WATER STREET ENGINEERING LTD.

INFRASTRUCTURE PLANNING AND DESIGN

City of Courtenay
Water Smart Action Plan

12 Sep 2019

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Revision History

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B	Draft	14 Jan 2019	First draft	NW
C	Final Draft	19 Feb 2019	Addressed City comments, add costing of programs and recommendations	NW
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1	Final	10 May 2019	Corrected Typo	NW
2	Final	12 Sep 2019	Revised Table 4-3 and 5-1	NW

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City of Courtenay
Water Smart Action Plan

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1 BACKGROUND

1.1 Purpose

This action plan provides a water conservation plan for the City of Courtenay that reflects the City's commitment to reducing indoor and outdoor water use. The goal of the plan is to reduce non-agricultural per capita consumption by 50% by 2050 from 2008 levels to meet the Comox Valley Regional District's (CVRD's) Water Efficiency Plan [REF 8] targets. Intermediate targets are as follows:

- 2020: 30% Reduction
- 2030: 40% Reduction
- 2040: 45% Reduction

This report:

- Reviews the City's water use consumption data including ADD, MDD, PHD, and monthly demand.
- Uses population, irrigated area and other inputs to break down existing water usage in Courtenay and forecast future baseline demands
- Identifies a set of water conservation programs for Courtenay to reach CVRD reduction targets

1.2 Introduction

The City of Courtenay is supplied by the CVRD's water system from Comox Lake. The CVRD also supplies a number of other water service areas including the Town of Comox.

The CVRD water system is water stressed in the summer months. The CVRD has staged watering restrictions (Stage 1 in normal summer to Stage 4 in extreme drought). Low water levels in the summers of 2014, 2015 and 2016 led to enacting Stage 2 and/or Stage 3 restrictions. In 2015, Stage 3 restrictions limiting watering to hand watering only were in place for 77 days from 3 Jul to 18 Sep. This is understood to be the main driver for water efficiency.

The CVRD-wide baseline average yearly consumption stated in the 2012 Water Efficiency Plan is 607 L/ca/day [REF 8, p13] based on average annual consumption from 2006-2009. Hence the CVRD average consumption target for 2050 is **304 L/ca/day**. The formula for calculating the target, q, is:

$$q = \frac{Q}{P * (365\ days)}$$

where:

- Q is the annual water consumption in L excluding agricultural usage but including industrial, commercial, institutional, parks, utility uses and leakage.
- P is the residential population of the service area.

The City's current (2017) average usage is 13,745 m^3/day (total annual supplied water including residential, ICI, and leakage but less agricultural uses and exported water) which corresponds to a gross per capita rate of **531 L/ca/day** (based on estimated population of 25,885). A reduction of 43% of current levels is therefore required to meet the goal of **304 L/ca/day**.

The primary driver for the water efficiency plan is summer time peak usage, which corresponds to the period when the CVRD supply from Comox Lake is most stressed.

1.3 Previous Relevant Work

1.3.1 2007 CVRD Universal Metering Study [REF 2]

This report by Koers & Associates Engineering Ltd. analyzes water use trends in the Comox Valley and considers the costs and benefits of a universal water metering program.

Summary information from the report for the City of Courtenay:

- 2006 water consumption: 5,261,000 m^3/yr
- 2006 residential population: 21,940 ca
- 2006 water use metric: 657 L/ca/day
- 2006 metering of services included all multi-family residential (> 4 DU), and industrial, commercial, and institutional services and some parks / municipal services. The City at that time had 624 billed-metered services, with quarterly readings.
- The remaining estimate of un-metered services was 7,946 services (single-family residential) of which 800 were already fitted with meter boxes.
- Total cost for implementing universal metering was estimated at $7,600,000 to $8,400,000 (2006 values), approximately $1,000 per connection.
- Estimated benefit of universal metering: 20% reduction in average use and 30% reduction in MDD use (note these estimated benefits were empirically-based on observations from other municipalities).

1.3.2 2009 CVRD Water Conservation Strategy [REF 3]

This study by Koers & Associates Engineering Ltd. evaluated potential water conservation strategies in the CVRD. Key relevant information includes:

- 2008 City of Courtenay water consumption: 4,687,000 m^3/yr (estimated 560 L/ca/day)[1]
- Costed water use reduction measures (and estimated water use reduction): Toilet rebates (8%), faucets & shower rebate (4.5%), clothes washer rebate (4%), rain barrels (<1%), Irrigation system controllers and irrigation watering restrictions (undefined benefit), and universal metering (10-30%)
- Recommended:
    - universal metering with a “seasonal and inclining block rate structure and a public education campaign” (most cost-effective measure) OR
    - alternatively, a voluntary metering program supplemented with rebate programs for toilets, washing machines, and irrigation system upgrading OR
    - alternatively, as a short-term measure only, strict summer watering restrictions.

1.3.3 2012 CVRD Water Efficiency Plan [REF 8]

The CVRD water efficiency plan (WEP) was updated in 2012 (the original WEP was adopted in 2009). The plan notes the system supply limitations from Comox Lake and is motivated by the desire to reduce the scale of future infrastructure upgrades and associated costs.

In addition to setting water use goals as discussed in the introduction, the 2012 update to the WEP summarized past experience with water efficiency measures as follows.

[1] Per-capita metric as derived by WSE from 2006 and 2011 Census residential population interpolation.

Table 1-1: CVRD WEP Measures per 2012 Update

Measure	2009 – 2012 Summary	Recommendation
Education / Media Plan	Wide-ranging number of advertising and demonstration activities. Thought to be successful but cannot be quantified.	Continue but with more focus on reducing summer consumption.
Toilet replacement rebates	2018 toilet rebates provided over period.	Continue with program of 900 toilet rebates per year.
Showerhead retrofits	1650 kits distributed. Estimated reduction of 0.8% (63,000 m^3/yr) of annual usage.	Discontinued.
Waterwise Pledge	Ran in conjunction with showerhead retrofits.	Discontinued.
Water efficient appliances	Not part of CVRD funding; BC Hydro funding for dishwashers and clothes washers	Not funded by CVRD.
Rain barrel / cistern program	163 rain barrels distributed. Low uptake and low reduction expected.	Discontinued.
Leak detection and pressure reduction	Low leaks in CVRD transmission system. Recommend funding of leak detection in member distribution systems.	Funded. See water audit reports summarized in following sections.
Water restrictions and enforcement	675 violations in City of Courtenay over 3-year period (2010-2012). Resulting in homeowner contact (278), delivery of bylaw info (336), warning letters (64), and tickets (1).	Continue enforcement efforts.
Corporate efficiency	Installation of water efficient fixtures	Continue efforts at corporate buildings.
Water Conservation development permit	Incorporated water conservation principles into two developments (Kensington Island Properties and Saratoga Beach Estates)	Investigate opportunities for development permit areas to promote water conservation requiring various measures in these developments.
Water Metering	Courtenay is progressing with multi-family and ICI metering.	n/a
Outdoor Water Efficiency Rebates	n/a	Recommended developing program for various irrigation system improvements / audits.

1.3.4 2012 CVRD Water Audit [REF 4]

This report was one of several by Veritec, commissioned by the CVRD as part of its Leak Detection Study. The audit indicated the following for City of Courtenay:

- 4,780,000 m^3/yr (13,100 m^3/day) total water supplied (estimated 533 L/ca/day, 29 L/ca/day reduction since 2009)[2]
- 1,026,000 m^3/yr (2,810 m^3/day) billed metered consumption from 640 connections
- 3,741,000 m^3/yr (10,250 m^3/day) billed un-metered consumption from 6,971 connections (of which 3,064,000 m^3 was estimated to be residential from 6,648 connections)
- negative real losses (-160 m^3/day) and ILI (-0.26)
- Unavoidable real losses of 225,000 m^3/yr (600 m^3/day).

The water balance for Courtenay is highly dependent on the estimated residential billed authorized un-metered consumption assigned. Based on the negative value for real losses (as noted in the report), the estimates are incorrect. The negative real losses are likely due either to overestimating un-metered consumption or source flow meter error.

For the 2012 water audit, Veritec assigned an average residential per capita consumption of 345 L/ca/day and a total of 24,400 ca to billed un-metered consumption. Revisiting the un-metered population with the benefit of Census data splits of single family and multi-family dwelling densities, a more likely estimate of the billed un-metered population in 2012 is 19,640 ca. This correction alone would lower the billed un-metered consumption by 591,000 m^3/yr (1620 m^3/day). This correction would lead to an estimated real loss of 1,460 m^3/day and an ILI of 2.36.

1.3.5 2014 CVRD Minimum Night Flow [REF 5]

Veritec completed two minimum night flow (MNF) tests for the CVRD system (including isolation of Courtenay flows). The first test, completed on 1 May 2013, was unsuccessful as the night flows were influenced by night-time irrigation.

The second test was completed on 1 Apr 2014. Veritec estimated the total MNF into the City of Courtenay (less flows to Comox and Komoks FN) as 211 m^3/hr. Of the total MNF, 160.3 m^3/hr (76%) went into the West Courtenay 87 m pressure zone. Accounting for expected customer night-time consumption, the night-time leakage rate (real losses), was assessed as 157 m^3/hr for the City of Courtenay system.

Of the total leakage, 123 m^3/hr (2,952 m^3/day) was deemed recoverable (the remainder being 'unavoidable' background leakage). Using a water rate of \$0.64/m^3, Veritec estimated that recoverable losses were resulting in \$687,000/yr in excess water charges.

Veritec reported a 'snapshot' ILI value of 6.3 for the system.

[2] 40-capita metric as derived by WSE using residential population interpolated from 2011 and 2016 Census.

1.3.6 2018 Water System Master Plan [REF 6]

As part of developing a water system master plan, GeoAdvice completed this technical memorandum which provides an estimate of growth in the water system over the next five and twenty years and assesses water system performance.

The growth assignment is of interest for the Water Smart Action Plan. The memorandum divides expected growth in the City into expected infill and greenfield developments. The total 20-yr growth estimate is an increase of 17,024 ca in the City. Demand was assigned very conservatively in this report at 600 L/ca/day for ADD and 1,200 L/ca/day for MDD (i.e., no accounting for actual irrigation areas or impact of low flow fixtures on new construction indoor water use).

1.4 Trends in Other Jurisdictions

1.4.1 2016 Residential End Use Study [REF 1]

The Residential End Uses of Water studies (Water Research Foundation, *Residential End Uses of Water*, Version 2, 2016, and Version 1, 1999; referred to as REU 2016 and REU 1999, respectively) provide the most detailed and comprehensive statistics available on water use in single-family houses in North America.

Both studies measured in detail the amount of water attributable to specific devices such as toilets, showers and washing machines, as well as outdoor usage, and leakage. Both measured demand in roughly a thousand single-family homes located in communities all over North America (Including Canada). Of note, the studies did NOT consider multi-family residential uses, nor did they consider seasonal peak (e.g., peak-day or -week) demands.

The studies documented a remarkable decline in average annual indoor household water use between the two time periods. Residential indoor water use in single-family homes has decreased. Per-capita average water use decreased 15 percent, from 262 L/ca/d to 222 L/ca/d. The improved water efficiency of clothes washers and toilets accounts for most of the decreases in indoor use.

REU 2016 developed two household indoor water use benchmarks, based on single family homes:

- An Efficiency Benchmark of 423 L/u/day or 164 L/ca/day (REU 2016, Table 8-5). This benchmark is based on a complete dwelling unit retro-fit with currently available efficient fixtures (to EPA WaterSense specifications) and normal observed efficiencies.
- An Ultra-Efficiency Benchmark of 363 L/u/day or 140 L/ca/day. This benchmark is based on further reductions in clothes washer and toilet water uses (Table 8-6).

1.4.2 Metro Vancouver Assessing Densification Impacts on Water Demands [REF 11]

WSE completed this study for Metro Vancouver which addressed the impact of residential densification on expected water demands. The study found that per-capita water demands are expected to continue to decrease due to:

- Indoor water use reductions resulting from new dwellings which are more efficient, mainly due to improvements in fixtures and appliances. Indoor water use in existing dwellings will also tend to decrease as inefficient fixtures are replaced during renovations and maintenance.
- Outdoor water use reductions resulting from decreases in the average amount of irrigable area per dwelling unit.

The study confirmed both that:

- Indoor residential water use in British Columbia is virtually the same as in the rest of North America on average (229 L/ca/day vs 222 L/ca/day in REU 2016).
- On a per capita basis (and averaged over a large number of users), indoor residential water use is not dependent on the density of development (single family vs multi-family).

The study also developed irrigable area as a metric for forecasting outdoor residential water use.

1.4.3 City of Guelph Water Conservation Program [REF 12, 14]

A case study completed by the Clean Air Partnership[REF 12] analyzed the impact of Guelph's Water Supply Master Plan on water consumption between 2006 and 2011. For reference in 2006, Guelph's average water production was 51,387 m^3/day for a population of 115,040 (447 L/ca/day gross per capita consumption). Guelph was able to achieve:

- 11% water production decrease from 2006-2011 with goal of 20% reduction from 2006 by 2025
- $ 250,000/yr savings on chemical and electrical requirements for water treatment
- Delayed a $19 million water and wastewater expansion
- Utilized the reclaimed capacity for new growth

These achievements were a result of a $1.8 million annual budget for water conservation (from 2006 to 2011). The most successful programs were:

- Residential water conservation programs (460 m^3/day reduction)
- Industrial, Commercial, and Institutional Efficiency Audits (700 m^3/day reduction)
- Leak detection and repair (1300 m^3/day reduction)

The 2016 Water Efficiency Strategy Update [REF 14], identified a $1,359,000/yr budget for the next ten years of the program. This update indicated that 2014 demands were reduced to 45,463 m^3/day, equating to a gross per capita consumption rate of 353 L/ca/day. Guelph's annual net residential-only consumption rate in 2014 was 165 L/ca/day (single family residential). Total reduction in demands in the eight-year period was approximately 6,000 m^3/day of which 2,800 m^3/day was attributable to the water efficiency program.

1.5 Acknowledgements

WSE would like to thank the following City staff for their assistance with the study:

- Beth Brooks, CTech, Water Technician: City project manager
- Kyle Shaw, Manager of Transportation and Utilities: Project oversight

We also would like to thank City Parks Department staff for assistance on gathering water consumption information and providing input on current and potential parks water conservation measures.

2 EXISTING WATER USE

2.1 Source Flows Summary

Table 2-1 shows the amount of water supplied to the City. In 2017, the total supplied flow was 5,043,000 m^3 (or 13,820 m^3/day). Peak month demands (in July) are more than double base demands (261% in 2017), showing the importance of irrigation in overall consumption. The trends in consumption are shown in Figure 2-1.

Table 2-1: City of Courtenay Water Supplied Summary (m^3/day)

Year	Annual Average (ADD)	Winter Metering Period (BD)	Summer Metering Period	Peak Month (Jul) Average
2003	14,400	9,700	22,200	26,000
2004	14,400	10,000	19,300	24,600
2005	12,800	9,600	18,200	22,100
2006	14,400	9,800	22,100	26,200
2007	12,600	9,900	18,000	22,300
2008	12,800	9,400	19,800	26,800
2009	13,000	9,100	18,100	21,900
2010	12,600	9,700	19,000	22,500
2011	12,700	10,400	18,500	19,900
2012	13,100	9,100	21,000	22,500
2013	12,300	8,200	18,700	24,800
2014	12,800	8,900	20,200	24,500
2015	12,700	9,400	13,200	23,400
2016	13,700	9,900	18,500	21,500
2017	13,800	9,300	21,900	24,300
Winter Metering Period is taken as Jan 1 – Mar 31. Summer metering period is Jul 1 – Sep 30.				

2.2 Residential Water Use Inputs

The following inputs were used to assist with assignment of un-metered residential demands to the water balance and forecast.

Table 2-2: Water Use Inputs (2017)

Input	Value	Source
Population – Total	25,885	2016 Census +1.12% (2011-2016 growth rate)
Population – Detached	19,263	
Population – Multi-family	6,022	
Population – Institutional	601	
Dwelling Units (DU) – Detached	8,332	
DU – Multi-family	3,499	
DU density – Detached	2.31 ca/DU	
DU density – Multi-family	1.72 ca/DU	
Population Increase to 2050	17,024	GeoAdvice 2017 [REF 6]
Population Growth Rate	1.59%/yr	

2.3 Customer Service Meter Data

The City of Courtenay has volumetric metering for a total of 646 customer meter accounts (per summer 2017 billing period). More detail on customer service data is included in Appendix 1.

In 2017, the metered-billed consumption was 1,312,000 m^3 or 26% of total water supplied to the City. Including metered (but un-billed) parks, the total metered consumption was 1,504,000 m^3 or 30% of water supplied.

The metering inventory indicates that multi-family residential and non-residential uses are typically metered but nearly all single-family residential dwellings are not. The vast majority of un-metered water use is attributable to un-metered detached residential water use.

Recent consumption by metering period is shown in Table 2-3. Metered consumption has been relatively consistent since 2013.

Table 2-3: Service Meter Summary by Metering Period

Year	Consumption (m^3) by Meter Period				Total
	Jan - Mar	Apr - May	Jul - Sep	Oct - Dec	
2013	254,000	259,000	426,000	260,000	1,199,000
2014	245,000	364,000	428,000	214,000	1,250,000
2015	209,000	329,000	338,000	235,000	1,111,000
2016	242,000	396,000	382,000	236,000	1,256,000
2017	229,000	349,000	479,000	255,000	1,312,000
2018	233,000	361,000	n/a	n/a	n/a
Note: Includes exported water and splash park / pool meters. Other (unbilled) parks meters for irrigation are not included in this table.					

2.4 Existing Water Use Balance

A water balance for the City of Courtenay's 2017 consumption is shown in Table 2-4. The terms used in the table correspond to standard water audit terminology, see illustrative Figure 2-3: AWWA M36 Water Audit Terms.

As the City is only partially metered, a number of assumptions were required to develop the water balance, as follows:

- A population of 25,885 was assumed for the City (2016 Census value plus 1.12%).
- Un-metered residential base (indoor) water use was assigned at a rate of 200 L/ca/day. Estimated based on metered residential and winter water balance.
- Un-metered residential seasonal (outdoor) water use was assigned at a rate of 1.8 mm/day (over summer irrigation period applied to calculated irrigable areas). Interpolated from summer water balance.
- Irrigable areas were calculated using methodology developed in the Metro Vancouver study [REF 11] from gross lot areas. Irrigable areas were capped as the lot area less building footprint (GIS layers provided by the City).
- Un-metered agricultural, civic, industrial, and parks lots were assumed to be un-serviced or supplied from neighbouring metered lots, i.e. no demand.
- Un-metered commercial lots were assumed to have low use if not metered with rates based on building area and irrigable area.

- Un-metered institutional lots were assumed to have typical use if not metered with rates based on building area and irrigable area.
- Seasonal use in peak month (July) was taken as seasonal component of peak metering period multiplied by 119%. The peaking factor was interpolated based on the seasonal component of the City's source consumption peaking.
- Real losses (i.e., leakage on mains and services) were estimated at 2400 m^3/day for the entire City. Minimum night flows (MNF) were provided for 2018 for West Courtenay. The 2018 MNF for this area compared very closely to the 2014 assessment by Veritec [REF 5]. Veritec's estimate for overall systems real losses was higher, at 2942 m^3/day. However, this estimate appears high as it would lead to un-reasonably low water use rates for un-metered residential base winter consumption.
- Apparent losses for unauthorized consumption, customer metering inaccuracy, and data handling errors were assigned typical (small) values per AWWA M36 [REF 9] water audit methodology.

Table 2-4 City of Courtenay Water Balance (2017)

		Flows (m3/day)				
Category	BCAA Sub-Class	Average (ADD)	Winter Meter Period (BD)	Summer Meter Period	July (Peak Month)	Notes
Billed Metered Authorized Consumption						
Agricultural	Agr	26	41	19	41	
Civic	Civic	128	149	114	149	Excludes exported water - CVRD Bulk Water Station
Commercial	Com	1457	995	2265	2502	
Industrial	Ind	67	60	82	86	
Institutional	Inst	135	54	257	295	
Residential Detached	R-Det	137	83	228	256	521 Dwelling Units, 1144 capita
Residential Institutional	R-Inst	165	120	218	236	441 capita
Residential Multi-family (strata)	R-MF	1022	766	1421	1544	2390 Dwelling Units, 4113 capita
Residential Multi-family (rental)	R-MF2	247	239	279	286	104 Dwelling Units, 178 capita
Residential Mixed Use	R-MU	29	23	35	38	17 Dwelling units, 29 capita
Vacant Residential	R-Vac	1	0	1	1	
Vacant Other	Vacant	34	29	46	49	
Unknown use	n/a	11	11	15	16	
Subtotal		**3,459**	**2,569**	**4,980**	**5,498**	
Billed Unmetered Consumption						
Agricultural	Agr	-	-	-	0	Assumed unserviced if not metered
Civic	Civic	-	-	-	0	Assumed unserviced if not metered
Commercial	Com	280	197	425	460	Assume low use if not metered (based on building area, irrigable area)
Industrial	Ind	-	-	-	0	Assumed unserviced if not metered
Institutional	Inst	22	8	47	52	Assume typ use if not metered (bldg footprint and irrig. area based)
Parks	Parks	-	-	-	0	Assumed unserviced if not metered
Residential Acreage	R-Acr	153	47	340	384	237 ca
Residential Detached	R-Det	6,391	3,576	11,337	12501	17,882 ca, assigned at 200L/ca/day (BD) and 1.8 mm/day (of irrig. Area)
Residential Institutional	R-Inst	42	32	61	65	160 ca
Residential Multi-family (strata)	R-MF	216	180	278	293	902 ca
Residential Multi-family (rental)	R-MF2	242	154	396	433	768 ca
Residential Mixed Use	R-MU	26	6	60	68	31 ca
Vacant Residential	R-Vac	-	-	-	0	Assumed unserviced if not metered
Vacant Other	Vacant	-	-	-	0	Assumed unserviced if not metered
Subtotal		**7,372**	**4,201**	**12,944**	**14,255**	
Unbilled Authorized Consumption						
Unbilled Metered Consumption (Parks)	Parks	525	-	1,334	1,856	Irrigation of Parks and Blvds (excl billed metered parks)
Unbilled Unmetered Consumption (flushing)	N/A	7	0	0	0	Estimate from UDF Program
Subtotal		**532**	**-**	**1,334**	**1,856**	
Apparent Losses						
Unauthorized Consumption		9	9	9	9	0.25% of metered total. Typical, default AWWA M36 Value
Customer Metering Inaccuracies		86	86	86	86	2.5% representing metering meter under-read
Data Handling Errors		9	9	9	9	0.25% typical , default AWWA M36 Value
Subtotal		**104**	**104**	**104**	**104**	
Real Losses						
Leakage on Mains & Services before meter/building	n/a	2,400	2,400	2,400	2,400	ILI=2.96
Breaks	n/a	0	0	0	0	tbd
Other		-95	23	42	27	minor values to balance
Subtotal		**2,305**	**2,423**	**2,442**	**2,427**	
Total Water Supplied	**All**	**13,771**	**9,296**	**21,804**	**24,141**	**Supplied Less Exported Water**
Water Exported	n/a	48	16	107	124	Exported Water - 4835 Headquarters Rd (CVRD Bulk Fill Station) and WOSM customers
System Input / Water Imported		**13,819**	**9,312**	**21,910**	**24,264**	**From CVRD records**

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Figure 2-1: City of Courtenay Water Consumption (2003-2018)

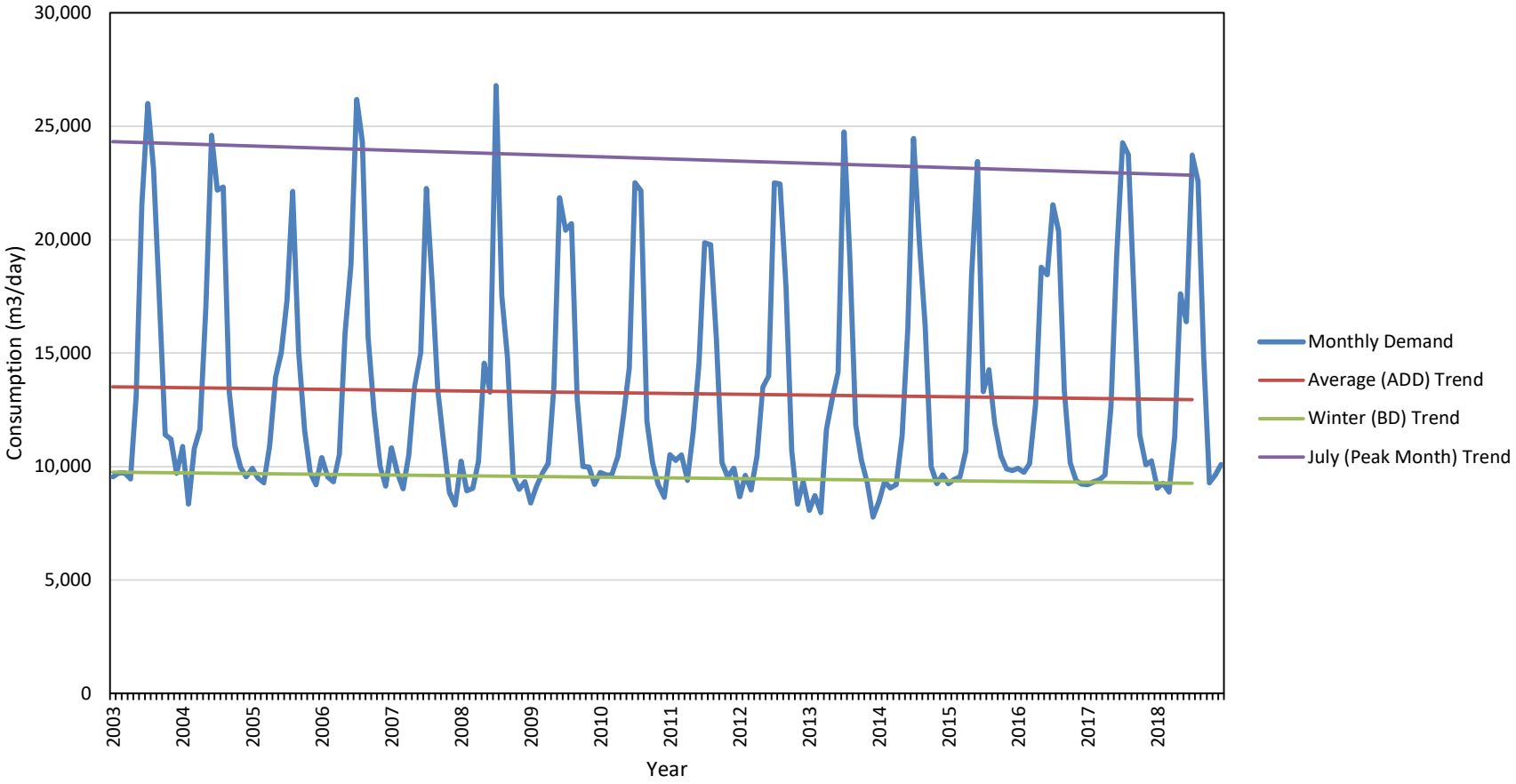

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Figure 2-2: City of Courtenay Water Balance (2017)

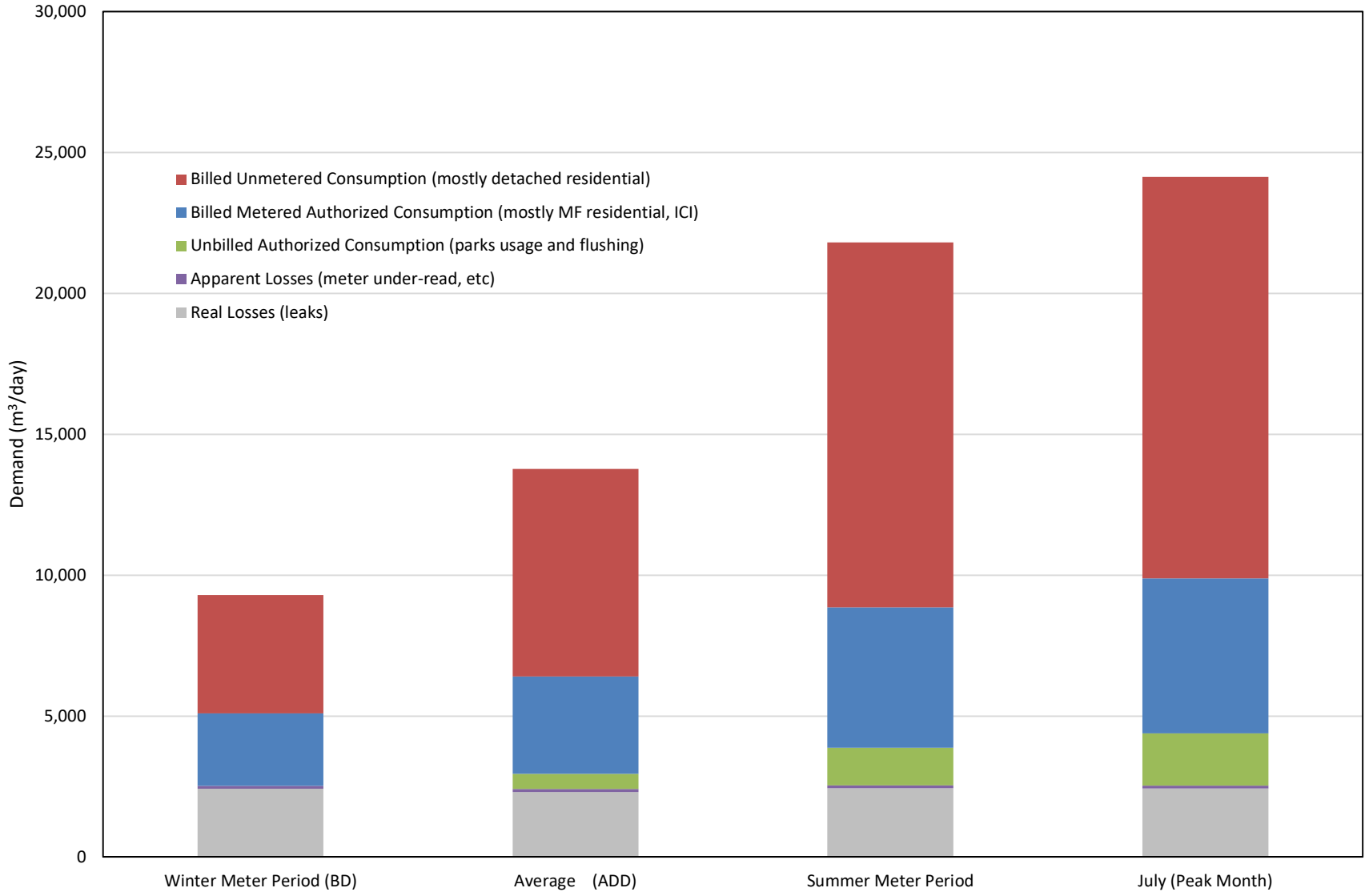

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Figure 2-3: AWWA M36 Water Audit Terms [REF 9]

<table>
<tr><td rowspan="11">Volume From Own Sources (corrected for known errors)

Water Imported (corrected for known errors)</td><td rowspan="11">System Input Volume</td><td>Water Exported (corrected for known errors)</td><td colspan="3">Billed Water Exported</td><td>Revenue Water</td></tr>
<tr><td rowspan="10">Water Supplied</td><td rowspan="2">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="8">Non-Revenue Water</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="6">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Unauthorized Consumption</td></tr>
<tr><td>Systematic Data Handling Errors</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to the Point of Customer Metering</td></tr>
</table>

2.5 Comparison of Current Water Use to Targets

The City's current (2017) average usage is 13,745 m^3/day (excluding agricultural uses and exported water) which corresponds to a gross per capita rate of **531 L/ca/day** (based on estimated population of 25,885). A reduction of 43% of current levels is therefore required to meet the goal of **304 L/ca/day**.

The July 2008 Courtenay consumption was approximately 26,600 m^3/day (total supplied of 26,788 m^3/day less allowances for export and agricultural). Based on a population estimate of 22,941, this corresponds to 1,160 L/ca/day. If the same 50% reduction is applied, the summer peak month target would therefore be **580 L/ca/day**. The current peak month demand is 24,100 m^3/day (or 931 L/ca/day), a reduction of 38% is required to meet the summer target.

2.6 2018 Water Use Questionnaire [REF 7]

The City undertook a survey of single-family residential water users in 2018. The responses are summarized in Appendix 2: 2018 Water Use Questionnaire Responses. Data was gathered from approximately 10% of single-family homes in Courtenay.

Important data was gathered on:

- The stock of efficient water fixtures (toilets, faucets and showerheads) in Courtenay (which resembles North American averages), and
- Irrigation practices in the City. Most single-family homes report to be routine irrigators (72%) with the majority of those having in-ground automatic sprinklers (65%). However only 22% of routine irrigators have a smart sensor to control their irrigation.

3 WATER USE FORECAST

3.1 Population Growth Estimate

As identified in section 2.2, an increase in residential population of 17,024 ca is considered[REF 6]. The resulting total population in 2050 under this forecast would be 42,909. The associated population growth rate to achieve this increase is 1.59%/yr. Compared to the most recent growth rate from the 2011 and 2016 Census (1.1%/yr), this would be a reasonably aggressive growth rate.

3.2 Water Use Forecast

Table 3-1 shows two water use forecasts for the City of Courtenay. The "**Low Density**" forecast shows the estimated water use if the existing average residential densities in the City were not improved and no improvements in indoor use were realized. The "**Densification**" forecast shows the expected water use if new development meets the 2016 REU study [REF 1] Ultra-Efficiency Benchmark of 140 L/ca/day for indoor water use and the amount of new irrigable areas are constrained (to a maximum of 32 m^2 of additional irrigable area per capita, or 200 m^2 lot area per dwelling unit as per proposed development plans) for outdoor water use. The increased density is consistent with more multi-family development and therefore less irrigable lawn area per capita. A peak month (July) irrigation application rate of 2.36 mm/day was used for both forecasts.

The "Low Density" forecast is expected to be overly conservative but shows that growth based primarily on low-density single-family residential development will prevent the City meeting its stated water use goals. It is presented here primarily as a caution that extensive low-density greenfield development is not consistent with the City's water use goals.

Given the current planned density of development (considerable infill zoning and multi-family projects) for the City where the amount of new irrigable area is limited, and observed usage for new residential construction to the 2012 BC Building Code [REF 11], it is expected that the **Densification** forecast is realistic.

The "Densification" forecast shows the expected impact of new development will be to reduce the ADD to 405 L/ca/day (101 L/ca/day above the goal) and the peak month demand rate to 676 L/ca/day (96 L/ca/day above the goal) by 2050.

These forecasts do not include changes to indoor water uses on existing properties, or the impacts of water conservation programs. These are considered in the following section.

Figure 3-1 shows the expected growth in water demands for each forecast from 2017 to 2050, as well as the trend in actual usage from 2003 onward. The water use forecast shows that the action plan needs to reduce annual consumption by 4,300 m^3/day (based on the forecast population of 42,909) and peak month consumption by 4,100 m^3/day.

Table 3-1 City of Courtenay Water Forecast (2050)

Category	Demands				Notes
	Average (ADD)	Winter Meter Period (Base Demand)	Summer Meter Period	July (Peak Month)	
Total Consumption (m3/day)					
2017 Consumption	**13,745**	**9,255**	**21,785**	**24,100**	
Low Density Forecast					
Residential Indoor Increase	3,132	3,132	3,132	3,132	based on 17,024 ca increase at 184 L/ca/day
Residential Outdoor Increase	1,909	-	5,265	7,313	based on 182 m^2 irrigable area/ca and current irrigation rates
Other Uses Increase	1,664	1,034	2,771	3,447	Estimate at 30% of residential demands
Low Density Growth	**6,706**	**4,166**	**11,168**	**13,893**	
2050 Consumption Forecast	**20,451**	**13,421**	**32,953**	**37,993**	
Densification Forecast					
Residential Indoor Increase	2,383	2,383	2,383	2,383	based on 17,024 ca increase at 140 L/ca/day
Residential Outdoor Increase	340	-	937	1,301	based on 32 m^2 irrigable area/ca and current irrigation rates
Other Uses Increase	899	787	1,096	1,216	Estimate at 33% of residential demands for ICI uses
Densification Growth	**3,622**	**3,170**	**4,416**	**4,901**	
2050 Consumption Forecast	**17,367**	**12,425**	**26,201**	**29,001**	
Per Capita Consumption (L/ca/day)					
2017 Consumption	**531**	**358**	**842**	**931**	based on population of 25,885 ca
2050 Low Density Forecast	**477**	**313**	**768**	**885**	based on population of 42,909 ca
2050 Densification Forecast	**405**	**290**	**611**	**676**	based on population of 42,909 ca
Targets	**304**	-	-	**580**	
Reduction Required to Meet Target	**101**			**96**	2050 Densification Forecast less target

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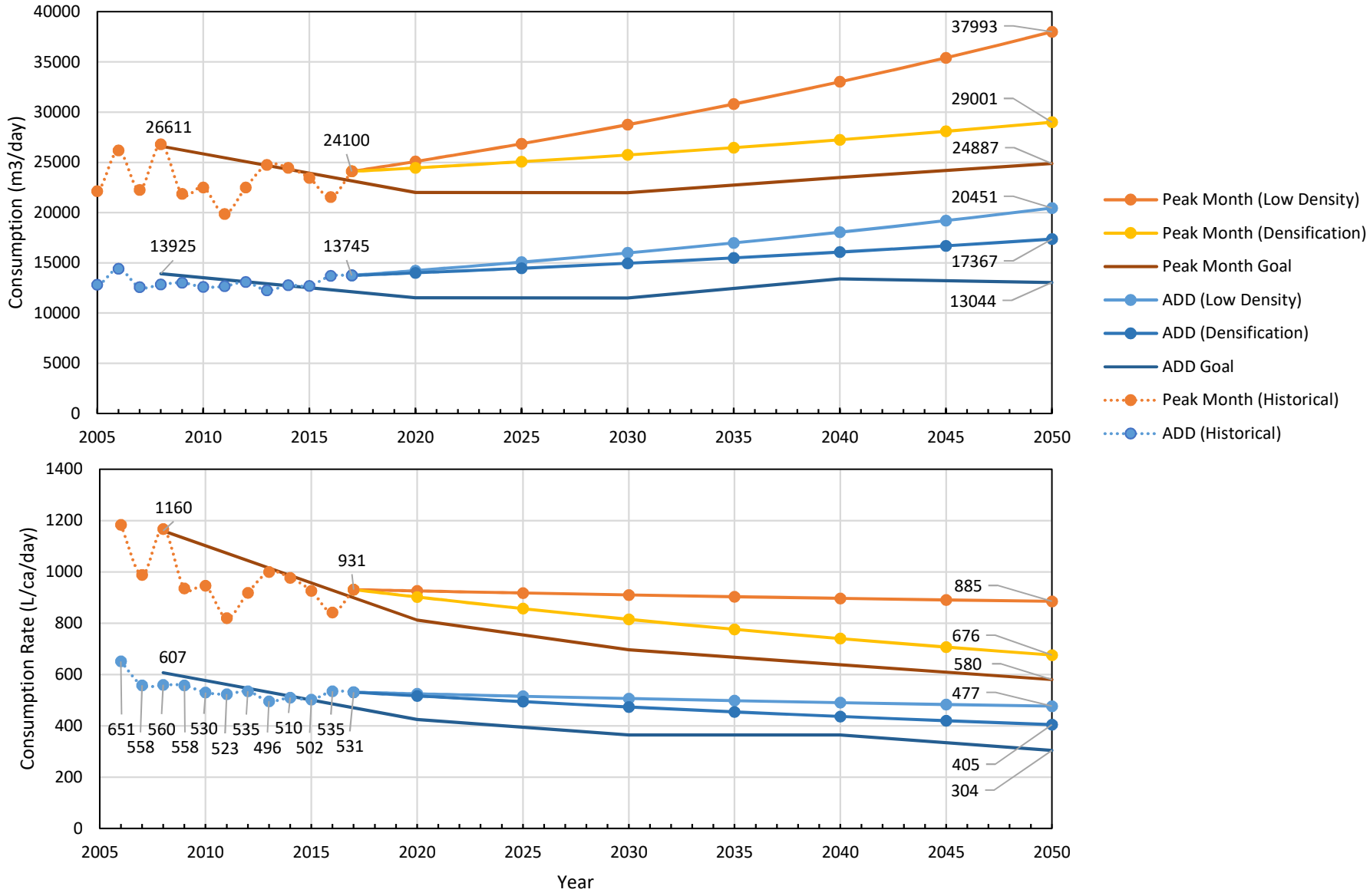
Figure 3-1 Water Use Forecasts



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4 ACTION PLAN

4.1 Action Plan Goal

As per the terms of reference the goal of the action plan is to reduce overall consumption (excl. agricultural uses) by 50% by 2050 (to the equivalent of 304 L/ca/day).

The City's current (2017) average usage is 13,745 m^3/day (excluding agricultural uses and exported water) which corresponds to a gross per capita rate of **531 L/ca/day** (based on estimated population of 25,885). A reduction of 43% of current levels is therefore required to meet the CVRD water efficiency plan goal of **304 L/ca/day** (i.e. a 50% reduction by 2050 from 2006-2009 CVRD-wide value of 607 L/ca/day[REF 8, p13]).

The primary driver for the water efficiency plan is summer time peak usage when the CVRD supply from Comox Lake is most stressed. Reducing peak summer month demands by at least a corresponding amount is desired. Accordingly, a separate (internal to City) peak summer month target is proposed.

The City of Courtenay's July 2008 consumption was approximately 26,600 m^3/day (total supplied of 26,788 m^3/day less allowances for export and agricultural), corresponding to 1,160 L/ca/day peak month consumption. The summer peak month target for the plan has is therefore set to 50% of this amount or **580 L/ca/day**. The current peak month demand is 24,100 m^3/day (or 931 L/ca/day), a reduction of 38% is required to meet the summer target.

The water use forecast developed in Section 3 shows that the action plan needs to reduce the forecasted annual consumption in the City by 4,300 m^3/day and peak month consumption by 4,100 m^3/day to meet this goal.

4.2 Potential Water Conservation Measures

4.2.1 Fixture Replacement Rebate Programs

A discussion of the impact of water efficient fixtures on indoor water uses is provided in Appendix 3. The BC Building Code requires the use of water efficient fixtures, as do building codes throughout North America. As a result, inefficient fixtures (toilets in particular) are not typically commercially available.

Rebate programs for indoor fixtures suffer from the fact that a certain portion of the fixtures will be replaced even without the program. This limits their effectiveness as a longer-term water conservation measure (where service life of the fixture is exceeded by the length of the program).

The estimated impact of changes in indoor water use due to fixture replacement in residential construction are summarized in Table 4-1 both with and without rebate programs.

The natural replacement rate residential savings of 890 m^3/yr amounts to a 17% reduction in base winter residential demands (currently 5,230 m^3/day). The impact of the natural replacement of fixtures in non-residential uses is more difficult to estimate. However, as a first approximation, a similar reduction in base demands can be extrapolated. A corresponding 17% reduction in the existing non-residential base consumption would amount to 260 m^3/day.

Table 4-1: Existing Residential Fixture Replacement Impact on Water Use

Water Use	High Efficiency Fixture (%)			Water Use (L/ca/day)			2050 Water Use Savings (m^3/day)	
	Current	Replacement Strategy		Current	2050			
		Natural in 2050	Full (with Rebates)		Natural Rate	With Rebates	Natural	Addl. w. Rebates
Residential								
Toilets	60	91	100	42	29	24	340	110
Clothes Washers	44	96	100	37	18	17	480	30
Shower	60	91	100	38	36	34	70	40
Others uses	n/a	n/a	n/a	85	85	85	-	-
Total				202	168	160	890	180
Non-residential Estimate							260	
Total							1150	

In summary, a total demand reduction of 1150 m^3/day can be expected through natural fixture replacement. This amount would be constant through the year (the same for both average and peak month). The maximum additional amount that could be saved with 100% effective residential toilet, clothes washer and showerhead rebate programs is 180 m^3/day.

4.3 Irrigation System Controller Rebate Program

DESCRIPTION

The CVRD currently runs a Smart Irrigation Controller rebate program which provides a $300 rebate for the purchase of a smart irrigation controller. Smart irrigation controllers account for weather and other conditions to determine the water required for efficient irrigation. The rebate includes inspection by the CVRD to verify the installations. CVRD's expectation is that smart controllers can reduce irrigation demands by 20 to 40% annually.

IMPACT

The City currently has 8,332 detached residential dwelling units. The water use survey indicated that 72% of the detached residential housing stock routinely irrigates (at least once a week). Of the total housing stock, 47% are regular irrigators with automatic irrigation systems. Of this subset, 34% have irrigation controllers with some form of rain or soil moisture sensor. This leaves approximately 2,500 candidates for smart irrigation controllers (i.e., existing regular irrigators without smart controllers).

The total estimate for residential detached usage is 6,391 m^3/day (ADD) and 12,501 m^3/day (PM) of which 2,815 m^3/day (ADD) and 8,925 m^3/day (from Table 2.4) is due to irrigation. Assuming that the irrigation is distributed amongst the 'routine irrigators', this gives an estimated per dwelling use of 480 L/day/DU (ADD) and 1,520 L/day/DU (PM).

Using the lower 20% estimate for reduction, the potential savings per dwelling use and overall are as follows:

- 96 L/day/DU ADD reduction per controller rebate
- 304 L/day/DU peak month reduction per controller rebate
- 240 m^3/day ADD reduction for 2,500 irrigation controllers
- 760 m^3/day peak month reduction for 2,500 irrigation controllers

COST

It is assumed that the $300 rebate/ controller amount is sufficient (with appropriate public education) to achieve the project goals. Based on 2500 units over 31 years, the desired goal would be 80 units/year at a net cost of $24,000. Adding an allowance for administration and public education of 25% gives a gross cost of $30,000/yr.

4.4 Parks Irrigation Conservation Program

DESCRIPTION

City parks and boulevard irrigation usage is estimated as 525 m^3/day (ADD) and 1,856 m^3/day (PM). As an application rate, the estimated average application rate is 2.36 mm/day (based on 78.6 ha of irrigable lot area). It is noted that in general irrigation meters are not billed and only read annually.

A detailed review of parks irrigation needs and usage (including additional meter reading) is recommended. This review would also establish a water savings goal and how to achieve it. Measures to reduce parks irrigation usage could include:

- Installing meters on un-metered irrigation connections
- Increasing meter read frequency for parks to better identify leaks and excess irrigation
- Internal volumetric billing of the Parks Department to encourage conservation (with corresponding initial budget adjustment so Parks programs are not impacted)
- Universal use of smart irrigation controllers for areas that require irrigation (already in use in many areas)
- Reduction in irrigated boulevard areas and parks area, typically by increased use of native plants and addition of topsoil depth to increase water retention (this may not be practical for sport fields) in areas currently intensively watered.

IMPACT

A goal of a 30% reduction in parks and boulevard irrigation is recommended as a preliminary goal (i.e., a reduction of 160 m^3/day (ADD) and 560 m^3/day (PM).

COSTS

Budget costs for the program are developed on the following basis:

- Installation of meters on un-metered irrigation connections. Allow for 6 meters and $4000/meter, $24,000 total.
- Additional read costs 5 times per year at $4/read at 52 parks meters. Total yearly read costs of $1,040/yr. Total cost for 31-year period of $32,000.
- Supply and install of smart irrigation controllers with soil moisture sensors at irrigated parks without this equipment. Assume 26 sites at $3,000/site.
- Assume that a 15% reduction (1/2 of goal) can be achieved via discovered irrigation efficiencies (leaks, overwatering, and overspray).
- Assume remaining 15% reduction (280 m^3/day) will be achieved via re-planting areas currently intensively watered with native plants in areas currently watered at peak rate of 6 mm/day (peak month moisture deficit in Courtenay). Total area assumed for re-landscaping area of 4.6 ha.
- Unit cost for native landscape installation of $90/$m^2$.
- Total re-landscaping cost $4,200,000 or $135,000/yr

The cost-benefit of the Parks Irrigation program are highly dependent on the gains that can be made through relatively low-cost efficiency measures (meter installs, increased meter reading, internal billing, smart irrigation controllers) versus high-cost landscaping measures (conversion to native plants).

4.5 Leak Detection/Repair and Pressure Management Program

DESCRIPTION

The water balance completed for this report indicates that the City's infrastructure leakage index is 2.96 +/- with 1,600 m^3/day in achievable savings.

Installation of distribution system zone metering is recommended as the next phase of a leak detection and repair program. Zone metering would be implemented within the distribution system meters in a way that would allow source flows to be divided into neighbourhood or pressure zone level components. The additional information provided by the zone meters allows for targeted leak detection and repairs.

Leak detection measures may include pressure reduction as a method. Pressures in most of the system are understood to be 80 to 110 psi.

IMPACT

The leakage from mains and services before customer connection is estimated at 2,400 m^3/day (based on minimum night flow analysis). The economic level of leakage for the system (UARL) is estimated as 800 m^3/day. Accordingly, a reduction of 1,600 m^3/day is expected to be achievable. It is noted that a portion of the estimated leakage could be due to source meter error and further work is required to define leakage.

COSTS

A cost for the installation of nine zone meters of $600,000 was provided by the City[REF 19]. Additional capital budget is required for additional leak detection equipment and training (allowance of $50,000). As well a yearly budget for leak detection and repairs is required (allowance of $30,000/yr based on a comparable program developed for a similar sized municipality. The total estimated program cost over 30-yr is therefore $1,580,000.

Developing a detailed leakage and reduction program is required to define Courtenay specific costs.

4.6 Multi-family Residential Audit Program

DESCRIPTION

Multi-family residential customers are generally metered in Courtenay. Some strata developments with single-unit ownership (typically townhouses) have individual meters to each unit. Multi-family residential units (such as apartment buildings) typically have a single meter and are billed collectively. Per capita consumption rates for this category appear to be significantly higher. The database indicates a total of 222 multi-family residential lots accounting for 3,464 dwelling units.

IMPACT

The current existing total multi-family residential consumption (including allowances for unmetered properties) is estimated as 1,726 m^3/day (ADD) and 2,555 m^3/day (PM).

AWWA M52 [REF 10], indicates that residential audits could reduce leakage by 5% (indoor) and 10% (exterior). Using these values, the potential savings are on the order of 100 m^3/day (ADD) and 190 m^3/day (PM).

One of the City of Guelph's water conservation programs is an example of such an audit program [REF 13]. The City of Guelph provides free water audits for residences with seven families or more, by metering water use for 24-48 hours and measuring fixture and appliance water flows. Following the audit, recommendations will be provided, with incentive options based around other water conservation programs.

COST

A budget allowance for each audit of $4000 is recommended. The program would include 222 multi-family services with a goal of auditing each service every 15 years, i.e. 15 audits per year. The yearly cost for the program would therefore be $60,000/yr.

4.7 Institutional Audit Program

DESCRIPTION

There are 28 lots identified as institutional in the database (15 are metered). Institutional uses include schools, universities, colleges, hospitals, churches and recreational clubs. The current existing total institutional consumption (including allowances for unmetered properties) is estimated as 157 m^3/day (ADD) and 349 m^3/day (PM).

IMPACT

AWWA M52 [REF 10], indicates that commercial audits could reduce leakage by 15% of all end uses, equating to potential savings of 25 m^3/day (ADD) and 50 m^3/day (PM).

COSTS

A budget allowance for each audit of $6,000 is recommended. The program would include 28 institutional services with a goal of auditing each service every 14 years, i.e. 2 audits per year. The yearly budget for the program would therefore be $12,000/yr.

4.8 Irrigation Requirements for New Developments

DESCRIPTION

New residential development provides an opportunity to build-in irrigation system water conservation measures as development permit and/or building permit requirements. Indoor water uses are for the most part well controlled by the current BC Building Code, which requires use of high efficiency fixtures. Outdoor water uses, however, are not similarly controlled.

The *Handbook of Water Use and Conservation* notes that a program designed to achieve outdoor water reduction goals typically involves a number of related initiatives, including the following components [REF 14]:

1. Establishing and implementing a local landscaping standard and/or bylaw for water efficiency (for new construction)
2. Defining a list of native and low water use turf and plants
3. Offering rebates or other incentives for installation of water-wise landscapes (typical for existing sites)
4. Developing partnerships and educating nurseries, builders, and developers
5. Establishing water-wise demonstration gardens.

Typically, water-efficiency landscaping standards still allow for a portion of the landscaped (irrigable) area to be used for turf and other high-water use. The standards also typically require a minimum soil depth, irrigation system design requirements (e.g., drip vs. spray, separate irrigation zones), and a level of landscape design.

Regarding potential water savings, the *Handbook* indicates[REF 14]:

> *The water savings that can be achieved from installing native and adaptive plants and turf vary, depending on what was replaced and to what extent the previous plants were irrigated, but at least a 20% reduction in water use can probably be expected.*

An example is given of a 28% reduction in overall residential water use for detached residential homes in New Mexico over a six-month period.

Extensive use of native plants to reduce water consumption is referred to as *xeriscaping*. Xeriscaping can reduce outdoor water use by 60% (Colorado WaterWise[REF 15]). While xeriscaping is often thought of as an arid-climate initiative, the basic principles of xeriscaping are applicable in moderate climates as well:

1. **Plan and Design** (for water conservation)
2. **Create Practical Turf Areas** (manage size, shape and grade)
3. **Select Low-Water Plants** and group them according to their water needs (hydro-zoning)
4. **Use Soil Amendments** (e.g. compost / fertilizer / additional topsoil)
5. **Use Mulches** like wood chips or cobble rock to reduce evaporation and to keep the soil cool
6. **Irrigate Efficiently**
7. **Maintain the Landscape Properly**

The City of Kelowna has implemented landscaping standards [REF 16] that require landscape design to include measures to effectively reduce the expected irrigation application ratio to less than 70% of the amount required by a turf-only landscape with spray irrigation.

The City of Kelowna's Water Smart program and water use bylaw [REF 16] requires submittal of *Landscape Water Conservation Reports* for any new or renovated irrigated landscaped areas of 100 m^2 or more. The reports develop a water budget based on the landscape area. The report template establishes a simplified approach for developing water use requirements for a variety of landscape treatments. The total water budget developed must be less than 70% of the amount required by a turf-only landscape with spray irrigation.

The outdoor water use goal of the City of Kelowna's Water Smart program is to reduce the outdoor water use applied by at least 30%, compared to 2007 levels. The program also requires good landscaping practices, including backflow prevention and irrigation isolation valves, group planting in 'hydro-zones', provision of adequate topsoil, emphasis of drip irrigation over spray irrigation, and 'smart' irrigation controllers.

IMPACT

The estimated increase in average and peak month residential water demands due to new development per the 'densification' forecast is 2,700 m^3/day and 3,700 m^3/day, respectively. Of this amount 340 m^3/day (ADD) and 1,300 m^3/day (PM) is attributed to outdoor water consumption. Not included in the above estimates is a certain amount of re-development. The above estimates also assume mostly high-density infill development.

A 30% reduction in the above amounts of irrigation water consumption is recommended as a goal, i.e. 100 m^3/day (ADD) and 390 m^3/day (PM).

COSTS

The costs for the program are limited to administration, enforcement and evaluation of effectiveness. A provisional allowance of $10,000/yr is recommended.

4.9 Irrigation Requirements for Re-Development

A similar program for improvement of the irrigation systems for re-development is a proposed goal. The program would require the Landscape Water Conservation Report as a building permit condition (for permits over a certain value) and/or where installation of irrigation system is proposed.

IMPACT

The total existing irrigation for residential and commercial customers (industrial, institutional, parks, and agricultural customers excluded) is estimated as 4,000 m^3/day (ADD) and 12,650 m^3/day (PM).

Assuming a capture rate of 30% (i.e., 30% of the existing customer base being re-developed under the program by 2050) and a 30% reduction in irrigation for those properties, the potential reduction from this program would be 360 m^3/day (ADD) and 1,140 m^3/day (PM).

COSTS

The costs for the program are limited to administration, enforcement and evaluation of effectiveness. A provisional allowance of $20,000/yr is recommended.

4.10 Conservation Rate Structure (Metered Customers)

DESCRIPTION

The City of Courtenay 2018 rate structure for multi-family residential and commercial users is as follows:

- $63.26 flat-rate per quarter for multi-family (MF) users, up to 48 m^3 consumption
- $66.85 flat-rate per quarter for commercial users, up to 48 m^3 consumption
- $1.53/$m^3$ for consumption of 48 - 566 m^3 for both MF and commercial users
- $1.23/$m^3$ for consumption above 566 m^3
- Similar declining block structure for outside-city users
- Flat rates for unmetered users ($467.53 for single family dwelling; most single-family residential customers are un-metered).
- Additional monthly rentals for water meters

The City's single-family residential customers are typically un-metered and hence billed a flat rate. Consideration of universal metering is outside the scope of this report. It is understood that the City is considering universal water metering separately.

For the metered multi-family rate component, 48 m^3/quarter works out to 526 L/day/dwelling unit or 194 L/ca/day (at typical Courtenay MF density of 1.72 ca/DU). This compares to an actual calculated usage of 186 L/ca/day for MF units per the 2017 water balance. Accordingly, for the average multi-family user the current rate structure does not provide an incentive to control water usage. Similarly, smaller commercial users would not have an incentive if their consumption was less than 48 m^3/quarter.

In comparison, the City of Guelph uses $0.26/day as a base charge, with $1.72 per cubic meter of water consumed. Removing the declining block structure and flat rate first block by implementing a similar structure as Guelph, or preferably an increasing block structure, could push users to be more conservative in their water use.

AWWA M52 [REF 10, p 111], indicates declining block structures and flat rate structures "offer little incentive for customers to improve water use efficiency". However, the manual also cautions that the impact of price on

water use (price elasticity) is weak. In particular, indoor water use is viewed as largely nondiscretionary and customers are not likely to reduce indoor water use based on price signals. Customer-side leakage and outdoor water use are more influenced by price signals. As an example, AWWA M52 cites values from a US utility water conservation plan [REF 10, p 64] of price elasticity of -0.05 for indoor use and -0.20 for outdoor use (i.e., a 1% increase in water rate would be expected to decrease indoor use by 0.05% and outdoor use by 0.20%). In practice, it is very difficult to isolate the impact of rate structure over time due to other changes in water use occurring in parallel.

AWWA M52 also recommends considering increasing billing frequency (i.e., monthly instead of quarterly) to improve customer awareness and response to water costs.

A rate study is recommended that would identify an optimal rate structure for water conservation. The rate structure would consider:

- Moving away from a complicated rate structure with little incentive for water conservation to a uniform rate structure (i.e., same charge for each m^3 of water consumed in the billing period).
- Seasonal peak pricing for the summer season (i.e., a lower winter and higher summer volumetric rate). A summer rate 50% higher than the winter rate is considered in the analysis below.
- Additional billing frequency for the summer period (monthly from April to Sep).

IMPACT

The total metered water use in the City of Courtenay is 3,459 m^3/day (25% of total use) so rate structure changes can only really be considered for this portion of the total. Using the above factors for price elasticity and summer surcharge, and adjustments to maintain neutrality it is estimated that a reduction of 3% (110 m^3/day) in average metered demands and 6% (240 m^3/day) could be achieved with the peak-season pricing revisions suggested. Other changes to the rate structure could increase the potential savings.

COSTS

The costs for the program are limited to development of revised rate structure. Once implemented the program would not have any ongoing costs (compared to current billing costs). A provisional allowance of $75,000 is recommended to develop and implement the revised rate structure. On a simplified annual basis, this equates to $2,500/yr over the life of the program (to 2050).

4.11 Supplemental Groundwater Irrigation for Parks

The City raised the potential for using groundwater irrigation for parks. More details are required to analyze this option. The supplemental groundwater irrigation project could form a means to meet the overall Parks irrigation reduction goal.

4.12 Universal Water Metering

Previous work by CVRD / Koers [REF 3] indicated an estimated potential reduction of 20% in average use and 30% in MDD use based on observations in other communities. A reassessment of the quantitative benefits of water conservation is not in the scope of this report. However, it is worth noting that investing in universal metering has the following qualitative benefits:

- Provides for fairness and equity in billing (user-pay principle)
- Provides a management tool for quantifying water use and water losses
- Provides a means for measuring the effectiveness of implemented water conservation measures
- Provides data for improved forecasting and evaluation of demand-side measures (water conservation) and supply-side measures (source development, transmission system upgrades) prior to implementation

- Provides an additional tool for emergency management (water budgeting) of water consumption if necessary
- Provides an incentive for water conservation if an appropriate rate structure is adopted

In general, the lack of universal water metering will both inhibit the potential reductions in water use considered in the preceding programs and inhibit the monitoring of program success. Universal water metering is recommended as a management tool.

4.13 Summary of Potential Programs

The programs analyzed and potential reductions in water consumption are summarized in Table 4-2. The shaded programs are short-listed and costed in the following section.

Table 4-2: Water Conservation Programs Summary

			Reduction (m^3/day)	
			ADD	**Peak Month**
Total Reduction Goal			4,300	4,100
Natural Fixture Replacement Residential			1,150	1,150
Net Goal			**3,150**	**2,950**
Program	**Impact**	**Costed**		
Full Toilet Replacement Rebate	Reduced indoor water use.	No	110	110
Clothes Washers Rebate	Reduced indoor water use.	No	30	30
Shower Rebate Program	Reduced indoor water use.	No	40	40
Irrigation System Controller Rebate	2500 controllers	Yes	240	760
Parks Irrigation Conservation	30% goal	Yes	160	560
Leak Detection and Repair	Reduce ILI=1	Yes	1,600	1,600
Multi-family Residential Audits	Reduce indoor use by 5% and exterior by 10%	Yes	100	190
Institutional Audits	Reduce end use by 15%	Yes	25	50
Irrigation Requirements for New Development	30% reduction in outdoor use	Yes	100	390
Irrigation Requirements for Redevelopment	30% reduction in existing residential & commercial outdoor uses	Yes	360	1,140
Conservation Rate Structure Changes	Delete flat rate, seasonal surcharge, increased summer read/ bill frequency	Yes	110	240
Supplemental Groundwater Irrigation for Parks	Reduce parks irrigation	No	Unknown	
Universal Metering	Separate study	No		
		Total All Programs	**2,875**	**5,110**
		Total Recommended Programs Only	**2,695**	**4,930**

The residential toilet, clothes washer and showerhead rebate programs were not costed due to expected poor cost-benefit. Universal metering is recommended but costing is not part of this plan.

4.14 Program Cost Effectiveness

Table 4-3 summarizes the estimated implementation costs and cost effectiveness of the proposed programs. The programs are ordered from the expected most cost effective to least.

Program costing has been taken from information in previous sections. The costing is annualized from the full costs for full completion of the programs.

The costing should be considered preliminary (+/- 50%), and suitable only for prioritizing of programs. In addition to the specific costing, allowances should be made for overall project management, evaluation, and administration. The unit costs are taken from the experiences of other municipalities and are not specific to the City of Courtenay. The costs and effectiveness of the programs should be further developed during project budgeting using City of Courtenay specific information (cost for labour, etc.) and including costs for administration.

Table 4-3: Water Conservation Programs Costing ($/yr)

Program	Scope	Cost ($/yr)	PM Impact (m^3/day)	Cost Efficiency ($/yr)/($m^3$/day)
Conservation Rate Structure Changes		2,500	240	10
Irrigation Requirements for New Development		5,000	390	13
Irrigation Requirements for Redevelopment		20,000	1,140	18
Irrigation System Controller Rebate	80 controllers/yr @ $300	23,000	760	30
Leak Detection and Repair	District metering, leak detection and repair	51,000	1,600	32
Parks Irrigation Conservation	Metering, smart irrigation controllers, re-plantings	135,000	560	240
Institutional Audits	2 audits/yr	12,000	50	240
Multi-family Residential Audits	15 audits/year	60,000	190	320
Total		308,500	4,930	63
Notes: Costs are annualized over length of program (2019-2050). Impact is the estimated peak month reduction at the end of the program (2050).				

5 CLOSING

5.1 Conclusions

In 2006, the City of Courtenay's average water use was 14,400 m^3/day, corresponding to a consumption rate of 651 L/ca/day. In 2017, average water use had declined to 13,745 m^3/day despite a significant increase in population. The 2017 average consumption rate was 531 L/ca/day, 18% lower than in 2006. The peak month consumption rate was 931 L/ca/day also significantly down (20%) from 2006. These decreases were the result of the combination of fixture unit turnover and water conservation efforts by the City and the CVRD.

The 2050 goal of 304 L/ca/day average demand and the proposed peak month goal of 580 L/ca/day will require significant reductions beyond what can be achieved by fixture turnover alone.

It is estimated that compared to a 'without water conservation' scenario, a reduction of approximately 3,150 and 2,950 m^3/day is required to meet the average and peak month goals, respectively. This amounts to approximately 70 L/ca/day.

The recommended water conservation program is expected to nearly meet the reduction required in average demands (2,695 m^3/day estimated savings vs 3,150 m^3/day reduction target) and exceed the reduction target for peak month demands (4,930 m^3/day estimated savings vs 2,950 m^3/day reduction target).

The estimated yr-2050 average demand with the programs in place is estimated as 315 L/ca/day (compared to goal of 304 L/ca/day).

5.2 Recommended Program

In general, the recommended programs focus on outdoor consumption and unaccounted for water (leakage), as opposed to fixture replacement.

The recommended programs and scope for a five-year program are shown in Table 5-1.

Table 5-1: Recommended 5-year Program

Program	Recommended Scope (2019-2024)	Cost ($)
Conservation Rate Structure Changes	Fully Implement	$ 80,000
Irrigation Requirements for New Development	Implement & maintain	$ 25,000
Irrigation Requirements for Redevelopment	Implement & maintain	$100,000
Irrigation System Controller Rebate	Continue program	$115,000
Leak Detection and Repair	Develop program, install district meters, purchase leak detection equipment. Complete repairs in highest leak areas	$800,000
Parks Irrigation Conservation	Focused program on watering efficiencies, defer larger expenditures for hard landscaping changes	$100,000
Institutional Audits	Trial audits for largest sites in 5-yr program (allow for 5 sites) to determine effectiveness.	$30,000
Multi-family Residential Audits	Trial audits for largest sites in 5-yr program (allow for 10 sites) to determine effectiveness.	$40,000
Total		$1,290,000

5.3 Other Recommendations

The cost-benefit for the implementation of universal water metering was not considered by the project directly. Previous work by the City indicates that it could result in considerable water savings. Universal water metering is recommended, but it is understood that the City will consider this question separately. While none of the above programs require universal metering specifically, the lack of universal water metering will impair the ability to evaluate the effectiveness of the program as a whole.

An important part of the overall program will be to evaluate the effectiveness of the program as a whole and each measure individually. This will require regular water audits to categorize and track usage.

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ABBREVIATIONS

ADD – Average Day Demand
BCAA – British Columbia Assessment Authority
CARL – Current Annual Real Losses
CVRD – Comox Valley Regional District
Det – Detached housing, includes single-family (with or without suite) and duplexes
DU – dwelling unit
HET – High Efficiency Toilet
ILI – Infrastructure Leakage Index (see glossary)
MDD – Maximum Day Demand
MF – Multi-family
PM – Peak month
UARL – Unavoidable Annual Real Losses (see glossary)

GLOSSARY OF TERMS

Actual Use Code: 3-digit code assigned by BCAA for each taxable property defining current actual use of the property (single family residential, industrial, vacant, etc.)

Apparent Losses: Per AWWA M36 methodology, total losses are Water Supplied less Authorized Consumption. Total losses are made up of Real Losses and Apparent Losses. Apparent losses included unauthorized consumption, customer metering and systematic data handling errors (i.e. underbilling).

Infrastructure Leakage Index (ILI): A non-dimensional measure of the amount of leakage in the system. Defined as CARL / UARL. A higher value indicates more real losses. A value of 1.0 indicates the system is meeting the benchmark expectation for real losses (CARL = UARL).

Real Losses / CARL: Per AWWA M36 water audit methodology, Total losses less apparent losses.

Unavoidable Annual Real Losses (UARL): The theoretical economic level of loss for the system as defined by AWWA M36 methodology based on length of mains, number and length of services, and water pressure.

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Appendix 1: Service Water Meter Data

Service Meter Summary by Customer Class (2017)

Account Code	# of Accounts	Consumption (m^3/yr)	Average Consumption (m^3/day)
SW – Sandwick	2	33,000	92
WOSM – Outside Service Area Metered	5	3,000	9
WCM – Commercial Metered	372	717,000	1,983
WRMFM – Multi-Family Metered	267	559,000	1,545
Totals	**646**	**1,312,000**	**3,629**

The meter data can also be summarized by actual use (per BCAA actual use codes) as follows:

- Multi-family residential: Mostly-metered, read and billed quarterly (estimated 2,511 DU, 72% of MF dwelling units)
- Detached residential fee-simple: Generally, not metered, billed on a flat rate. Some strata detached developments are metered under WRMFM category (18 lots / 521 DU metered, amounting to 5.9% of detached dwelling units)
- Institutional residential (e.g., group homes, assisted living): Typically metered (11 lots, 73% of institutional lots, weighted by building footprint)
- Agricultural: Three accounts, assume all water use is metered. Significant lot area.
- Industrial, Commercial, Institutional: Mostly-metered and billed quarterly. GIS analysis shows 69% of lots are metered weighted by building footprint area. It is expected that the actual portion of ICI water use that is metered would be higher than this.
- Civic facilities: Read and billed as per ICI properties. GIS analysis shows 90% of building footprint area on 'Civic' lots are metered.
- Parks: Irrigated parks are generally metered and read annually but not included in the billing system. Three exceptions exist (Pool, Splash Park, and Cemetery accounts) which are metered and billed. A few parks and boulevard connections exist without meters, the City provided estimates for these connections.

Previous work by Urban Systems[REF 18] indicated the following:

Customer Type	Metered Accounts	% Metered
Residential Single-Family	0	0%
Residential Multi-family	247	85%
Industrial	0	0%
Commercial	345	55%
Institutional	43	100%

Appendix 2: 2018 Water Use Questionnaire Responses

The City undertook a survey of single-family residential water users in 2018. The survey successfully collected 827 responses, 821 of which were for single family dwellings while the remaining 6 responses were for townhouses.

The survey addressed the following questions:

- type of residence and number of occupants
- how much of the property is watered and what is being irrigated?
- how frequently residents irrigate and what time of day do residents irrigate?
- how residents irrigate (hand, manual, in-ground)?
- how are automatic sprinklers activated (if applicable)?
- types of water features
- if and how often sidewalks, vehicles, etc. are being washed?
- types of water fixtures in the household?
- water use and conservation habits

With respect to developing a water use model for the City, the following key responses were noted:

- Summary data:
    - sample size: 10%: 827 households of 8,240 occupied single-family dwelling units in 2016 Census
    - average no. of residents per dwelling unit: 2.30 (note that this may be slightly undercounted as responses of >4, were entered as 5), matches 2016 Census density of 2.31 for Courtenay.
- Indoor water use:
    - 77% of respondents reported having low-flow toilets
    - 68% of respondents reported having low-flow showerheads
    - 50% of respondents reported having low-flow faucets
- Outdoor water use
    - 72% of respondents are routine irrigators (at least once per week)
    - 93% (of the irrigable area) on irrigated lots are irrigated (as estimated by respondents that are routine irrigators)
    - 65% of routine irrigators have in-ground sprinklers (for at least a portion of their system).
    - 22% of routine irrigators have sensors controlling their sprinkler system (either soil moisture and/or rain sensor or Wi-Fi-controlled smart sensor)

Appendix 3: Indoor Water Use changes due to Efficient Fixtures

REPLACEMENT OF TOILETS AND OTHER FIXTURES (EXISTING CONSTRUCTION)

Indoor water use has been declining over the last 30 years on a per capita basis in North America due to the impact of more efficient fixtures. The vast majority of the efficiency gains are due to replacement of inefficient toilets and clothes washers with newer efficient models. Water use from faucets, showers/baths, and dishwashers has remained relatively constant.

TOILET REPLACEMENT

The 2016 *Residential End Uses of Water* study (2016 REU [REF 1]) found that toilet flushing is the largest single indoor end use of water, making up 24% of all indoor water use, on average 54 L/ca/day. Toilets also represent the second-largest decrease (16 L/ca/day) in residential water use over the last two decades (between the 1999 and 2016 REU studies). This is largely due to penetration of the market by increasingly efficient toilets, including high efficiency toilets (HETs).

A timeline for the introduction of high-efficiency / low-flush toilets in North America is as follows[REF 11]:

- Pre-1975: Typical toilet water use of 18-25 L/flush
- 1980 to 1994: Typical new toilet requirement of 13 L/flush
- 1994: US *Energy Policy Act* requires toilets of 6 L/flush
- 1995: City of Vancouver 6 L/flush bylaw
- 1999: Introduction of HETs (4.8 L/flush) into North American market
- 2008: British Columbia Building Code (BCBC) amendment requirement for 6 L/flush toilets
- 2010: California requires 4.8 L/flush toilets.
- 2010: BCBC requires 4.8 L/flush (or dual flush equivalent) toilets.

The 2016 REU study estimated that the average flush volume was 9.8 L/flush in 2016, compared to 13.8 L/flush in 1999. The reduction is attributed to the significant turn-over from inefficient to more efficient toilets. The 1999 REU study found that 8.5% of homes had relatively efficient toilets (less than 7.5 L/flush), versus 37% in 2016.

The CVRD ran a successful residential toilet replacement program which has now been terminated. The City's water use questionnaire indicated that 77% of single-family residential users already have low-flow toilet(s) installed. It is felt this estimate is artificially high.[3]

Previous work [REF 11] indicates a natural replacement rate of 4%/yr for toilets. Given the time horizon to the target goal for 50% reduction (34 years from 2016 to 2050), and assuming 2016 stock is 37% HET (per 2016 REU), it is estimated that 84% of toilets (in existing residential units) will be HET by 2050.

This natural reduction would lead to an estimated 29 L/ca/day usage for existing residential units. This compares to 24 L/ca/day if 100% of toilets were all HET.

[3] Unfortunately, the survey was based on self-reporting and indicated 1980 as a year in which toilets were to be considered non-low flow. The survey also didn't allow for multiple bathrooms with different types of toilets.

CLOTHES WASHER REPLACEMENT

The 2016 REU study showed that adoption of efficient clothes washers (defined in that study as those using less than 114 L/cycle) is more prevalent than for high-efficiency toilets between 1999 and 2016: 40% increase (from 6% to 46%) for washers, compared to 28.5% for HETs.

This is consistent with expectations, as clothes washers have a shorter lifespan than toilets (and therefore a higher replacement rate). The 2016 REU study recorded that 64% of respondents to a water use survey indicated that they replaced their clothes washer in the last 10 years, which is equivalent to a 9.8% per year replacement rate. Other sources cited in the 2016 REU indicate replacement rates of 6 to 9% (8% used in analysis below).

Despite the lack of enforcement by building code, implementation of reasonably efficient clothes washers (about 88 L/cycle) is expected to be nearly universal by 2050:

- Inefficient washers have high energy costs.
- Inefficient washers will become increasingly unavailable in the market.
- Washers have a relatively short lifespan (e.g., compared to toilets).

Accordingly, over a long period program (to 2050) almost all (96%) of the clothes washer stock is expected to be high-efficiency by the end of the period even without a rebate program.

SHOWERS

The 2016 REU study showed that residential shower usage is the second largest indoor water use (42 L/ca/day). Unlike toilets, improvements in shower water use efficiency have been more limited (2 L/ca/day decline since 1999).

The City's water use questionnaire indicated that 68% of respondents reported having low-flow showerheads

OTHER INDOOR WATER USES

The 2016 REU study found that recent changes in water consumption for other uses has not changed appreciably since 1999. Of note, the impact of low-flow faucets has been found to be negligible (in terms of impacting overall observed indoor residential water use).