CITY OF Quesnel

Water Conservation Strategy

March 2020
1190.0188.01

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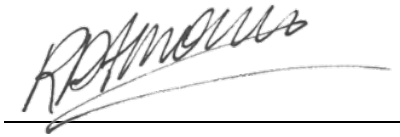
URBAN SYSTEMS

Water Conservation Strategy

Client: City of Quesnel

Prepared by: Urban Systems Ltd.



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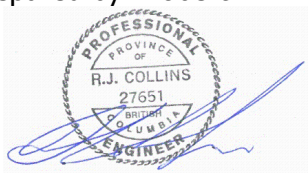

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EXECUTIVE SUMMARY

British Columbians have one of the highest per capita water use rates in the world. The Province's BC Living Water Smart document identifies that, for many BC communities, less than 3% of municipally-treated water is actually used for drinking. The rest goes down the drain or toilet, or on our gardens. Although the value of water conservation is often defined primarily in terms of avoided supply-side costs, there are many additional benefits to consumers and society at large that span all three pillars of sustainability: social, environmental and economic.

In Quesnel, average daily water use is 700 litres per capita per day (2012 -2019 average). This is significantly higher than the provincial average of 490 litres per person per day, as noted in the BC Living Water Smart document. Water use is highest during the summer months, where a large portion of water is consumed for irrigation and other outdoor activities.

The City continues to invest in the water system to ensure sufficient water is available to meet the water demands of the community. The cost to produce and deliver water in Quesnel is currently approximately \$85/100 m^3 and will increase to approximately \$105/100m^3 once the City has reached a sustainable water revenue.

Quesnel is working towards developing a City water treatment system. It is important to consider the impacts that water conservation will have on the sizing and design of the potential water treatment system. There is potential for significant capital cost savings from water conservation.

The cost will further increase when water treatment is included.

Since water treatment is an upcoming reality, it is important to assess which water conservation measures are a good investment to reduce water treatment project capital costs.

The following guiding principles, which are aligned with the City's 2011 water conservation report, are recommended to move Quesnel's Water Conservation Program forward:

1. Reduce overall water consumption levels;
2. Engage community-wide participation;
3. Ensure equity and transparency;
4. Lead by example;
5. Quantify the effectiveness of the water conservation program on an on-going basis; and,

6. Ensure water conservation measure make efficient use of resources.

The City is currently practicing a few methods of water conservation, including outdoor water restrictions (sprinkling regulations), leak detection, bulk water station, full cost of service recovery and public education. The City is initiating a review of once-through coolers in 2020. There are a variety of other cost-effective options for improving conservation in Quesnel, specifically around:

- Educational Measures
- Regulatory Measures
- System Improvements

Reducing water use now will support a variety of sustainability objectives and decrease the cost implications should treatment be needed.

The objectives of the City's Water Conservation Strategy are to:

- Understand the importance of water conservation;
- Understand the characteristics of the water system and current water usage,
- Predict what infrastructure upgrades will be required to meet future demands;
- Assess the viability of water conservation measures relevant to the City; and
- Identify steps the City can take in an effort to reduce waste of water.

Water conservation is aligned with the City's Integrated Community Sustainability Plan, Council's Strategic Plan, and the Official Community Plan. An ongoing water conservation program can be used to integrate conservation measures into the City's municipal and community practices, thus realizing triple bottom line sustainability.

1.0 INTRODUCTION

The City of Quesnel actively supports sustainability, in principle and practice. Continued sustainability initiatives by the municipality and throughout the community have led to successful results across the three pillars of sustainability (social, environmental and economic). Water is a basic need for any community, and this Water Conservation Strategy considers both the current and future requirements for maintaining a prosperous, healthy and resilient Quesnel.

Water System Sustainability Initiatives is a strategy identified in Council's 2018 Strategic Plan. The Climate Action policies

in the Official Community Plan support the City in these initiatives. This Water Conservation Strategy is aligned with both of these plans and builds on recent successes with the Bulk Water Distribution Plant and the Quesnel Water Conservation Guide. Specifically, the Water Conservation Strategy will enable the City to take a leadership role in implementing a water conservation program and promoting education around water use.

The objectives of the City's Water Conservation Strategy are to:

- Understand the importance of water conservation;
- Understand the characteristics of the water system and current water usage;
- Predict the impact of water conservation on water system infrastructure (water treatment system);
- Assess the viability of water conservation measures relevant to the City; and
- Identify steps the City can take in an effort to reduce waste of water.

2.0 WHY IS WATER CONSERVATION IMPORTANT?

Canada has approximately one fifth of the world's supply of fresh water, but less than 10% is renewable. In British Columbia, there is a need for careful stewardship to ensure the long term sustainability of the Province's fresh water supply. Action is necessary at a local level.

Although the value of water conservation is often defined primarily in terms of avoided supply-side costs, there are many additional benefits to consumers and society at large. Benefits of water conservation can be seen in all three pillars of sustainability:

- Social
- Environmental
- Economic

An ongoing program will provide measurable results that can be used to integrate water conservation measures into other municipal and community practices.

In many BC communities, less than 3% of municipally treated water is actually used for drinking. The rest goes down the drain or toilet, or on our gardens.

2.1 Social Benefits

Water conservation is most effective when there is community buy-in and a desire to take ownership for local initiatives. A water conservation program creates an awareness of usage, so it directly involves the community in making decisions about their resources and the costs to provide water and wastewater services. By informing the public about how water is delivered to individual homes and businesses, residents are empowered to understand the implications of their individual actions and how they can protect local resources. Water conservation can provide solutions for ensuring the equitable allocation of water costs to all users. In addition, water conservation can contribute to the City's high quality of life by ensuring there is always sufficient water available for health and safety measures.

2.2 Environmental Benefits

Environmental benefits of water conservation relate to the availability of water as a sustainable resource and the amount of energy used to convey water to users. A water conservation program can create an awareness of water and energy waste and its impact on the environment to help preserve vital environmental resources. Reducing water use translates into lower wastewater treatment costs by decreasing the volume of effluent to be treated, as well as minimizing energy resources necessary for pumping water. Lower energy consumption helps to achieve greenhouse gas emissions targets and decrease the carbon footprint of the City, thereby addressing climate change. This program is an opportunity to establish measures for long term environmental protection.

2.3 Economic Benefits

Infrastructure deferrals and reduced operating costs are the primary economic benefits from conservation. The main variable cost in water consumption is power and operator labour. The on-going implementation of a water conservation program will reduce the volume of water being conveyed and therefore decrease operating costs. Water conservation can also defer the need to expand existing infrastructure to accommodate water demands and usage. The main capital cost savings would be from the proposed water treatment facilities. This also applies to wastewater treatment facilities. A reduction in water usage and disposal will result in a reduction of operating costs for both water and wastewater treatment.

Healthy water and watersheds are vital to Quesnel's economy.

3.0 WHAT ARE THE PRINCIPLES GUIDING WATER CONSERVATION IN QUESNEL?

Water conservation guiding principles are an important part of any water conservation program. They assist with establishing a framework to develop an effective conservation strategy. Suggested guiding principles for a Water Conservation Program include the following:

Guiding Principles
1. Reduce overall water consumption levels
2. Engage community-wide participation
3. Ensure high profile and visibility
4. Lead by example
5. Quantify the effectiveness of the water conservation program on an on-going basis
6. Ensure water conservation measures make efficient use of resources

1. Reduce overall water consumption levels

a. Promote reductions in overall water use per person on annual and seasonal (summer) basis.

b. Encourage reductions with major users.

2. Engage community-wide participation

a. Facilitate meaningful and effective public consultation that provides opportunities for feedback from all stakeholders. The entire community should feel they are a positive part of the action.

b. Encourage residents and business owners to become actively involved in water conservation. Each water user should feel they are a catalyst for reducing demand.

c. Water conservation should be part of everyday life. This can be achieved by ensuring water conservation is constantly "out in front" of the community.

d. Demonstrating appreciation for public support of conservation measures to date will go a long way towards garnering momentum and support for programs.

3. Ensure equity and transparency

a. Ensure the fair allocation of water costs while maintaining reasonable rates.

b. Communicate information and decision-making openly.

4. Lead by Example

a. Demonstrate commitments to water conservation through municipal practices.

b. Water conservation is an ongoing, incremental process. Implementing programs that generate momentum and build on past efforts will produce results.

5. Quantify the effectiveness of the water conservation program on an on-going basis

a. Track how water is used and the quantities of water used.

b. Document significant events (i.e. boundary expansion to include South Quesnel, periods when water conservation programs were in place, changes in enforcement of water restrictions, correlation with weather conditions, etc.).

6. Ensure financial responsibility

a. Defer and reduce capital expenditures through reductions in water use.

b. Decrease operating costs by effectively managing and utilizing water and infrastructure resources.

c. Ensure the financial sustainability of the City's assets.

Adapting to climate change and reducing our impact on the environment is a condition for receiving senior government infrastructure

4.0 WHERE DOES QUESNEL'S WATER COME FROM?

4.1 Quesnel's Water System

The City of Quesnel relies on six groundwater wells to meet its domestic water demands. The wells are fitted with water meters and demand is recorded approximately three times per week at each location. The wells, in combination with eight reservoir sites, meet the City's commercial, industrial, and residential water supply needs through an integrated network of pipes (approximately 114 km in total), pump stations, and pressure relief valves. To date no treatment measures are in place. A summary of this system is provided in *Table 4.1*

Table 4.1: Major Water System Components in Quesnel

Water Services		**Hydrants**	457
• **Residential**	3,040	**Reservoirs**	8
• **Commercial**	409	**Wells**	6
• **Industrial**	41	**Bulk Water Distribution Plant**	1
Pipes	114 km		

The service area is divided into six distinct pressure zones to ensure adequate pressure is available throughout the system. *Table 4.2* provides a description of each pressure zone.

Table 4.2: Pressure Zone Characteristics

Pressure Zone	Service Area	Comments
Sugar Loaf / Pinecrest	Residential Downtown	The City wells pump into this pressure zone.
Shadow Heights	Airport Large Industrial West Pine Medium Density Fiberboard Plant	Pinecrest Booster Station pumps into this pressure zone.
South Quesnel	Residential (large proportion) Highway Commercial (more anticipated in future) Maple Park Shopping Centre	North Star Booster Station pumps into this pressure zone.
Dragon Hill	Residential, Institutional and Commercial	North Star Booster Station pumps into this pressure zone.
Uplands	Primarily Residential	Healy Street Booster Station pumps into this pressure zone.
Uplands Booster	Primarily Residential	Uplands Booster Station supplies this area.

Two industrial service connections are metered and billed on a volumetric basis. The remainder of services are charged a flat rate per type of land use.

5.0 HOW MUCH WATER DOES QUESNEL USE?

5.1 Water Use

Over the course of a year, water use in Quesnel will generally follow the trend shown in Figure 5.1. Water use is highest during the summer months, where a large portion of water is consumed for irrigation and other outdoor activities. Water use in the winter months is much lower, as it is mainly for domestic or indoor consumption.

Records of water pumped through the system were used to determine the average day demand (ADD) and maximum day demand (MDD) from 2012 to 2019. This is illustrated in Figure 5.2.

The ADD calculated over the 10 year period is 700 L/cap/day. The average calculated MDD is 1,300 L/cap/day. The MDD over recent years (2016 and 2017) was lower, but these do not represent typical water use years. MDD data was not available

for 2018. The ADD, MDD and PF values are generally constant (within 20%) over the period studied.

Figure 5.1: Typical Daily Water Use in Quesnel

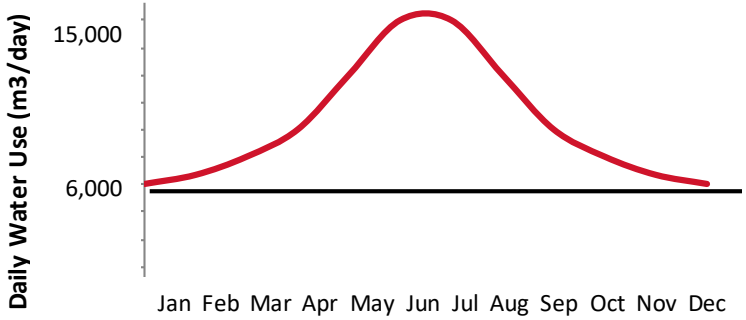
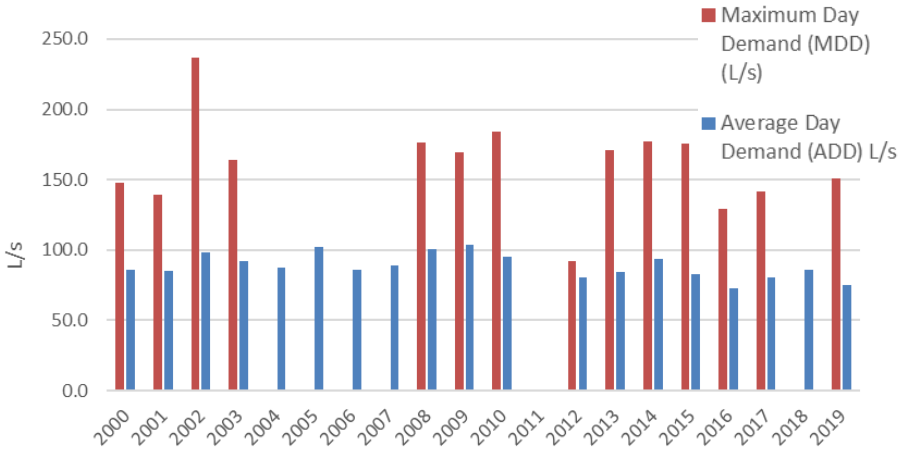


Figure 5.2: Annual Water Use in Quesnel (2012-2019)

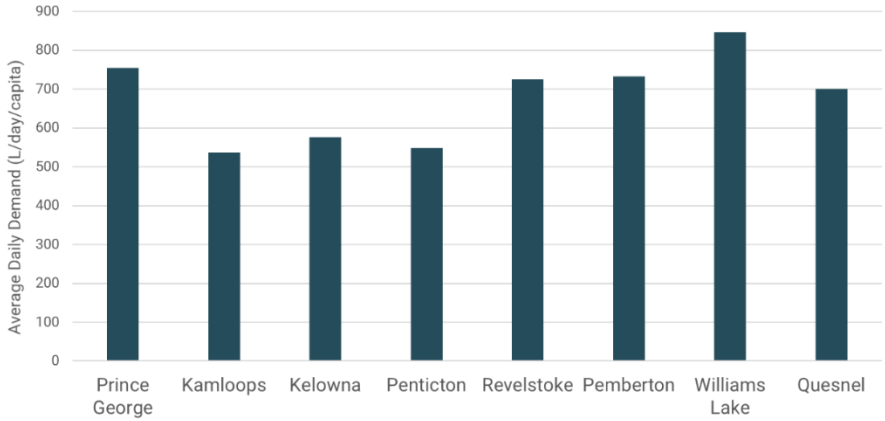


Comparison of Water Use

Canadian per capita water use, which includes residential, industrial, commercial and other uses of water provided by public utilities, averaged 427 litres per person per day in 2017, as per StatsCan. Quesnel's ADD of 700 litres per person per day is significantly higher than the Canadian average. It stands to reason that there are a lot of opportunities for conserving water in Quesnel, without compromising the needs of the community.

Refer to Figure 5.3 to see how Quesnel's water use compares to other municipalities in BC. Note that Kamloops, Kelowna and Penticton have widespread water metering in place, which may partially account for these municipalities' reduced water use as compared to unmetered communities.

Figure 5.3: Comparing Water Use to Other BC Municipalities



6.0 WHAT IS QUESNEL'S WATER DEMAND FORECAST AND SYSTEM UPGRADING REQUIREMENTS?

6.1 Estimate of Service Population Growth

An estimate on the growth in the population being served has been considered to help understand the City's future water system needs with respect to the water conservation.

Table 5.1 provides the City's population projections over the next 20 years according to a mid-range growth rate of 0.5%. This growth rate was determined to be appropriate during the 2011 Water Conservation Strategy Update and is still considered appropriate. The 2020 population was determined with input from City planning staff, who indicated that existing population data from census or BC Stats is not reflective of the City boundaries. As such, the City has stated the estimate of 10,000 currently in City limits.

Table 6.1: 20 Year Population Projections for Quesnel

	2020	2025	2030	2035	2040
Growth (0.5%)	10,000	10,250	10,500	10,750	11,000

6.2 Future Water Demand Estimate

Future water demand in Quesnel was estimated based on the service population identified in Table 5.2 and the current per capita water use.

Table 6.2: Future Water Demand

Parameter	Units	Current 2020	2025	2030	2035	Projected 2040
Average Day Demand (ADD)	L/s	82	84	86	88	90
Maximum Day Demand (MDD)	L/s	175	179	184	188	192

The current ADD of 82 L/s is the average determined from 2012 – 2019 water use records. of 82 L/s. The current MDD is 175 L/s. Note that 2019 MDD was 151 L/s, but was 175 L/s in 2014 and 2015, so it is reasonable to assume that this MDD could occur again.

6.3 Sustainable Well Capacity

Well yields and source capacity were an issue discussed in the 2011 WCS. Since that time, the City has installed a new well (PW10), and significant hydrogeological work has been completed to confirm that the existing wells provide sufficient sustainable yield to meet the current and future City demands.

The exception is the planned replacement of Well 7 (PW7), which is a planned replacement due to age.

The City is undertaking the permitting process to ensure that the yield needed from the existing and planned replacement well can meet the community's water supply needs. For this reason, source capacity is no longer an influence that needs to be examined in regard to water conservation.

6.4 Future Upgrades

The City has a strong track record of capital reinvestment, including in the water system. As part of ongoing strategies such as Water Master Planning and Capital Planning, the City has identified upgrades to water system infrastructure that will need to occur in the coming years. Some of these upgrades include the following:

- Full replacement of Two Mile Flat watermain
    - This project is required based on the condition and alignment of the existing watermain. The new upsized watermain will also provide higher level of fire protection.
- Replacement of groundwater well in the West Region (West Quesnel). The existing well (PW7) is reaching the end of its useful life and will need to be replaced to ensure a reliable water source in the West Region.
- Major repair or replacement of the Dragon Hill reservoir. The existing aboveground concrete reservoir condition is deteriorating and will require major repair or replacement.

These upgrades are important City priorities but will need to occur regardless of City water use. In other words, the extent of water conservation will not have a meaningful impact on the scope of these upgrades.

Permanent decreases in water use will result in decreases to capital costs for treatment infrastructure, along with decreases in associated operational costs.

The largest capital investment that would be impacted by water conservation is the potential water treatment system. Water treatment capital costs are proportional to the amount of water being used. This means that any permanent decrease in the amount of water being used in the community will result in decreased capital costs for treatment infrastructure. Similarly, operational costs are based on total water throughput and are related to energy and treatment costs. Embracing a

conservation mindset now, will ensure that treatment infrastructure is sized appropriately and will reduce capital and ongoing operation and maintenance costs.

Note that widespread water metering is likely the conservation measure that would have the most significant impact on water use – metering is discussed in greater detail later in this report.

6.5 Water Treatment Sizing Scenarios

In order to determine what portion of water treatment capital costs could potentially be deferred with water conservation, it is important to understand the potential treatment design scenarios.

Multiple design scenarios are being evaluated as part of the ongoing water treatment project. Each scenario presents a different water treatment capacity, as summarized in Table 5.3. The Distant Future scenario was considered to understand potential buildout sizing for the water treatment system, outside of the 20 year projection. For now, no significant analysis is warranted for the Distant Future scenario, since the City would not choose to move forward with oversized infrastructure.

The Water Master Plan determined that the City water treatment system would consist of three separate treatment sites for the sake of system robustness and to reduce the risk of service interruptions. With multiple treatment sites, it becomes important to evaluate each scenario under best case (all WTPs online), and worst case (largest WTP offline).

The overall water treatment capacity needs to be able to meet MDD. For this reason, reducing the MDD can have direct impact on the required treatment capacity.

The City's water treatment design work involves sizing the facilities so that MDD is provided over 20 hours. This means that the water treatment infrastructure would be sized to produce MDD over 20 hours, allowing 4 hours per day for maintenance/down-time.

Table 6.3: Water Treatment Sizing Scenarios

Scenarios	Total Water Treatment Plant Capacity (L/s)
Distant Future – considered for future buildout of sites	330
Comfortable – meets 20 year water demand with some redundancy	280
Minimum - possible first phase, requires 30% water conservation	215

6.6 Implications of Water Conservation for Water Treatment Scenarios

Figure 5.4 presents MDD (over 20 hours) and MDD (over 22 hours) with 10% conversation. With the Central Plant offline, remaining treatment capacity is higher than the projected MDD with 10% conservation. MDD supplied over 22 hours is shown because it is assumed that the City would accept the need to pump for more hours when a major part of the treatment infrastructure is not working.

Figure 5.5 compares 30% water conservation with the Minimum Scenario. The City would have to understand the risks presented by this scenario – with the largest treatment site offline, the projected MDD with 30% conservation would not be fully met, so water restrictions would have to be in place.

A 10% level of conservation is likely achievable without extensive measures such as full water metering. 30% conservation would likely require implementation of full water metering as part of the conservation approach.

Figure 6.4: Comfortable Scenario with 10% Conservation

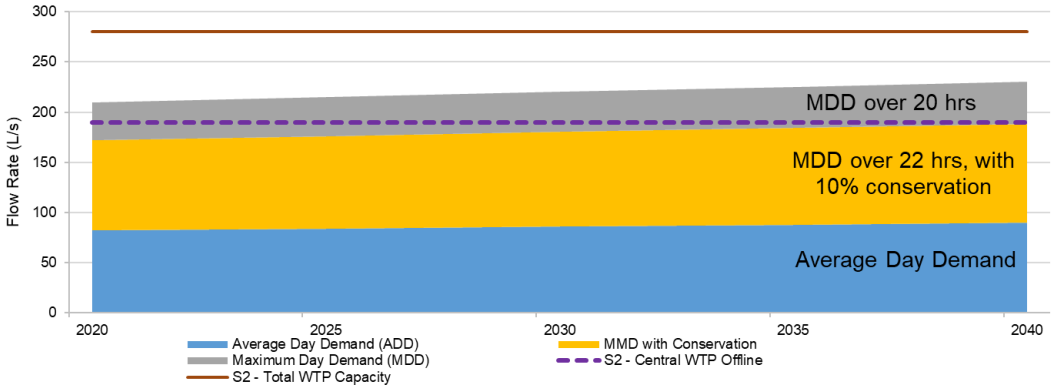
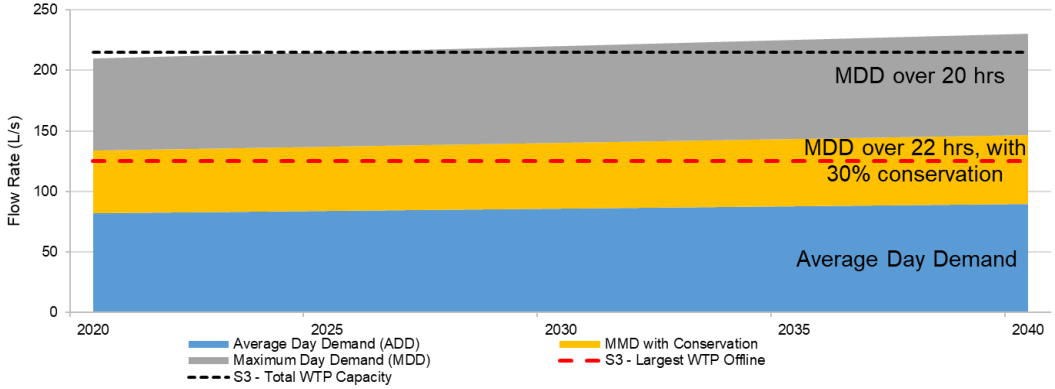


Figure 6.5: Minimum Scenario with 30% Conservation



7.0 WHAT CAN QUESNEL DO TO CONSERVE WATER?

7.1 Current Water Conservation Practices

Municipalities have many tools at their disposal to encourage water conservation within their boundaries. Although these tools will be discussed in detail in later sections of this report, it is important to identify what Quesnel is currently doing to conserve water.

It is becoming common practice for communities to restrict outdoor watering during hot summer months. Currently, Quesnel has sprinkling regulations which apply to water used for watering lawns and gardens. The regulations stipulate that even numbered street addresses can water on even calendar days and odd numbered addresses can water on odd calendar days. There are also time-of-day restrictions for this watering, depending on climate. Water restrictions have been in place for outdoor summer use in the City since 2003.

The 2011 Water Conservation Strategy identified that watering restrictions in Quesnel have been an effective water conservation method. Since that time, water use records indicate an approximate 15% reduction in MDD, which could indicate that watering restrictions are effectively reducing water use peaks in the warmer summer months. However, the impact of changing industry may have also played a role in this reduction.

Quesnel has utilized mail outs as well as newspaper and radio advertisements in its water conservation efforts to remind residents of the sprinkling regulations. This public education approach is utilized by many communities to provide information to consumers about the peak water demand periods, how much water is utilized within the home, and can provide tips on what consumers can do to reduce their water usage. It is a cost-effective method for communication with the public.

Other current water conservation practices include leak detection and bulk water sales. A bulk water distribution plant was built in 2010 to ensure the safety and integrity of the water system, for cost recovery, and for user convenience. It is also an effective way to encourage the responsible use of water.

The City has undertaken work to achieve full cost-of-service accounting which means that users understand the full costs that are associated with providing water. The outcome of this work is that water user rates through the Water Utility have been incrementally increased in order to achieve a sustainable level where existing water system infrastructure can be fully

supported. The City has determined that a sustainable water revenue will be achieved within the next 7 – 10 years.

7.2 Potential Water Conservation Measures

Reducing overall water demands in the City is increasingly important due to on-going summer demands, increased service base, and impending infrastructure upgrade requirements. Reductions can be realized through a number of measures, which range in cost, administrative burden, and effectiveness. Certain water conservation methods will have a more significant effect on average demand compared to peak demand. The following is a discussion of these measures and their relevance for the City of Quesnel.

1. *Water Metering:*
   Metering is a fundamental tool of both water system management and conservation. This approach is being implemented more frequently across the Province. Metering could consist of one or more of the following:
   - Source water metering,
   - Universal water metering (institutional/ commercial/ industrial, and residential service connection meters),
   - Public use metering.

   Currently the City of Quesnel meters its source water. Service connection meters are not in place at this time with the exception of two industrial customers, and one of those customers only has a City's water supply for fire protection.

   In other communities across the country, an average reduction of 30% has been realized with the implementation of universal water meters (i.e. service connection metering).

   Mayor and Council have indicated that in addition to the water conservation benefits from metering, the ability to improve funding equity amongst water users is an advantage that needs to be considered. Social and environmental benefits from metering need to be weighed in the evaluation process.

2. *Water Accounting and Loss Control:*
   A water accounting system helps track water throughout the distribution system and identifies areas that may need attention, particularly large volumes of unaccounted for water. Associated measures include:
   - Water system accounting,
   - Repairing known leaks,

- Analysis of non-account water,
- Distribution system audit,
- Leak detection and repair strategy,
- Automated sensors/telemetry,
- Loss-prevention program.

According to the National Research Council of Canada, the national average for lost water is 25%.

Because service connection metering is not currently practiced in Quesnel, detailed accounting is not possible at this time. The lack of meters also makes it difficult to determine unaccounted for water usage.

Leak detection is limited to methods other than water accounting and may be best implemented as part of an infrastructure rehabilitation program.

3. *Information and Education:*
   Information and education are critical to the success of any conservation program. Information and education measures can directly produce water savings by changing customer's water-use habits. These measures can include:
   - Events that promote awareness of water use,
   - Website with water conservation regulations and tips,
   - Understandable/informative water bills,
   - Informational products (e.g. brochures, utility bill inserts),
   - School/public education programs,
   - Industry workshops,
   - An advisory committee.

   Although the United States Environmental Protection Agency (USEPA) estimates a 2-5% water savings from information and education initiatives, some Interior BC communities (such as Kamloops and Prince George) have realized savings of 15-20% through public education initiatives.

   The City has already started to implement educational measures – this is discussed later in the report.

4. *Water Use Audits:*
   Water use or end use audits can provide water systems and their customers with invaluable information about how water is used and how usage might be reduced through specific conservation strategies. Feasible audits may include:

- Audits of large volume users, or
- Large landscape audits.

Audits will provide information on what the water is being used for and can assist with the determination of alternative technologies that can assist in water conservation efforts. This is particularly effective for industrial users as their water consumption can often times be a significant portion of a City's total water demand.

The anticipated savings can vary largely depending on the types of users on the system.

5. *Retrofits (No Longer as Effective Due to improved technology now commonly used by Water Customers):*
Retrofitting involves making an improvement to an existing fixture or appliance (versus replacement) in order to increase water use efficiency. Retrofits may include:

- Supply and distribution of retrofit kits, or
- Targeted programs.

Retrofit programs usually target plumbing fixtures. Unfortunately, users often remove the retrofit devices because their usage can deter from the original performance of the fixture (e.g. toilet dams causing toilets to flush inadequately).

The average garden hose pours out 20 litres per minute.

Retrofits are a short-term conservation measure with limited long term reduction in overall water use (<5%). Although this approach was once quite commonly used, retrofit kits are no longer an effective conservation measure due to improved technology now commonly on the market.

A water saving toilet (6 litres per flush) can save you up to 14 litres each time you use it! For the average family that's 25,000 litres per year, which would fill 25 hot tubs!

6. *Pressure Management:*
Reducing water pressure can decrease leakage, amount of flow through open faucets, and stresses on pipes and joints which may result in leaks. Lower water pressure may also decrease system deterioration, reducing the need for repairs and extending the life of existing facilities. Pressure management measures include:

- System wide pressure management, and
- Pressure reducing valves on individual water service connections.

The BC Building Code mandates pressure reducing valves in all new buildings.

Reducing pressure in residential areas can realize water use reductions of 5- 30%, depending on each situation.

7. *Landscape Efficiency:*
   Outdoor water usage drives maximum day demand, which in turn drives requirements for storage and source water pumping facilities. Reducing outdoor usage can thus be an effective conservation strategy. Outdoor water use can be reduced through efficiency-oriented landscaping principles, such as xeriscaping. There are a variety of methods for encouraging such landscaping, and it can be tied effectively to public awareness campaigns and materials. Landscape efficiency measures include:
   - Regulating landscape efficiency,
   - Selective irrigation sub-metering,
   - Landscape planning and renovation, and
   - Irrigation management.

   Water savings in excess of 10% can be obtained through widespread use of xeriscaping principles and large landscape management.

8. *Replacements and Promotions:*
   In order to accelerate the replacement of older fixtures, utilities can offer rebates and other incentives. The replacement of older, high water use toilets, clothes washers and dishwashers are a typical focus of rebate programs.
   Incentives offer a subsidy between the cost of buying a new high-water use appliance and considering a lower water use solution. They may also be used to stimulate replacement in advance of such appliances failing, or to promote new technologies.

   The City could also consider how to assess new development with a water conservation lens. This could include promotions for high efficiency appliances, densification, or smaller lots. Part of this strategy should consider tailoring City planning bylaws to meet these goals.

   Utilities can design incentive rebate programs that are targeted to the residential and nonresidential sectors, or to indoor and outdoor uses.

   It is important to consider that with the recent emphasis on sustainability across all industries, many new appliances are only being constructed with water/energy

conservation in mind. In such cases, incentives will not realize the desired intent and alternate measures may be more effective.

9. *Reuse and Recycling:*
   An alternative water source for some systems is "graywater," or treated wastewater for non-potable water uses. Recycled wastewater can be used for some industrial purposes, agricultural purposes, groundwater recharge, and direct reuse. The most likely applications for water reuse are:

   - Industrial applications,
   - Large volume irrigation applications, and
   - Selective residential applications.

   Significant care should be used to ensure that potable water sources are not cross connected to "gray water" systems. Water systems will need to check with local plumbing codes and ordinances for possible conditions and restrictions.

   This is an expensive retrofit for developed neighborhoods but could potentially be incorporated into future developments.

10. *Water Use Regulation:*
    Regulations should be in place to manage water use during droughts or other water supply emergencies and can be utilized to promote conservation during non-emergency situations. Water-use regulations include:

    - Restrictions on non-essential uses, such as lawn watering, car washing, filling swimming pools, washing sidewalks, and irrigating golf courses.
    - Restrictions on commercial car washes, nurseries, hotels, and restaurants.
    - Standards for water using fixtures and appliances, particularly for new development.
    - Bans or restrictions on certain types of water use or practice (i.e. once-through cooling, or non-recirculating car washes, laundries, and decorative fountains).

    Enforcement of any regulations is fundamental to the success of those regulations in promoting water conservation within the community. The cost of this enforcement should be considered.

8.0 WHAT CONSERVATION MEASURES ARE BEST FOR QUESNEL?

8.1 Business Case Approach to Selecting Conservation Measures

There are several options in terms of the approach the City could take to encourage water conservation. To find the option that will have the most impact, the following considerations need to be reviewed:

Cost to Implement - for a water conservation program to be successful it must be affordable to implement and result in cost savings that are consistent with the cost of implementation. It is important for the City to consider whether a program's cost will outweigh the potential economic benefits for residents, business owners and the City itself.

Complexity of Option - if a program is not simple to implement or becomes too administratively cumbersome, it might prevent residents and businesses from participating, or it might be costly in terms of staff time for the City, negating any costs savings the water conversation might represent.

Impact on Water Consumption- it is important that the program is effective at reducing water consumption. This must be able to be easily measured and monitored to ensure that an impact is being made.

Impact on other values and priorities - water conservation will have a positive environmental impact in terms of reducing the impact on groundwater resources and the wastewater treatment facilities. The water conservation program may impact other important priorities such as asset management. It is important to recognize the opportunities for water conservation to integrate with other priorities.

An analysis has been performed to determine the most effective methods of water conservation for the City from a business case perspective. The analysis includes quantitative and qualitative analysis of each of the conservation methods relevant to the City. Before introducing additional measures within the City, the benefit cost analysis associated with each measure should be considered.

8.2 Cost of Providing Water

It is important to understand the cost of implementing conservation measures in comparison to the value of the water that will be saved. The cost of providing water in Quesnel (producing and delivering) is summarized in the table below.

Table 8.1: Cost of Providing Water

	Total Cost ($/m³)	Variable Cost ($/m³)
Current Cost of Water	$ 0.85	$ 0.21
Cost of Water at Sustainable Revenue	$ 1.05	$ 0.21
Cost of Water with Treatment	Varies dependant on sizing/technology/grant funding	$ 0.26

The current cost of water is based on the current water utility revenue divided by the current annual water use. The cost of water at sustainable revenue is based on the increased water utility revenue that the City will achieve in the next 7 – 10 years. For the purpose of this analysis, the cost of water at sustainable revenue is used since it represents the true cost of water condition that the City is working towards.

While a water demand reduction will reduce the City's costs, there are some fixed expenditures such as administration that will stay the same. For this analysis, it is therefore assumed that approximately 30% of the current cost to supply water, which is $0.21/m^3, is tied to the quantity of water supplied to the system. This is the variable cost of water and is the portion that will reduce with demand.

The total cost for treated water will vary depending on system sizing and selected technology. Carrying forward the same assumption that a portion of the total cost of treatment is variable, the addition of water treatment results in relatively small variable cost increase ($0.05).

Variable costs do not include capital costs – they include recurring annual costs such as labour, chemicals, energy costs, and equipment replacement costs over a 20-year period. Note that full depreciation of the assets is not included in the variable costs.

8.3 Financial Analysis Method

The analysis includes a benefit cost ratio approach for assessing the value of conservation measures. This method employs the following process:

- Assume a linear growth of water demands from 2020 to 2040
- Estimate the water savings for each conservation approach and identify the volume of water saved each year
- Based on the variable cost of water discussed above, assign a cost savings each year and translate the amounts over 20 years into a present worth value.
- The analysis used the variable cost of water with treatment to represent probable conditions. Since treatment increases the variable costs, the benefit/cost

ratios are slightly more favorable compared to when treatment is not considered.

- Compare present worth of the water savings to present worth of the costs of implementing those savings
- Costs are based on the implementation of each conservation measure independently. Both start-up and ongoing annual expenditures are considered in the analysis. The estimated water savings is predicted for both ADD and MDD, in appreciation of the fact that some measures target different types of demands. Appendix A provides calculations related to developing the benefit cost analysis.
- Note that initiating multiple conservation measures will not result in total cumulative results (i.e. 3 water saving measures each estimated to reduce ADD by 25% will not combine to reduce demands by 75%) as there will be diminishing returns as more practices are undertaken. Therefore, the calculated benefit cost ratios are considered the best-case values and some conjecture regarding the effectiveness of multiple approaches is required.

A summary of the benefit cost results is provided in Table 7.2, followed by details about each water conservation measure in order of preference.

8.4 Conservation Measures with Favorable Benefit Cost Ratios

Conservation measures with a benefit cost greater than 1.0 are considered favorable, since the present worth of the water savings are higher that the present worth of implement those savings.

Table 8.2: Conservation Measures with Favorable Benefit Cost Ratios

CONSERVATION MEASURE	WATER SAVINGS ESTIMATED	COST BENEFIT
Cost-of-service Accounting	Already in place	
Sprinkling Regulation	Already in place	
Continue Public Education Program	2%	2.7
Incentive Rebate Program	3%	2.0
Audits of Large Volume Users	1%	1.3
Expand Leak Detection and Repair Program	6%	1.0
Retrofit Kits/Targeted Retrofits	3%	1.0

Note: Retrofits may have a benefit cost of 1, but it is noted these programs are reducing in their benefit because water saving fixtures are very commonly used.

8.4.1 Cost-of-Service Accounting

This measure has already been adopted by the City. A sustainable water utility revenue is forecast to be achieved in the next 7 – 10 years.

8.4.2 Sprinkling Regulations

Restriction of landscape irrigation is a regulatory measure that the City should continue to enforce. Restricting watering to morning and evening periods on a permanent basis is a simple and cost-effective method of municipal-wide water conservation. A commitment to enforcement is fundamental to the success of this measure. Beginning with a student bike patrol for education, and moving to more strict regulatory measures, is a low-cost method for transitioning such an approach into the community.

8.4.3 Continue Public Education Program

The continued development of an active public education campaign provides the most favorable benefit cost ratio. A benefit cost ratio of 2.7 was derived assuming a conservative water savings of 2%, which is reflective of the fact that the City has already implemented education programs and will not likely see the full benefit of education moving forward. Aspects of the continued campaign can include:

- Educational programs in elementary schools,
- Student bike patrol,
- Advertising and promotions, and
- Media coverage.

In order for water conservation awareness to be successful, it is important to keep the messages out in front of the public on an on-going basis with additional emphasis on reducing overall water consumption. It is recommended the City proceed with a strategy that will provide long term continuity and direction. To be successful, the strategy needs to engage the public in a meaningful way.

There are also a variety of initiatives that can be carried out in conjunction with a public education campaign and cross over into the other types of measures. Such initiatives, which have benefit cost ratios between 1 and 3, are summarized as:

a. Process Oriented:

- Industry workshops,
- Audits of large volume users.

b. Physical Upgrade:

- Incentive rebate programs, and
- Targeted retrofits.

It is recommended that process-oriented initiatives be adopted before the physical initiatives. Program costs are greater for incentives associated with the physical upgrades,

and both result in similar returns on investment. Although once quite a common physical upgrade, retrofit kits are not recommended due to technology now commonly on the market and the preferable approach to targeted retrofits.

Water use, and the related generation of wastewater are significant environmental factors within the realm of municipal operations. Therefore, facilitation of the information and education process should include guidance from the Environmental Advisory Committee.

8.4.4 Incentive Rebate Program

This measure has a positive benefit cost but is only feasible for replacement of older appliances. The low cost to implement makes this measure favorable.

8.4.5 Audits of Large Volume Users

It is expected that the City could reduce water use by completing audits at large volume users. An ongoing example of this type of work is the upcoming once-through-cooler inspections that are expected to be led by the City in 2020.

8.4.6 Expand Leak Detection and Repair Program

The City currently has a leak detection program. Water system leaks have been located and repaired. This measure has a benefit cost ratio of 1.0, indicating that increasing the leak detection program is expected to positive impacts on water conservation, and break-even with regards to water savings. The repair of water leaks is a system-wide improvement. Quesnel currently allocates an annual amount towards the repair of leaks, which is an ongoing operational expense for the City's water system. A coordinated leak detection and repair strategy will increase effectiveness over time, as more leaks are identified and repaired.

Without a full water metering program in place, providing an accurate estimate of potential water savings is difficult. The scope and related cost of the program can vary greatly. Visual identification and checking for leaking valves and reservoirs is a good starting point. Pressure tests can be completed on suspect mains and acoustic equipment can be employed.

8.4.7 Retrofit Kits/Targeted Retrofits

The City could see benefits from retrofit kit programs but need to be aware that modern technology has improved, and retrofits are no longer as effective as they were in years when household plumbing appliances were less efficient. The investment in this practice as a municipal initiative is therefore not suggested.

8.5 Conservation Measures with an Unfavorable Benefit Cost Ratios

The following conservation measures have unfavorable benefit cost ratios, meaning that present worth to implement and operate are higher than the present worth of the water savings.

Table 8.3: Conservation Measures with Unfavorable Benefit Cost Ratios

CONSERVATION MEASURE	WATER SAVINGS ESTIMATED	COST BENEFIT
Large Landscape Audits	0.1%	0.3
Reuse and Recycling	1%	0.0
Xeriscaping/Landscape Management	5%	0.0
System Wide Pressure Management	Impractical with existing system layout	
Pressure Reducing Valves on Some Properties	0.8%	0.4

8.5.1 Large Landscape Audits

Large landscape audits are not favorable because this type of setting by private property owners is not extensive in Quesnel, and therefore isn't a significant water user.

8.5.2 Reuse and Recycling

The capital costs for implementation of a centralized reuse and recycling system for City wastewater are estimated to be high (assume $30 million). Additionally, there are not any clearly identified uses for the reused water. For these reasons, this measure is unfavorable.

8.5.3 Xeriscaping/Landscape Management

Though the level of water conservation from this measure could reduce MDD by up to 20%, the capital cost for converting thousands of City lots to xeriscaped is high, so this measure is unfavorable.

8.5.4 System Wide Pressure Management

This measure is not feasible with the existing system layout.

8.5.5 Pressure Reducing Valves on Some Properties

Pressure reducing valves could result in some water savings, but the cost is not offset by the value of the savings, whether they are installed in small areas or in a more wide-spread way.

8.6 Conservation Measures that Require Widespread Metering

The following measures are not feasible without prior implementation of widespread water metering. For this reason, their benefit can't be assessed yet.

Table 8.4: Conservation Measures that Require Widespread Metering

CONSERVATION MEASURE	WATER SAVINGS ESTIMATED	COST BENEFIT
Water Accounting	Requires metering	
Distribution System Audit	Requires metering	
Loss-Prevention Program	Requires metering	
User Rates based on Water Use	Relevant only if users are metered	

8.7 Water Meters

The initial benefit cost ratio for water meters was 0.3 and 0.2 for industrial/commercial/industrial and residential respectively (without any capital deferral). It is unsurprising to see such low benefit cost ratios, since the capital cost for water metering is high (estimated at approximately $4.6 million for residential and ICI metering in the City). All assessments for water metering are based on the City contributing 100% of the capital cost for water meters, since there aren't any grant programs available at this time to support new metering and since the City has noted other pressing projects that would compete for grant priority.

The potential of deferring capital investment was also reviewed in the form of delaying investments or reducing the size of the treatment plant facilities due to water conservation. Water treatment capital costs have been prepared as part of the ongoing Conceptual Design project. As discussed earlier in this strategy, a significant level of water conservation (30%) could make the Minimum Scenario worth considering. Therefore, the potential capital deferral was calculated based on the cost differences between needing to implement the Comfortable Scenario and the Minimum Scenario. The capital deferral for this condition is comprised of two primary savings:

- The Minimum Scenario would allow for the construction of the West Region treatment plant to be deferred by 5 years. In the short term, a chlorination system would be installed at the existing PW7 site. This system could remain in the future as a back-up system. This deferral represents a savings of $1.4 million.
- The Minimum Scenario would allow for the Northern Region treatment plant to be sized with a capacity of 90 L/s, as compared to 130 L/s in the Comfortable Scenario. This represents a savings of $1 million. Note that for this analysis, it is assumed that the Northern Region treatment plant building would be sized for 130 L/s even with Minimum Scenario.

The total capital deferral is $2.4 million. Updated benefit cost ratios for metering are below.

Table 8.5: Benefit Cost Ratios for Water Metering with Deferred Capital

CONSERVATION MEASURE	WATER SAVINGS ESTIMATED	COST BENEFIT
Residential Water Metering	14%	0.5
Industrial/ Commercial/ Institutional Water Metering	3%	0.8

- *The water treatment plant capital cost savings are only realized if both categories of water meters are implemented*
- *Water meters will promote water conservation and equity in payment, but will require more investment*

The analysis indicates that even with the capital deferral as described above, the benefit cost ratio for meters is still not favorable, though becomes more economically viable when deferred capital is considered.

It is important to note that even with 30% water conservation, the Minimum Scenario may not be the preferred treatment scenario. That scenario would still not provide MDD with 22 hours of pumping, so additional water restrictions would need to be enforced if the largest of the treatment plant was not functioning, therefore the calculated benefit would likely not be achievable. So as best-case scenario, the benefit cost ratios are not above 1.

Even though the benefit cost ratio for installing meters is less than 1.0, it could be justifiable to invest in meters so that all services can be metered and benefits such as better water accounting and consistent rates can be adopted. This will result in improved equity among water users.

Due to the high implementation and operating costs, it is recommended that a more detailed review be conducted regarding the viability of the program prior to making a final judgment.

It is noted, however, that investing in zone meters, at pump stations and pressure reducing stations, is a recommended to better understand how water is being used across the City. Coordinating those meter installations should be coordinated with retrofits and replacements to help minimize capital costs.

8.8 Recommendations

There are a variety of cost-effective conservation measures which can be implemented in Quesnel. In order to maximize the effectiveness of Quesnel's Water Conservation Program, a comprehensive approach that incorporates several of the

water conservation measures is recommended. A phased implementation strategy, that can be included in the City's capital and operating budgets over the next several years, is also recommended. It should be noted, however, that this is a proposed approach and the City may wish to accelerate the program to achieve more expedient results.

The following water conservation measures are recommended to be prioritized:

- Cost-of-Service Accounting
- Enforce Sprinkling Regulation
- Continue Public Education Program
- Implement an Incentive Rebate Program
- Complete Audits of Large Volume Users
- Expand Leak Detection and Repair Program
- Complete Zone Metering

APPENDIX A

BENEFIT COST ANALYSIS (2020)

Summary of Water Conservation Benefit Cost Ratio Analysis

CONSERVATION MEASURE	START UP COSTS	YEARLY COSTS	# YEARS	PRESENT VALUE OF COST (Discount Rate = 5%)	% OF TOTAL WATER USAGE AFFECTED	WATER SAVINGS OF AFFECTED (ADD)	TOTAL WATER SAVINGS (ADD)	PRESENT VALUE OF ANNUAL SAVINGS (ADD)	WATER SAVINGS OF AFFECTED (MDD)	TOTAL WATER SAVINGS (MDD)	WTP CAPITAL SAVINGS (MDD)	BENEFIT COST RATIO	COMMENTS
Water Meters													
Source Water Metering	Already in place.												
Zone Metering	$50,000	$2,500	20	$81,156	75%	1%	1%	$62,360	1%	1%		**0.8**	Consider source meter locations. Consider number of existing, and location of new meters. For example, include when PRVs are retrofitted going forward?
Commercial/Industrial Water Metering	$589,600	$29,500	20	$957,235	30%	10%	3%	$249,441	15%	5%	$480,000	**0.8**	314 commercial, instutional & industrial businesses x $1400 (average) + design, implementation. Assume 5% Yearly cost, including 1% O&M, and 4% depreciation/replacement. WTP Capital Savings based on 2020 Conceptual Design work
Residential Water Metering	$4,010,000	$200,500	20	$6,508,673	70%	20%	14%	$1,164,058	30%	21%	$1,920,000	**0.5**	Residences as per Customer Count data x $1150 per 1" service, (2" is $1500/per, 3" is $2500 per, 4" is $4500 per) + design and implementation (average). Assume 5% Yearly cost, including 1% O&M, and 4% depreciation/replacement. WTP Capital Savings based on 2020 Conceptual Design work
Water Accounting and Loss Control													
Water Accounting												**n/a**	requires meters
Distribution System Audit												**n/a**	requires meters
Leak Detection and Repair Program		$40,000	20	$498,488	100%	6%	6%	$498,882	4%	4%	$0	**1.0**	Already underway Quesnel. To be expanded.
Loss-Prevention Program												**n/a**	requires meters
Costing and Pricing												**n/a**	Quesnel is approaching sustainable water revenue. Further equity possible with meters
Information and Education													
Public Education Program (Already occured savings reflect there is some additional savings potential but not as much as if program was starting from nothing)		$5,000	20	$62,311	100%	2%	2%	$166,294				**2.7**	Already underway in Quesnel - return on investment in now lower, but still positive.
Water Use Audits													
Audits of Large Volume Users	$65,000			$65,000	20%	5%	1%	$83,147				**1.3**	
Large Landscape Audits	$25,000			$25,000	10%		0.1%	$8,315				**0.3**	
Retrofits													
Provide/Distribute Retrofit Kits	$15,000	$37,000	5	$175,191	100%	3%	3%	$249,441				**1**	4600 residential kits x $40 (considered short-term measure); plus engagement/implementation
Pressure Management													
System Wide Pressure Management	Perhaps impractical with existing system layout												
Pressure Reducing Valves	$62,140	$6,214	20	$139,580	5%	15%	0.8%	$62,360				**0.4**	5% of 3107 dwellings @ $400/service
Landscape Efficiency													
City-funded Xeriscaping /Landscape Management		$900,000	20	$11,215,989	100%	5%	5%	$415,735	20%			**0.037**	3107 residential properties x $6000 per home over 20 years
Replacements and Promotions													
Incentive Rebate Program	$10,000	$23,000	5	$109,578	25%	10%	3%	$207,867				**2**	$150 to 5% of homes for 5 years
Reuse and Recycling	$30,000,000	$1,000,000	20	$42,462,210	100%	1%	1%	$83,147				**0.002**	Assume no grant funding. $30M allowance without engineering study.
Water Use Regulation													
Sprinkling Regulation	Currently in place. Alternate odd and even addresses												
Ban on Once Through Cooling Units	$20,000		5	$20,000	1%	20%	0.2%	$16,629				**0.8**	Not known how many are in service. Need to budget for inspections