviewed: universal metering (e.g. all service connections are metered) and ICI metering. These two options were compared to the business as usual (BAU) case.

1.1 Abbreviations

The following abbreviations are used throughout the Technical Memorandum.

ICI	Industrial, Commercial, and Institutional
RMOW	Resort Municipality of Whistler
BU	Bed Unit
BAU	Business as Usual (i.e., no change to current practices).
FTE	Full Time Equivalent – Hours worked by one employee on a full time basis

2. Background

2.1 Water Conservation Target

RMOW has established a water conservation target of 425 L/ca/day by 2020, based on the average annual population, which takes into consideration the tourist population.

2.2 Population and Tourists Traffic

The estimated 2015 permanent residential population is 10,447[1]. The estimated average monthly number of visitors in the past three years is summarized in Table 2-1.

Table 2-1: Average Monthly Visitation

Visitation (person/month)												
Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
213,734	212,812	226,723	198,534	225,175	291,210	375,388	390,266	275,136	191,440	110,232	121,795	**2,832,445**
Source: Tourism Whistler 3 year averaged unique visitors data (2013/14-2015/16)												

2.3 Existing Service Connections and Meter Inventory

The number of services connection and meters within the GIS dataset are summarized in Table 2-2 by sector.

Table 2-2: Summary of Service Connections and Meters

Customer Type	No. of Service Connections	No. of Meters
Single Family & Duplex	3,045	1126
Strata Lots (Townhouses)	2,815	415
Multifamily (Apartments)	4,296	1848
TOTAL "Residential"	***10,156***	***3,389***
ICI	190	370
Total	10,346	3,759
Sources: RMOW from Adam Wicks via Tempest actual use codes and water meter GIS dataset		

Strata units in some complexes are individually metered. RMOW staff estimate that there are currently 165 strata complexes.

[1] Source: www.Whistler.ca/about

The distribution of installation dates for residential and ICI water meters is summarized in Tables 2-3 and 2-4.

Table 2-3: Residential Meter Inventory

Meter Installation Date													Total
Older than 1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Newer than 2005	Unknown	
325	400	537	244	97	385	96	115	95	33	51	694	317	3,389
Source: RMOW Water meter GIS dataset													

Table 2-4: ICI Meter Inventory

Meter Installation Date													Total
Older than 1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Newer than 2005	Unknown	
37	38	20	18	12	19	7	4	13	10	8	77	107	370
Source: RMOW Water meter GIS dataset Note does not match the total number of ICI meters													

2.4 Commercial Meter Field Assessment

Between June and October 2016, Corix completed a field assessment of properties with a business license. The excel workbook provided by Corix had numerous data inconsistencies and required substantive effort to determine how to interpret these inconsistencies. Numerous entries of "Yes" in a column used to mark whether a meter exists had entries of "no meter exists" or likewise in the comments column and no recorded serial number. Entries of "No" in the column used to mark whether a meter exists were also found to have meter sizes entered and ambiguous notes. KWL utilized the serial number entries and reviewed the comments columns of the spreadsheet to determine the number of water meters were located. A summary of the work orders is presented in Table 2-5:

Table 2-5: Summary of Work Orders

1	Total number of work orders (1,865 business licences)	1,865
2	# of businesses serviced through a water meter	476
	# of ICI water meters servicing the 476 metered businesses. This was based off unique serial number or note stating serial number could not be read)	**151**
3	No Meter to business	277
3a	*No Meter – Subset described as primarily a Multi Family Residential dwelling*	*83*
3b	*No Meter – Subset that are primarily commercial businesses*	*194*
4	Residential property (Does not include 3a)	815
5	No water service to property	87
6	Water Source other than Municipal	43
7	Unable to complete the work order	87
8	Duplicate work order (Same site twice)	80

It is noted that the 151 meters located Corix does not match the 370 ICI meters within the GIS. The discrepancy could be due:

- No institutional sites, schools, hospital, churches, etc., were investigated by Corix.
- Some older meters, in the GIS database, may have been removed.
- A portion of the meters listed as ICI in the GIS may have been coded as residential by Corix.
- A portion of the meters listed as ICI in the GIS may have been at businesses where Corix could not complete the work order.

Corix provided recommendations for replacements and whether replumbing or a strainer is needed for the 151 meters that were located. Figure 2-6 provides statistics on the size of the meters located and recommended replacements.

Table 2-6: Corix Field Assessment of Existing ICI Meters Results

Meter Size	Total Number	% of Total	Needs Replumbing	Needs Strainer	Meters to be Replaced	Total Needing Work
3/4" Meter	30	20%	0	2	4	6
1" Meter	33	22%	1	3	10	14
1.5" Meter	21	14%	0	2	4	6
2" Meter	23	15%	2	3	5	10
3" Meter	17	11%	3	4	5	12
4" Meter	27	18%	1	4	8	13
Total	**151**	**100%**	**7**	**18**	**36**	**61**

The following is noted from Table 2-6:

- 71% of the meters are 2" and smaller.
- 40% of the meters require work including plumbing changes, installation of strainers and replacement of the existing meters.

Given the results of the field assessment we assume approximately 500 meters are required to obtain 100% metering of ICI customers and that the size distribution will match that of the 151 meters located by Corix.

2.5 Water Use

The total annual water use and maximum day demand (MDD) is summarized in Table 2-7 and

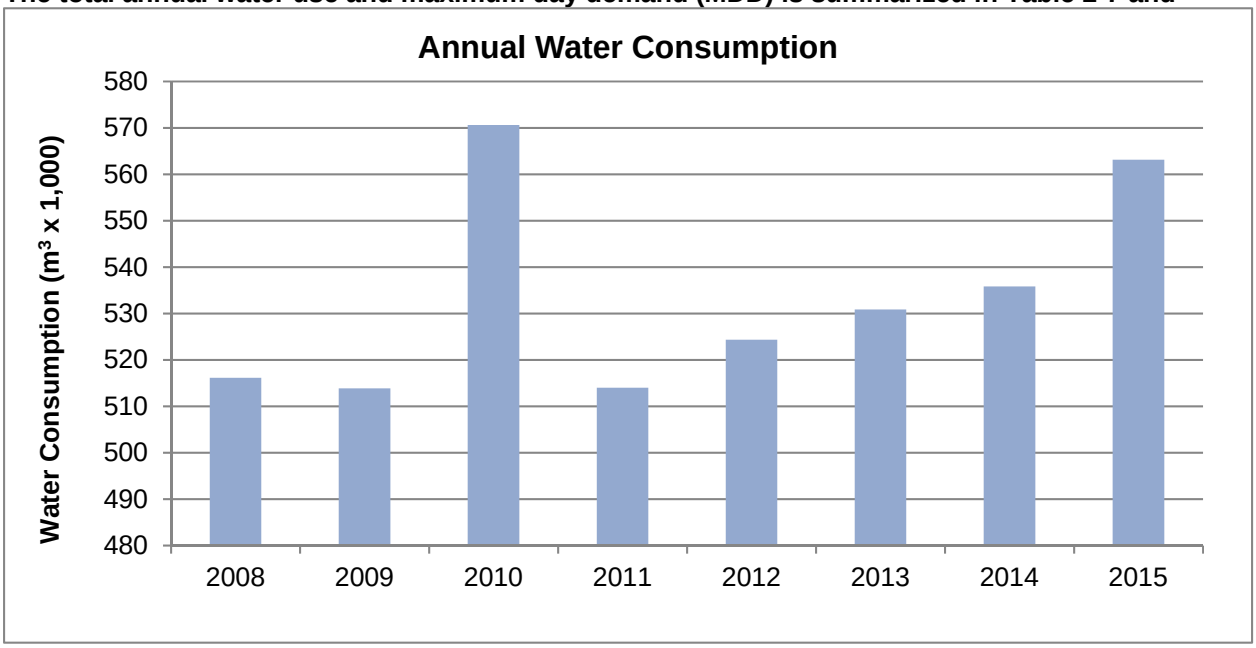

Figure **2-1**.

Table 2-7: Annual Water Consumption and Maximum Day Demand

	Water Consumption							
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Total Annual Water Use (m^3)	5,161,300	5,138,769	5,705,956	5,139,932	5,243,423	5,308,459	5,358,245	5,631,380
Average Day Demand (m^3/day)	14,102	14,079	15,633	14,082	14,326	14,544	14,680	15,428
Maximum Day Demand (m^3/day)	22,340	24,350	25,210	22,180	21,550	25,670	27,110	24,482
Source: RMOW Annual Water Report data sheets								

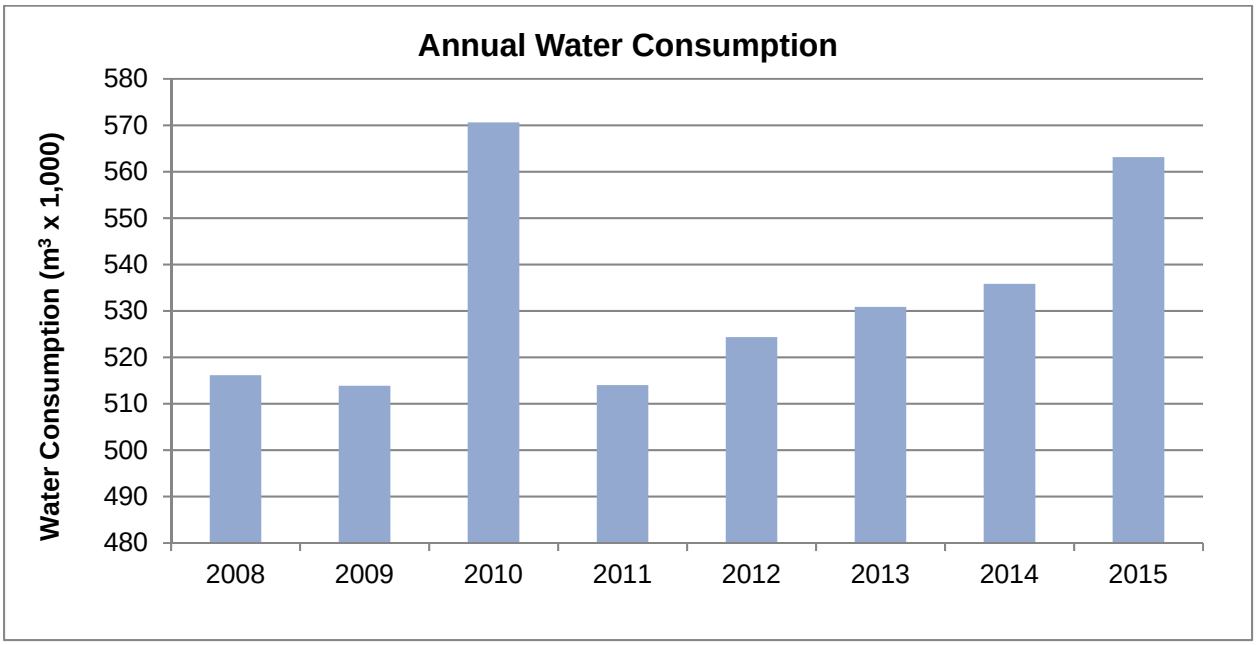

Figure 2-1: Annual Water Consumption

Monthly demand is shown in Table 2-8 and Figure 2-2.

Table 2-8: Monthly Water Consumption

Year	Monthly Water Consumption (m^3/month)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
2010	412,616	456,665	644,432	442,401	453,649	404,370	607,986	749,232	438,521	322,522	363,348	410,214	5,705,956
2011	353,656	518,862	434,141	378,461	395,377	477,786	471,883	707,794	438,319	365,972	305,501	421,737	5,269,489
2012	379,353	405,506	381,065	459,341	347,627	394,211	645,777	516,917	494,041	457,579	303,577	458,429	5,243,423
2013	338,324	376,055	370,200	433,944	410,157	440,513	689,232	620,990	532,394	321,850	306,120	470,288	5,310,067
2014	368,414	364,722	369,247	438,730	335,721	442,836	683,140	602,495	605,319	340,677	333,660	476,836	5,361,797
2015	371,817	377,507	488,889	353,026	384,361	697,981	615,593	612,770	553,712	365,046	315,323	506,709	5,642,734
Average	370,697	416,553	447,996	417,651	387,815	476,283	618,935	635,033	510,384	362,274	321,255	457,369	5,422,244
Source: RMOW - Whistler annual drinking water report data													

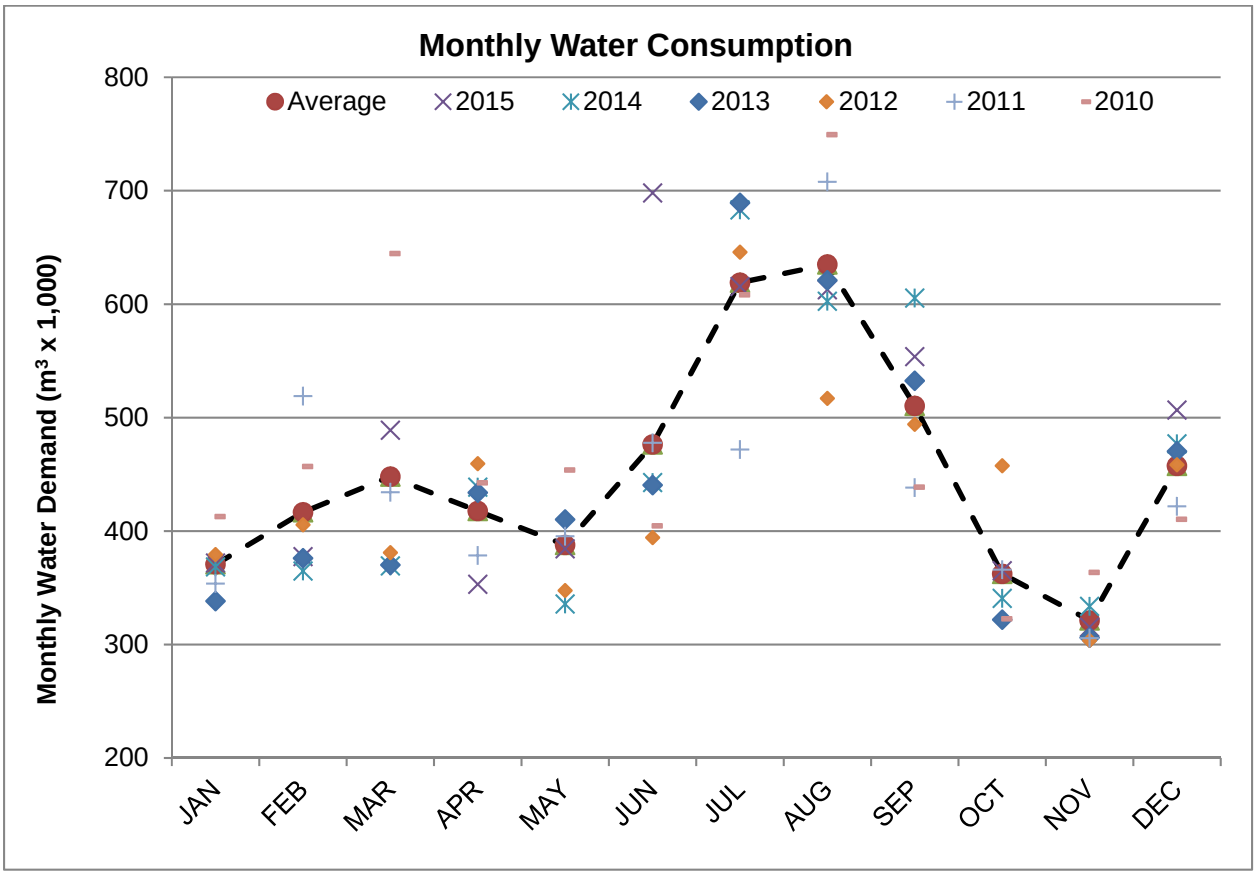

Figure 2-2: Monthly Water Consumption

The annual water demands generally correlate to the monthly tourist population, with the peak occurring in August. Summer demands may also be exacerbated by seasonal demands (i.e. irrigation).

2.5.1 Metered Water Use

RMOW currently bills 8 ICI customers based on volume; the meters are read on an annual basis. Table 2-9 summarizes the historical meter reads for the 15 associated meters.

Table 2-9: Billing Meter volumes

Client Name	Water Consumption (m^3)					
	2010	2011	2012	2013	2014	2015
Van West	52,779	52,243	55,224	52,010	69,934	77,744
410 Whistler Way	6,522	6,289	6,150	5,931	6,198	6,915
4599 Chateau Blvd	125,100	116,220	128,960	108,245	137,570	124,170
101-4204 Village Sq.	4,880	5,630	4,250	3,310	3,140	2,600
4001 Whistler Way	324	148	112	109	118	123
203-2222 Castle Dr.	187	191	197	232	172	185
2177 Lake Placid Road	195	broken	357	173	211	157
2177 Lake Placid Road	15	34	27	6	14	26
2178 Lake Placid Road	220	163	128	107	206	136
2178 Lake Placid Road	258	32	73	30	39	36
43-2250 Nordic Drive	54	45	48	55		
4910 Glacier Lane	7,484	6,255	8,155	5,942	5,856	3,620
P277	90	33	25	137	100	100
P265	459	231	352	362	353	414
106-4368 Main Street	5	3	4	1	3	1
Total	**198,571**	**187,517**	**204,063**	**176,649**	**223,912**	**216,227**
% of Annual Total	3.5%	3.6%	3.9%	3.3%	4.2%	3.8%

Source: RMOW annual water meter reading utility billing 2015 file

In addition to the eight customers that are billed annual basis based on volume, RMOW also intermittently reads other water meters. A sample of meter data for various customer types is provided in Tables 2-10 through 2-13.

Table 2-10: Sample of Residential Water Meter Reads

Customer	Start Date	Initial Meter Reading	End Date	Final Meter Reading	Consumption (L/dwelling/day)
Example 1	6/27/2013	5,938	6/28/2016	9,889	3,602
Example 2	6/27/2013	6,496	6/28/2016	7,791	1,180
Example 3	6/27/2013	5,117	6/28/2016	6,289	1,068
Average					**1,950**
Source: RMOW					

The average water consumption over the three year period for the sample properties is 1,950 L/dwelling /day. The Residential End Uses of Water Study2 found that for a climate similar to Whistler's (i.e. Annual Precipitation = 1227.8 mm), annual water demands were observed to be approximately 586 L/dwelling/day. This suggests high potential to reduce single family residential water demands; however, the sample may not be random or representative. A larger, random sample of single family residential dwellings should be monitored to obtain a statistically representative estimate.

Table 2-11: Sample of Multi-Family Meter Reads

Customer	Start Date	Initial Meter Reading	End Date	Final Meter Reading	Consumption (L/dwelling/day)
Example 1	6/5/2013	2605.5	5/18/2016	2983.0	350
Example 2	6/5/2013	3392.0	5/18/2016	3930.0	499
Example 3	6/5/2013	1466.5	5/18/2016	1772.0	283
Average					**378**
Source: RMOW					

The average water consumption the sampled multi-family complexes is 378 L/dwelling/day. Assuming two (2) persons per unit, the per capita water demand would be 189 L/ca/day. Since apartments generally have little irrigation demand, it assumed that the 189 L/ca/day is indoor water usage. This value is in line with research findings that have found indoor residential usage is approximately 220L/ca/day[2]. Based on this finding, large water savings may not be achievable at the multi-family complexes if multi-family dwellings in Whistler are occupied at an average near 2 people per dwelling.

Table 2-12: Sample of Hotel Meter Reads

Customer	Rooms	Start Date	Initial Meter Reading	End Date	Final Meter Reading	Consumption (L/room/day)
Example 1	550	1/1/2015	0	1/1/2016	124,170	610
Example 1	450	3/11/2016	0	6/15/2016	22,817	530
Example 2	250	3/11/2016	0	6/14/2016	7,342	310
Example 3	215	3/11/2016	0	6/14/2016	5,822	290
Weighted Average						**489**
Source: RMOW						

[2] Water Research Foundation, Residential End Uses of Water, Version 2 , 2016

The sampled hotels on average use approximately 486 L/room/day. Luxury hotels are estimated to use on average 662 L/room/day[3], which is more than the sample hotels are currently using. The Pacific Institute estimated that the average use per hotel rooms is approximately 490 L/room/day, which is in line with the Whistler sample. The Pacific Institute estimates that by implementing water conservation measures (i.e. new toilets, faucets) water savings of 30-34% could be achieved.

Table 2-13: Sample of Restaurant Meter Reads

Customer	Start Date	Initial Meter Reading	End Date	Final Meter Reading	Consumption (L/ day)
Example 1	6/12/2013	11,375	7/7/2016	14,204	2,500
Example 2	7/3/2012	17,312.0	6/10/2013	18,171.5	2,500
Example 3	9/19/2011	3,547.0	7/3/2012	3,756.5	700
Average					**1,900**

Source: RMOW

The average consumption for the sampled restaurants is approximately 1900 L/day. To determine how the restaurant demands compare with industry standards, additional information on the restaurants should be gathered. Information that should be gathered would include: number of employees, number of meals served and/or restaurant square footage.

2.6 Utility Rates

Water and sewer fees are generally charged on a flat fee basis, but a few businesses are charged based on volume annually. The annual water service charge for a single-family or multi-family dwelling is $114.70. Based on RMOW current water rates the total cost for 250 m^3 of water annually would be $210. Statistical data on municipal water charges is published annually under the National Water and Wastewater Benchmarking Initiative.[3] The median residential water service charge in 2013 for 250 m^3 of water was $433, and the minimum charge recorded in the 2013 study was $216, which is nearly double RMOW's residential water charge and more than a typical residence would pay at RMOW's metered rates.

[3] AECOM, 2014. http://www.nationalbenchmarking.ca

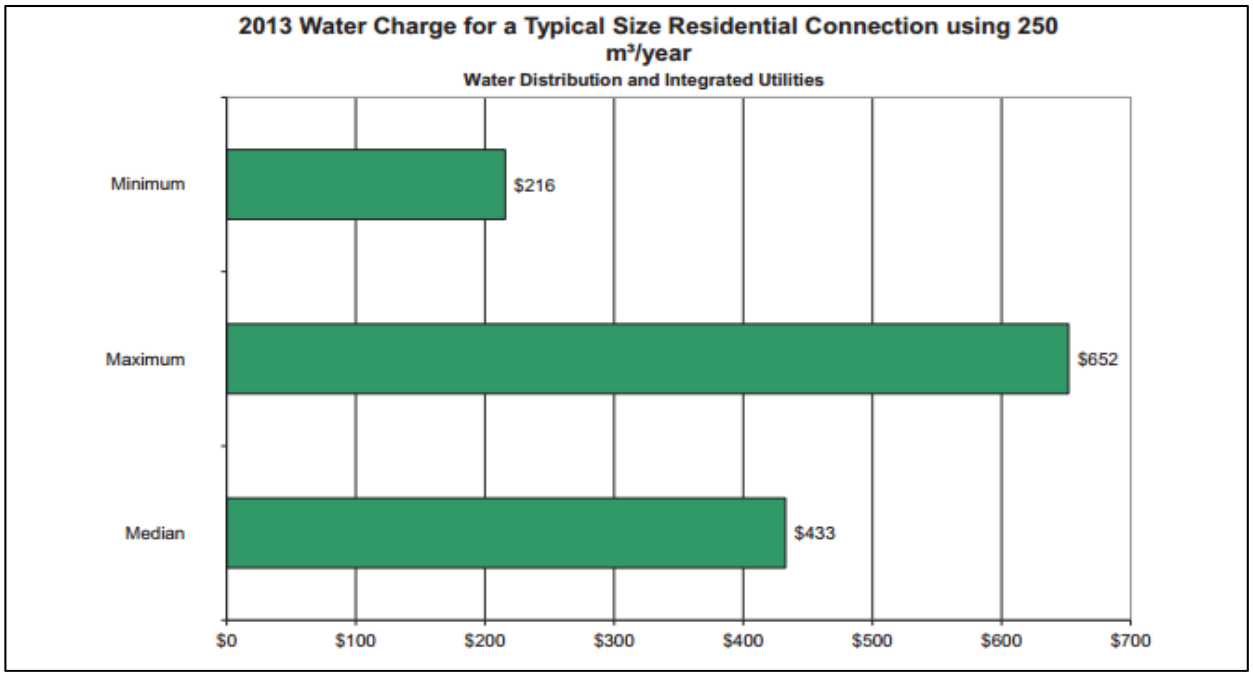

Figure 2-3: 2013 National Benchmarking Study - 2013 Typical Water Charges

The RMOW volume-based utility rates are summarized in Table 2-14.

Table 2-14: Utility Rates

Utility Rates	First 6,000 m^3	Next 12,000 m^3	Next 24,000 m^3	Greater than 42,000 m^3
Water Rates ($/$m^3$)	0.84	0.65	0.53	0.47
Sanitary Rates ($/$m^3$)	1.09	0.9	0.7	0.56
Sources: RMOW Bylaw NO, 2089, 2015 (Water) Schedule "A" Water User Fees RMOW Bylaw NO, 2090, 2015 Schedule "A" Sewer User Fees				

Water is billed to some ICI customers on a declining block structure, which rewards high water use. It is recommended that the utility rates be reviewed, and that new rates be designed to encourage water conservation and recover the full cost to operate the water and sanitary system.

3. Financial Analysis

A 20 –year life cycle cost analysis was completed for three metering options:

- Business As Usual Case: This option assumes that no new meters will be installed, but that existing meters will be replaced once the meters reach the end of their service life (assumed to be 20 years). Operation and maintenance costs for the existing program were estimated based on the number of existing meters.
- ICI Metering: This option assumes that all ICI customers are metered, either by a single meter or as a larger group of customers off a single water service. New meters are assumed to be installed in 2018. Existing meters (residential and ICI) are assumed to be replaced on a 20-year cycle.
- Universal Metering: This option assumes that all service connections are metered in 2018, and that existing meters are replaced on a 20-year cycle.

The financial analysis is provided for project planning purposes only, and is based on incomplete site information and are derived from unit costs for similar projects. The costs of upgrading or repairing existing meters are included in the analysis, based on an inventory and condition assessment of existing ICI meters conducted by Corix in 2016.

3.1 Current Water Meter Program Costs

The 2015 Comprehensive Water Conservation and Supply Plan indicates that significant changes have occurred since the previous water meter cost estimate was completed in 2012. The changes include:

- The labour cost for meter inspection and replacement of residential meters was reported by RMOW to be less than previously estimated, at less than $50 per site;
- The labour cost for meter replacement of 3” and 4” compound meters was on average $3,500 in 2015;
- No external meter reading antennas are required; and
- RMOW has purchased a new software system that will expedite the production of water bills.

The labour cost to inspect and replace a residential meter, is lower than what other municipalities have found. For example, the City of Nanaimo estimated that the labour cost to replace residential meters in an outside pit was $92 (2013 dollars). Since the residential meters are installed indoors, RMOW has additional challenges to consider in the replacement of the residential meters, such as:

- Customer engagement: an outreach program will need to be designed to inform customers about any upcoming meter replacement, and to schedule installation times; and
- Meter location: In many instances, no records exist as to the location of the existing meter. Installed meters may not be easily found and could even be hidden behind walls.

To account for these potential challenges in estimating the costs of a universal metering program, the residential meter installation cost is assumed to be $100 per meter.

3.2 Capital Costs

3.2.1 Meter Costs by Diameter

The cost for meters is summarized in Table 3-1.

Table 3-1: Neptune Water Meter List Prices (2016)

Meter Type	Meter Size	List Price[1]	Notes
Positive Displacement	5/8"	$420.50	Cost includes R900i transceiver
	3/4"	$465.50	
	1"	$565.50	
	1 1/2"	$895.50	
	2”	$780.80	
Compound	2"	$2,885.50	Tru/Flo Compound Cost includes R900i transceiver
	3"	$3,705.50	
	4"	$5,240.50	
	6"	$9,420.50	
Source: Geoff Korinetz, Fred Surridge Ltd.			

3.2.2 Cost to Rectify Existing ICI Meter Deficiencies

To rectify the existing deficiencies identified in the Corix commercial meter field assessment, described in Section 2.4, the following assumptions were made;

- New ICI meters installed assumed to be Tru/Flo Compound style meter;
- ICI meters identified to be replaced will be replaced with like-sized meter;
- Installed ICI Meters smaller than 2” assumed to have same install cost as a 2” meter;
- New meter cost for ICI meter is described in Table 3-1 by size;
- Installation cost for new ICI meter assumed to be $3500 for all sizes;
- ICI meters identified as needing replumbing will include the cost of installing a new meter along with replumbing;
- ICI meters identified as needing a strainer will include the cost of installing a new meter along with replumbing; and
- Cost for replumbing of an ICI meter line assumed to be $5000 for all sizes.

The capital cost of rectifying all identified ICI meter deficiencies is described in Table 3-2. Note that these are simply meter and piping replacements and does not include for installation of new meters to create a network of one meter per commercial property.

Table 3-2: Capital Cost to Rectify Existing ICI Meter Deficiencies

Option	Capital Cost (Rounded)
Cost to Replumb and Replace 25 Deficient Meters	$302,000
Total Cost to Replace 36 Deficient Meters	$253,000
Total Cost to Rectify all Deficient Meters (61)	$555,000

3.2.3 Meter Reading Equipment Costs

RMOW currently uses a Trimble hand-held meter reader and a R900® Belt Clip Receiver to collect meter reads. The Trimble units are generally replaced on a 3 to 5 year cycle, but advances in technology may allow these units to be replaced in the future with a tablet[4]. The replacement cost and replacement frequencies for RMOW's current equipment are summarized in the Table 3-3 below.

Table 3-3: Meter Reading Equipment List Price

Equipment	Cost	Replacement Frequency
Trimble Hand-Held Reader	$5,100	3-5 years
R900® Belt Clip Receiver	$5,250	unknown
Annual System Support fees[2]	$3,000	

Source:
1) List prices provided by Geoff Korinetz, Fred Surridge Ltd.
2) List Prices provided by Neptune Technologies Inc.

The life expectancy of the R900 Belt Clip Receiver is unknown[4], for this analysis it was assumed that the unit was replaced on a 5 year cycle.

3.2.4 Capital Cost Assumptions

- The analysis does not account for population growth;
- The 2015 population is 10,447;
- Metering technology includes a Neptune meters with RF end points capable of walk-by read;
- Meter reading software has already been purchased, and is integrated with Tempest billing software;
- No additional reading equipment is required (i.e. no additional handheld units or drive by units), but the two existing units are replaced on a 5-year basis;
- New meters are installed in 2017;

[4] Geoff Korinetz from Fred Surridge – Neptune Supplier

- Fire services are separate from domestic and therefore will not require a meter;
- Meters are replaced after 20 years in service;
- Meters with unknown installation dates are replaced in 2017;
- Residential meters are assumed to be 5/8" positive displacement meters; and
- The following number and size of ICI meters are assumed:
    - 100 - ¾" meters;
    - 110 – 1" meters;
    - 70 – 1.5" meters;
    - 75 – 2" compound meters;
    - 55 – 3" compound meters;
    - 90 – 4" compound meters;
    - TOTAL = 500 meters.

3.2.5 Capital Cost Summary

Based on the above assumptions, estimated 20-year life cycle capital costs for the three options are summarized in Table 3-4.

Table 3-4: Summary of Life Cycle Capital Costs

Option	20-year Life Cycle Capital Cost (Rounded)
BAU	$3,887,000
ICI Metering	$4,630,000
Universal Metering	$8,152,000

A detailed cost estimate is appended to this report.

3.3 Operating and Maintenance Costs

Operating and maintenance costs for a metering program can vary widely. 2013 National Benchmarking study was used to estimate the potential operating and maintenance costs. The assumptions are listed below:

- The median values for 2011 were used.
- Cost of Billing is $11.50 /service connection.
- Cost of Customer Care is $0.77 / population served
- Cost of Meter Operation and Maintenance $12.30/ meter
- Number of employees (FTE) is 0.07 per 1000 meters.
- Software support is estimated to be $3,000 per year.

- FTE is assumed to be 2080 hours per year.
- A loaded rate of $55.52 was used for employees.

Based on the above assumptions the operations and maintenance for the metering programs was estimated for a 20-year life cycle as shown in Table 3-5.

Table 3-5: Summary of O&M Costs

Option	Annual O&M Cost	20-year Life Cycle O&M Cost (Rounded)
BAU	$130,000	$2,738,000
ICI Metering	$142,000	$2,986,000
Universal Metering	$358,000	$7,516,000

A detailed breakdown of operation and maintenace costs is appended to this report.

4. Water Metering Benefits

Customer water meters are a valuable water management tool that can facilitate system optimization and equitable customer billing. Water meters paired with water rates that encourage water conservation (i.e. inclining block, or flat volume rate), can provide strong incentives for water conservation and have proven effective in British Columbia and worldwide.

Several BC municipalities that had limited water sources or very high residential water demands have implemented universal metering programs. The District of Chetwynd, City of Kelowna and the City of West Vancouver all experienced demand reductions of 15% or more when they adopted universal metering. Small water utilities that serve a combination of full-time residences and vacation cottages in the Gulf Islands have also experienced water demand reductions greater than 15% when retrofitted with universal water metering, despite no change to their fixed quarterly user charges.

Other benefits of water meters include:

- Ability to price water consumption and set effective water budgets for residential users with inclining block rates
- Improved capacity to detect and isolate leaks in the distribution system and on customer property
- Improved user pay equity (high users pay their share)
- Ability for the Municipality to monitor water consumption of its customers,
- Ability to implement other water conservation measures more effectively.

Water meters will allow for RMOW to target water conservation measures to customers, and evaluate the success.

5. Cost Analysis

As illustrated in Figure 2-1, RMOW has experienced a significant and accelerating trend in increasing water demand since 2011. Water demand per capita also been increasing, which is inconsistent with the broader North American trend of decreasing unit water demands resulting primarily from changes to fixture water efficiency standards and natural replacement rates. The increasing water demand is partly

driven by increasing visitation to Whistler in the same timeframe; however, the average demand per bed unit has also increased since 2011.[5] Hot, dry summer weather in 2015 was a significant factor, however the causes of broader trends in water demand are difficult to ascertain due to the lack of metering particularly on ICI connections.

A combined maximum day demand (MDD) for Whistler and Whistler South of 28 m^3/min occurred on July 3, 2015. This was only 7% below the maximum capacity of all RMOW's water sources combined, and 10% over the supply capacity with the 21 Mile Creek source offline. The 21 Mile Creek source cannot be used when turbidity exceeds 1 NTU, which is relatively common in early summer.[6] The business case for metering must consider the magnitude of the current risk of a water supply shortfall in a drought year such as 2015, particularly if the 21 Mile Creek source is unavailable at the time of maximum seasonal demand.

For conducting a benefit-cost analysis, the following assumptions are made:

- The ICI sector uses 50% of total customer water demand in RMOW.[7]
- For each customer class, metering all customer connections and introducing a conservation-oriented pricing structure for water and wastewater services based on metered usage will result in a 15% reduction in both annual average and maximum day water demands by the customer class. Savings in the range of 10% to 20% are likely to be achieved.
- A 20-year average life cycle, reflecting the expected lifespan of meters installed under the program; and
- A 2.96% discount rate, representing the current indicative 20-year MFA lending rate.

Based on the foregoing assumptions, and using 2013-2015 averages as a baseline, universal metering may reduce annual average demand from 5.4 to 4.6 Mm^3/year, and MDD from 18 to 15 m^3/min. Metering ICI accounts is estimated to achieve half of these reductions.

A life cycle benefit-cost comparison for each metering option is presented in Table 5-1.

Table 5-1: Preliminary Benefit-Cost Comparison

Option	20-year Life Cycle Capital Cost	Annual O&M Cost	Total Annualized Cost[1]	Net Annualized Cost	Estimated Max Flow Reduction (m^3/min)	Unit Cost of Max Flow Reduction ($/$m^3$/min)
Business as Usual	$3,887,000	$130,000	$390,000	$0	0	n/a
ICI Metering	$4,630,000	$142,000	$452,000	$62,000	1.3	$48,000
Universal Metering	$8,152,000	$358,000	$904,000	$514,000	2.7	$190,000

[5] Although water demand increased by 9.5% between 2011 and 2015, estimated population increased by only 0.3% (BC Stats). Total annual visitation, however, increased by 12% in the same time period (RMOW Community Monitoring). RMOW uses bed units (BU) as a basis for calculating unit water demand, and estimates that both annual average and maximum day water demands per BU have increased since 2011 (*Comprehensive Water Conservation And Supply Plan 2015 Update Report*, RMOW, September 2015).

[6] *Comprehensive Water Conservation And Supply Plan 2015 Update Report*, RMOW, September 2015.

[7] Based on 5.4 Mm^3 total annual demand, assuming 250 L/c/d annual average residential demand x (10,447 permanent residents + 15,000 annual average temporary occupants of residences), and 15% system losses.

In Table 5-1, the total annualized cost is the approximate annual cost of the metering program including the O&M component, and debt servicing costs for the total 20-year capital cost amortized over the life cycle. Since most of the capital cost for each option must be expended at the beginning of the program life cycle, converting to an annual program expense is assumed to require borrowing.

Given that the life cycle cost of business as usual is an unavoidable cost, the net annualized cost to meter all ICI customers is estimated to be $62,000/year, and to adopt universal metering is $514,000/year.

A unit cost per avoided m^3/min of MDD is then calculated to compare the cost-effectiveness of each measure based on the net cost above the status quo. Based on the assumptions used in the analysis, ICI metering is estimated to be nearly four times more cost-effective than universal metering.

There is a large degree of uncertainty in this benefit-cost analysis, arising from an unknown breakdown of water demand by sector and required number of ICI meters. Additional measurement and analysis of ICI water demands based on available flow and facility occupancy data would substantially reduce the uncertainty in this analysis.

Reducing total annual water demand and peak summer demand would both yield significant benefits, including avoidance of capital projects to reduce risks of water shortages and reduced adverse impacts on aquifers and streams. Quantifying these benefits is beyond the scope of this assessment. The benefit of metering in reducing water demand is also dependent on the pricing structures and communication initiatives implemented to utilize the meter data.

6. Recommendations

1) Evaluate the cost of supply side improvements that would be required to mitigate anticipated risks of a water supply shortfall over the next 20 years.
2) Complete a cost of service based water and sanitary rate review based on the AWWA M1 standard.
3) Read all existing meters on a quarterly basis for a period of at least one full year. This will allow RMOW to track seasonal water usage better, and will encourage metered customers to review their water use on a more regular basis, which could aid in water conservation. The resulting large sample of individual customer usage would also enable the uncertainty in assessment and planning of metering or other demand management strategies to be reduced substantially.
4) Conduct a business case analysis for phasing in ICI or universal metering and consumption based billing over the next five years, based on measured water demands for a sample of ICI and residential customers and a 20-year forecast of costs to increase the capacity or reliability of water supply.

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Encl.: Cost Estimate Tables

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Revision History

Revision #	Date	Status	Revision Description	Author
0	September 25, 2017	Sealed		RYL

Life Cycle Capital Cost Tables

Table 1: Business as Usual

Program Year	No. of Meters					# of meter employees	Capital Costs				Operations and Maintenance Cost						Total	NPV
	New Residential Meters	New ICI Meters	Replaced Residential Meters	Replaced ICI Meters	Total Meters		Meter Installation Cost				Billing	Customer Care	Meter Maintenance	Meter Program Management	Software Support	Total		
							Residential	ICI	leter Equipmer	Total								
2017			1579	202	3759	0.26	$821,870	$1,136,573		$1,958,443	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$2,088,831	$2,088,830.69
2018			244	18	3759	0.26	$127,002	$101,279		$228,281	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$358,669	$351,771.31
2019			97	12	3759	0.26	$50,489	$67,519		$118,008	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$248,396	$238,933.87
2020			385	19	3759	0.26	$200,393	$106,905		$307,298	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$437,686	$412,917.26
2021			96	7	3759	0.26	$49,968	$39,386	$10,350	$99,704	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$230,092	$212,896.83
2022			115	4	3759	0.26	$59,858	$22,506		$82,364	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$212,752	$193,066.79
2023			95	13	3759	0.26	$49,448	$73,146		$122,593	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$252,981	$225,159.04
2024			33	10	3759	0.26	$17,177	$56,266		$73,443	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$203,830	$177,925.00
2025			51	8	3759	0.26	$26,546	$45,013		$71,558	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$201,946	$172,890.26
2026			694	77	3759	0.26	$361,227	$433,248	$10,350	$804,825	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$935,213	$785,257.54
2027			0	0	3759	0.26	$0	$0		$0	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$130,388	$107,375.68
2028			0	0	3759	0.26	$0	$0		$0	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$130,388	$105,310.76
2029			0	0	3759	0.26	$0	$0		$0	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$130,388	$103,285.55
2030			0	0	3759	0.26	$0	$0		$0	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$130,388	$101,299.29
2031			0	0	3759	0.26	$0	$0	$10,350	$10,350	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$140,738	$107,237.58
2032			0	0	3759	0.26	$0	$0		$0	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$130,388	$97,440.63
2033			0	0	3759	0.26	$0	$0		$0	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$130,388	$95,566.77
2034			0	0	3759	0.26	$0	$0		$0	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$130,388	$93,728.95
2035			0	0	3759	0.26	$0	$0		$0	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$130,388	$91,926.47
2036			0	0	3759	0.26	$0	$0	$10,350	$10,350	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$140,738	$97,315.31
2037			0	0	3759	0.26	$0	$0		$0	$43,000	$8,000	$46,000	$30,388	$3,000	$130,388	$130,388	$88,424.83
Total							**$1,763,975**	**$2,081,842**	**$41,400**	**$3,887,217**	**$903,000**	**$168,000**	**$966,000**	**$638,148**	**$63,000**	**$2,738,148**	**$6,625,364**	**$5,948,560**

Table 2: ICI Metering

Program Year	No. of Meters					# of meter employees	Capital Costs				Operations and Maintenance Cost						Total	NPV
	New Residential Meters	New ICI Meters	Replaced Residential Meters	Replaced ICI Meters	Total Meters		Meter Installation Cost		Meter Equipment	Total	Billing	Customer Care	Meter Maintenance	Meter Program Management	Software Support	Total		
							Residential	ICI										
2017		349	1579	0	4108	0.29	$821,870	$1,963,683		$2,785,553	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$2,927,762	$2,927,762.23
2018			244	17	4108	0.29	$127,002	$95,652		$222,654	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$364,864	$357,846.92
2019			97	17	4108	0.29	$50,489	$95,652		$146,141	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$288,350	$277,366.28
2020			385	17	4108	0.29	$200,393	$95,652		$296,045	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$438,254	$413,453.25
2021			96	17	4108	0.29	$49,968	$95,652	$10,350	$155,970	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$298,180	$275,895.84
2022			115	17	4108	0.29	$59,858	$95,652		$155,510	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$297,719	$270,172.26
2023			95	17	4108	0.29	$49,448	$95,652		$145,100	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$287,309	$255,711.50
2024			33	17	4108	0.29	$17,177	$95,652		$112,829	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$255,038	$222,624.40
2025			51	17	4108	0.29	$26,546	$95,652		$122,198	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$264,407	$226,364.15
2026			694	17	4108	0.29	$361,227	$95,652	$10,350	$467,229	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$609,439	$511,718.83
2027			0	0	4108	0.29	$0	$0		$0	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$142,209	$117,110.65
2028			0	0	4108	0.29	$0	$0		$0	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$142,209	$114,858.53
2029			0	0	4108	0.29	$0	$0		$0	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$142,209	$112,649.71
2030			0	0	4108	0.29	$0	$0		$0	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$142,209	$110,483.37
2031			0	0	4108	0.29	$0	$0	$10,350	$10,350	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$152,559	$116,245.04
2032			0	0	4108	0.29	$0	$0		$0	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$142,209	$106,274.87
2033			0	0	4108	0.29	$0	$0		$0	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$142,209	$104,231.12
2034			0	0	4108	0.29	$0	$0		$0	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$142,209	$102,226.67
2035			0	0	4108	0.29	$0	$0		$0	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$142,209	$100,260.78
2036			0	0	4108	0.29	$0	$0	$10,350	$10,350	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$152,559	$105,489.34
2037			0	0	4108	0.29	$0	$0		$0	$47,000	$8,000	$51,000	$33,209	$3,000	$142,209	$142,209	$96,441.67
Total							**$1,763,975**	**$2,824,553**	**$41,400**	**$4,629,928**	**$987,000**	**$168,000**	**$1,071,000**	**$697,396**	**$63,000**	**$2,986,396**	**$7,616,324**	**$6,925,187**

Table 3: Universal Metering

Program Year	No. of Meters					# of meter employees	Capital Costs				Operations and Maintenance Cost						Total	NPV
	New Residential Meters	New ICI Meters	Replaced Residential Meters	Replaced ICI Meters	Total Meters		Meter Installation Cost		Meter Equipment	Total	Billing	Customer Care	Meter Maintenance	Meter Program Management	Software Support	Total		
							Residential	ICI										
2017	6767	349	1579	0	10875	0.76	$4,344,093	$1,963,683		$6,307,776	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$6,665,691	$6,665,690.57
2018			244	17	10875	0.76	$127,002	$95,652		$222,654	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$580,568	$569,403.60
2019			97	17	10875	0.76	$50,489	$95,652		$146,141	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$504,055	$484,854.56
2020			385	17	10875	0.76	$200,393	$95,652		$296,045	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$653,959	$616,951.37
2021			96	17	10875	0.76	$49,968	$95,652	$10,350	$155,970	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$513,884	$475,480.53
2022			115	17	10875	0.76	$59,858	$95,652		$155,510	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$513,424	$465,918.78
2023			95	17	10875	0.76	$49,448	$95,652		$145,100	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$503,014	$447,693.67
2024			33	17	10875	0.76	$17,177	$95,652		$112,829	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$470,743	$410,914.61
2025			51	17	10875	0.76	$26,546	$95,652		$122,198	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$480,112	$411,033.39
2026			694	17	10875	0.76	$361,227	$95,652	$10,350	$467,229	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$825,143	$692,836.74
2027			0	0	10875	0.76	$0	$0		$0	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$357,914	$294,745.52
2028			0	0	10875	0.76	$0	$0		$0	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$357,914	$289,077.34
2029			0	0	10875	0.76	$0	$0		$0	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$357,914	$283,518.16
2030			0	0	10875	0.76	$0	$0		$0	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$357,914	$278,065.89
2031			0	0	10875	0.76	$0	$0	$10,350	$10,350	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$368,264	$280,604.82
2032			0	0	10875	0.76	$0	$0		$0	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$357,914	$267,473.88
2033			0	0	10875	0.76	$0	$0		$0	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$357,914	$262,330.15
2034			0	0	10875	0.76	$0	$0		$0	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$357,914	$257,285.34
2035			0	0	10875	0.76	$0	$0		$0	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$357,914	$252,337.55
2036			0	0	10875	0.76	$0	$0	$10,350	$10,350	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$368,264	$254,641.56
2037			0	0	10875	0.76	$0	$0		$0	$125,000	$8,000	$134,000	$87,914	$3,000	$357,914	$357,914	$242,725.58
Total							**$5,286,198**	**$2,824,553**	**$41,400**	**$8,152,151**	**$2,625,000**	**$168,000**	**$2,814,000**	**$1,846,198**	**$63,000**	**$7,516,198**	**$15,668,349**	**$14,203,584**