Water Management and Conservation Plan

June 2011

Prepared for

City of Bend, Oregon

Prepared by

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Contents

Exhibits

Appendices

Executive Summary

The City of Bend (City) completed its first Water Management and Conservation Plan (WMCP or the "Plan") in August 1998. The purpose of the Plan is to guide the development, financing, and implementation of water management and conservation programs and policies to ensure sustainable use of publicly owned water resources while the City plans for its future water needs. Development of this Plan was required by the City's Permits G-11379 and G-11380. The Oregon Water Resources Department (OWRD) issued a final order approving the City's Plan in May 1999, and required an update in 2004. The City submitted an updated WMCP on December 30, 2004. On February 28, 2005, OWRD issued a final order approving the updated Plan and requiring the next update by January 10, 2010.

This WMCP also was developed to meet the requirements of the City's Permits G-16177 and G-16178, which are conditioned to require an updated WMCP by January 1, 2010. Finally, the City's WMCP is submitted to meet the requirements of the final order approving an extension of time for the City's Permit G-8565. The November 15, 2007 final order required the City to submit a WMCP within 3 years from the date of the order. On September 29, 2009, OWRD extended the above-described deadlines for submitting the City's WMCP to January 3, 2011.

This WMCP fulfills the requirements of the Oregon Administrative Rules (OAR) adopted by the Water Resources Commission in November 2002 (OAR Chapter 690, Division 86). This Plan describes water management, water conservation, and curtailment programs to guide the wise use and stewardship of the City's water supply. The City also is submitting this Plan to gain access to water under its "extended permit" G-8565.

The Plan is organized into the following sections, each addressing specific sections of OAR Chapter 690, Division 86. Section 2 is a self-evaluation of the City's water supply, water use, water rights, and water system. The information developed for Section 2 is the foundation for the sections that follow. The later sections use this information to consider how the City can improve its water conservation and water supply planning efforts.

EXHIBIT ES-1
WMCP Organization

Section	***Requirement***
Section 1 – Water Supplier Plan	*OAR 690-086-0125*
Section 2 – Water Supplier Description	*OAR 690-086-0140*
Section 3 – Water Conservation Element	*OAR 690-086-0150*
Section 4 – Water Curtailment Element	*OAR 690-086-0160*
Section 5 – Water Supply Element	*OAR 690-086-0170*

Description of Municipal Water Supplier

The City's service area includes the City's current urban growth boundary (UGB), which includes most of the City of Bend, as well as the Tetherow Development and Juniper Ridge Development Phases 1 and 2. Two private water utilities, Avion Water Company and Roats Water System, Inc., serve the portions of the area within the UGB not served by the City's water system. The City's water system had approximately 22,000 meters serving residential and non-residential customers in 2009 and an estimated service area population of approximately 62,800.

The City's primary water sources are groundwater from the Deschutes Aquifer and surface water from Bridge Creek and Tumalo Creek. The City currently appropriates groundwater from the Deschutes Aquifer using 21 production wells associated with water rights. Groundwater levels in the City's wells are stable.

The City's surface water intake is located 11.5 miles west of the city limits on Bridge Creek in the Bridge Creek watershed. The surface water supply system was developed in the 1920s as an unfiltered, gravity-operated system. It provides approximately half of the City's annual water supply. Water diverted at the Bridge Creek intake facility consists of flows from the Bridge Creek watershed and flows from natural springs within the Tumalo Creek watershed that are conveyed into Bridge Creek. The City's Bridge Creek intake facility consists of a diversion structure that spans Bridge Creek and diverts water into two transmission mains. The diverted water is conveyed to the City's Outback site, which then sends the water to the onsite disinfection facility and into the City's water service area and distribution system. The City is now entering the design phase of a project to build a new treatment facility for the water it diverts from Bridge Creek and to replace the existing supply pipes.

The City holds 12 groundwater rights that authorize the use of groundwater at a rate of up to 68.2 cubic feet per second (cfs); 44.1 million gallons per day [mgd]) for municipal purposes: 7 certificates and 5 permits. In addition, the City holds six surface water rights that authorize a total use of up to 36.1 cfs (23.3 mgd) from Bridge Creek and Tumalo Creek for municipal purposes. The City's existing water right capacity is sufficient to meet its current peak water demands. The City's current water supply, however, is limited by stream flow, surface water right regulation, volume limitations on water rights, system capacity, and mitigation requirements in the Deschutes Groundwater Study Area.

Water Conservation

OWRD's WMCP rules require cities to have 5-year benchmarks for initiating or expanding conservation measures related to the following required conservation programs. A summary of the 5-year benchmarks is provided below, and in Exhibit ES-4 at the end of this Executive Summary.

Annual water audits. A water audit involves an accounting of all water entering and leaving the water distribution system to identify system leakage, as well as authorized or unauthorized water uses. For example, the City does not have a system to track unbilled consumption and its billing by customer class is unreliable. To resolve these issues, the City has established the following benchmarks.

5-year Benchmarks:

- The City will develop and implement an annual water audit program within the next 5 years. As part of this effort, the City will develop a method to calculate and track unbilled authorized consumption, which may include development of additional measurement methodology, to more accurately determine revenue and non-revenue water.
- The City also will reorganize and update customer classes and service codes, as well as work toward equipping all water meters with automated metering infrastructure (AMI).

System metering. The City's water system became fully metered in December 2004. In addition, all hydrant use within the Bend service area now requires metering, resulting in better tracking of non-fire-related hydrant water use.

***5-year Benchmark*:**

- The City will continue to install meters at all new service connections.

Meter testing and maintenance. The City is testing and rebuilding all meters that exceed 2 inches. Each of these meters is checked and calibrated every 2 years or checked through computer analysis of customer usage each month. The City tests meters if requested by customers, and if the tested meter is found to be 3 percent above or below the proper reading, the meter is repaired or replaced.

Most residential meters are relatively new because of recent efforts to meter all residences. The City also is working to update its meters and expects to install 12,500 AMI by December 2010. Residential meters typically are replaced on a 15- to 20-year basis in accordance with American Water Works Association (AWWA) guidelines. The City is eliminating the 5/8 x ¾ inch meter so that base meters for residential units will be ¾ inch.

In 2008, the City installed a new master meter at the end of the Bridge Creek transmission line to measure the amount of surface water that it conveys into the distribution system.

5-year Benchmarks:

- The City will continue to replace all existing meters with the new AMI standard within the next 5 years.
- The City will use improved technology when upgrading or replacing existing source meters during the next 5 years.

Unit-based billing program. The City's customers are billed on the basis of the quantity of water use metered and a base fee. Customers pay a base fee based on meter size, which includes a quantity allowance of up to 4 ccf (ccf = 100 cubic feet). Customers also pay a per ccf unit rate for their monthly water use exceeding 4 ccf.

5-year Benchmarks:

- The City will continue to bill customers based, in part, on the quantity of water metered.

- The City intends to reduce the base quantity allowance from 4 ccf to zero ccf within the next 5 years.

Leak detection and repair. Most of the distribution system water mains are relatively new ductile iron pipe with low potential for excessive leakage, which were put in place during the City's recent period of rapid growth. Since 2004, City staff and contractors have conducted leak detection surveys of 45 to 50 miles of water mains. During 2005-2006, contractors conducting leak detection surveys found no sizable leaks, but did discover and repair two meters with small leaks. City staff have conducted leak detection using in-house electronic equipment and tested for leaks during valve and hydrant maintenance activities. In February 2009, the City tested the Bridge Creek transmission line for leakage. The City also works cooperatively with customers when leaks are discovered on the customer side of the meter, typically in the older galvanized service lines.

5-year Benchmarks:

- The City will continue to carry out leak detection surveys to monitor changes in pipe integrity over time.
- The City will continue to monitor customer consumption records for evidence of leaks and to work cooperatively with customers when leaks are discovered.
- The City will install AMI data technology at all of its meters, which will record hourly consumption and radio transmit that information to the City. This "real-time" information will help the City find and address leaks in the system on the customer side of the meter.

Public education. The City provides water conservation information through numerous media and programs. The City's WaterWise Web site (www.waterwisetips.org) focuses on water conservation and includes information on indoor water use, xeriscaping, rain gardens, and landscape watering. The City sponsored or participated in at least four public events per year during the last 5 years including school events, various summer fairs, and outdoor events throughout the spring, summer, and fall. The City also continues to provide conservation information to the public using fact sheets, publications, bill stuffers, City Edition Videos, and related outreach in partnership with the City Communications Manager. Finally, the City re-establish a position in its 2010 fiscal year budget to manage the City's water conservation benchmarks and to help develop, implement, and track related projects.

5-year Benchmarks:

- The City will continue to provide water efficiency and conservation outreach information to the public using print materials, radio, and video.
- The City will continue to update its Web site and outreach materials as needed.
- The City will explore the potential for development of cost-share partnerships between the City's three water utilities: water; stormwater, and wastewater. The water and stormwater utilities have the potential to jointly hire an employee that can serve both programs.

Technical and financial assistance. The City's technical and financial assistance program has had three components: large landscape program partnerships, large customer water audits, and indoor water use, which includes toilet tank leak detection and shower timers. The City has developed partnerships with customers that have large landscapes requiring irrigation to help them improve their water conservation efforts. The City helps these partners by providing technical and financial assistance in a variety of formats.

Water audits for large customers analyze a customer's water use and identify ways to make water use more efficient. However, the City and water conservation studies[1] have found that audits generally are not cost-effective because customers are reluctant to pay for the audits or recommended improvements. As a result, the expense did not materialize into actual water savings.

The indoor water use component of the City's technical and financial assistance program has two components: toilet tank leak detection dye tablets and shower timers. To decrease leaks that occur on customer premises, the City distributed more than 2,500 toilet tank leak detection dye tablets per year during the past few years. Shower timers are intended to reduce both water and energy use by making shower users aware of their time in the shower. The City distributed more than 1,500 shower timers at schools and public events, and in the display booth set up in City Hall. They are also available by phone and e-mail request.

5-year Benchmarks:

- The City will continue efforts to develop and maintain WaterWise partnerships with large use customers during the next 5 years.
- The City will continue to distribute toilet tank leak detection dye tablets, shower timers, and related information to customers during the next 5 years.
- The City will conduct cost analyses aimed at the creation of cost-effective rebate programs within the next 5 years.
- The City will develop a pilot program for creation of water budgets for targeted customer groups, based on evapotranspiration data.
- The City will continue to fund and promote the use by all customers of the Agrimet weather station and its Web site, including a pilot project to place real time evapotranspiration data on the City Web site for use in creation of outdoor water use budgets.

Retrofit/replacement of inefficient fixtures. The City manages and maintains 136 landscape sites covering 439 acres, many of which require irrigation. Maintenance and management plans have been completed for all of these landscape sites. The City has retrofitted 66 of these sites with smart irrigation controllers. The City recently retrofitted 14 of those 66 sites as part of the City Landscape Retrofit Project. The sites of the 14 retrofits had their irrigation systems and/or landscapes altered or completely rebuilt to decrease maintenance and meet irrigation water savings goals, which often included reducing the area irrigated and xeriscaping.

[1] HDR Technical Memorandum, *Conservation Program for Water Management and Conservation Plan,* December 8, 2010.

5-year Benchmarks:

- The City will continue to pursue greater irrigation efficiency of its existing City-owned landscapes and all new landscapes so they will meet the latest specification and standards, which includes the use of smart irrigation controller technology, xeriscaping principles and other sustainable landscape practices.
- The City will study the cost effectiveness of implementing a toilet rebate replacement or incentive program based on the new voluntary federal high efficiency toilet (HET) standard.
- The City will become a partner in the U.S. Environmental Protection Agency (EPA) Water Sense Program and make related information available through its Web links, bill stuffers, and other methods.
- The City will provide a list of qualifying toilets that meet the various flush standards along with the creation of a toilet efficiency fact sheet.

Reuse, recycling, and non-potable water opportunities. The Resort at Pronghorn, located downhill of the City's wastewater treatment plant, obtains recycled water from the City. Class A (Level IV) to Class C (Level II) effluent from the wastewater treatment plant enters infiltration ponds and an irrigation system that waters two golf courses during the irrigation season. The resort is not within the City's existing drinking water service area.

In July 2010, the City completed a scope of work for a full-scale feasibility study that will investigate increasing the use of recycled water both inside and outside the City's service area.

5-year Benchmark: During the next 5 years, the City will continue to look for opportunities to increase the use of recycled water.

Other measures.

- ***Irrigation Restrictions:*** The City currently has even-odd irrigation restrictions and time of day water restrictions in place. Even house numbers irrigate on even-numbered days and odd house numbers irrigate on odd-numbered days. Irrigation hours are 5 a.m. to 10 a.m. and 4 p.m. to 10 p.m. These policies were put in place many years ago when the City used a flat rate water billing system and were designed to keep reservoirs from being drained by unlimited water use. Code changes are now under consideration in the next fiscal year and may include a recommendation to move away from the even-odd day irrigation restriction system. The City would like to move exclusively to a time of day restriction that aims to provide an enforceable program that incentivizes smart water use, as well as off-peak irrigation time periods, to prevent or reduce the need for costly engineering improvements necessary to meet maximum demands in the morning and evening peaking periods.

  5-year Benchmark: Within the next 5 years, the City will evaluate adoption of modified irrigation restrictions based on time of day (hours that promote efficient water use).

- ***City Standards and Specifications:*** The City recognizes that conservation and water efficiency standards need to be included in City contracts with landscaping and irrigation

work, so the City currently is upgrading its related standards and specifications. The City also created a landscape standard.

5-year Benchmark: The City will continue to implement current landscape standards through related approval processes during the next 5 years.

- ***Collaboration among the City's water utility programs:*** The City has three water-related utilities and several areas of regulatory responsibilities, including water utility, water reclamation, and stormwater programs, that are related to more efficient use of water and the benefits of conservation. The City has implemented a communication effort encompassing all of these areas, which it has promoted as "WaterWise" programs. Collaborations include exploring how to combine funds from different programs to hire staff and present information on stormwater, safe drinking water, water conservation, and industrial pretreatment programs within the homepage of the City's WaterWise Web site and related efforts.

  5-year Benchmark: The City will continue to look for coordination opportunities to more efficiently communicate and implement related programs.

- ***Hydrant Meter Program for temporary and permanent water uses:*** Use of hydrants now requires a permit and use of a temporary metered fill station that also includes backflow protection. All water is measured and billed. In addition, the City has installed one permanent fill station that has the added feature of a card-lock billing system to address the use of multiple users at one location. Contractors have the option of bringing their own water trucks to the fill stations to fill up with water as needed, or using the portable hydrant meter boxes.

  5-year Benchmark: The City will continue to implement the hydrant meter program and related fill station.

- ***Review and implementation of the Water Conservation Analysis Project:*** In 2010, HDR Engineering (HDR) conducted a water conservation analysis project for the City to examine opportunities to enhance its existing water conservation program. HDR compiled demographic information for the City's service area, applied assumptions for customer participation rates for each conservation measure, calculated the savings achieved by shifting to more efficient hardware or behavior, and calculated the direct costs for those shifts. HDR developed four "conservation packages." These packages included (1) a conservation potential assessment of 37 of the 49 analyzed measures that were not mutually exclusive, which included both behavioral and "hardware" based measures; (2) hardware measures for both indoor and outdoor water conservation; (3) hardware measures for outdoor water conservation only; and (4) hardware measures for indoor conservation only.

  5-year Benchmark: During the next 5 years, the City will work with its Engineering Department and the City Council to develop capital improvement and conservation budgets to identify which conservation measures to fund and implement.

Water Curtailment

In the event of a water shortage, the City needs a detailed response plan based on predetermined objective criteria. The curtailment plan describes how the City will respond to specific water-shortage conditions. The City's curtailment plan presented in this WMCP has four distinct stages, each of which is triggered by one or more identified events. The four stages, increasing in order of severity, are summarized in **Exhibit ES-2**. Any of the initiating conditions described in Exhibit ES-2 will trigger the appropriate curtailment stage. Initiating conditions and response actions are described in detail in Section 4 of this WMCP.

EXHIBIT ES-2
Curtailment Stages 1 through 4

Curtailment Stages	Initiating Conditions
Stage 1: Water Shortage Alert	• Forecasts of below normal summer streamflows • Forecasts of above normal temperatures • Minor damage to transmission mains or distribution system • Minor mechanical or electrical malfunction at one to three wells
Stage 2: Mild Water Shortage **Demand Reduction Target:** **10 percent of MDD**	• Supply capacity is 91 to 100 percent of demand • Mechanical or electrical malfunction at four to seven wells • Extended periods of above normal temperatures or below normal streamflows • Declaration of drought by Governor pursuant to ORS 536.720 • Extensive damage to water supply infrastructure
Stage 3: Serious Water Shortage **Demand Reduction Target:** **20 percent of MDD**	• Supply capacity is 81 to 90 percent of demand • Mechanical or electrical malfunction at 8 to 12 wells • Imminent terrorist threat against supply system • Multiple failures to transmission mains or distribution system
Stage 4: Severe Water Shortage **Demand Reduction Target:** **40 percent of MDD**	• Supply capacity is less than 81 percent of demand • Loss of utility electrical service to wells • Fire in Bridge Creek watershed or near wells • Contamination of source of supply • Extensive damage to transmission, pumping, or treatment processes caused by natural disaster • Intentional acts or fire, contamination of source, or any other event resulting in an immediate, sustained deprivation of water supply

MDD = maximum day demand.
ORS = Oregon Revised Statute.

Water Supply

Consistent with the Optimatics Master Plan Update projections, the City used its Buildable Lands Inventory (BLI) database and water use data to develop demand projections. For the 2020 demand projection, the estimated number of dwelling units at medium density was multiplied by the estimated per capita usage. Then the demand for the non-residential areas along with Tetherow and Phase 1 of Juniper Ridge Developments were included to provide the projected 2010 average day demand (ADD) of 21.7 mgd. This equates to a yearly increase in average day demand of 0.74 mgd between 2010 and 2020. The projected 2030 ADD was developed by increasing demand by 0.74 mgd per year, which results in a 29.1 mgd ADD. Maximum day demands (MDD) were developed by applying a 2.25 MDD to ADD factor. The future demands are summarized in **Exhibit ES-3.**

EXHIBIT ES-3
Future Demands for the City's Water Service Area (mgd)

Year	ADD	MDD
2010	14.3	32.2[1]
2020	21.7	48.8
2030	29.1	65.5

[1] The City's actual 2010 MDD was approximately 20 percent less than the projected MDD for that year. The reduced demand compared to the projections is likely due to the cool, wet weather during the spring and summer of 2010, the City's recent efforts to optimize system operations, as well as less demand because of the current economic downturn.

The City holds surface water rights that authorize the use of up to 36.1 cfs (23.3 mgd). For the purposes of planning for the amount of surface water available to meet peak needs, the City evaluated historic stream flows in Tumalo Creek to establish a likely low-flow scenario. Under that evaluation it was determined that a stream flow of 42.5 cfs and a proportional share for the City of 11.5 cfs (7.4 mgd) should be the "firm" planning-level peak demand surface water supply. The City also holds groundwater rights authorizing use of 68.2 cfs (44.1 mgd).
The City may need up to approximately 65.5 mgd to meet its MDD by 2030. The water supply provided by the City's existing water rights, however, currently can be relied upon only to provide approximately 51.8 mgd of supply during periods of high demand. Consequently, the City will need to fully exercise its existing water rights and may need additional water supply to meet its projected 2030 MDD.

Based on projected water demand growth, the City anticipates fully exercising all of its existing surface water and groundwater rights during the next 20-year planning period.

Exhibit ES-4 provides a summary of the City's water management and conservation measure 5-year benchmarks.

EXHIBIT ES-4
Summary of Water Management and Conservation Measure 5-year Benchmarks

Annual Water Audit • Develop and implement an annual water audit program. As part of this effort, develop a method to calculate and track unbilled authorized consumption, to more accurately determine revenue and non-revenue water. • Reorganize and update customer classes and service codes, as well as work toward equipping all water meters with automated metering infrastructure (AMI).
System-Wide Metering • Continue to install meters at all new service connections.
Meter Testing and Maintenance • Continue to replace all existing meters with the new AMI standard. • Use improved technology when upgrading or replacing existing source meters.
Rate Structure and Billing Program • Continue to bill customers based, in part, on the quantity of water metered. • Continue to reduce the base quantity allowance from 4 ccf to zero ccf. • Continue to send monthly bills and to provide water efficiency and conservation information to the public with periodic bill stuffers and electronic messaging with related conservation information and links to the City's conservation Web site.
Leak Detection and Repair • Continue to conduct leak detection surveys to monitor changes in pipe integrity over time. • Continue to monitor customer consumption records for evidence of leaks and to work cooperatively with customers when leaks are discovered. • Install AMI data technology at all of its meters, which will record hourly consumption and radio transmit that information to the City. This "real-time" information will help the City find and address leaks in the system on the customer side.
Public Education • Continue to provide water efficiency and conservation outreach information to the public using print materials, radio, and video. • Continue to update the City Web site and outreach materials as needed. • Explore the potential for development of cost-share partnerships between the City's three water utilities: water, stormwater, and wastewater. The water and stormwater utilities have the potential to jointly hire an employee that can serve both programs.
Technical and Financial Assistance • Continue efforts to develop and maintain WaterWise partnerships with large use customers. • Continue to distribute toilet tank leak detection dye tablets, shower timers, and related information to customers. • Conduct cost analysis aimed at the creation of cost-effective rebated programs. • Develop a pilot program for creation of water budgets for targeted customer groups, based on evapotranspiration data. • Continue to fund and promote the use by all customers of the Agrimet weather station and its Web site, including a pilot project to place real time evapotranspiration data on the City Web site for use in creation of outdoor water use budgets.

Retrofit/Replacement of Inefficient Fixtures

- Continue to pursue greater irrigation efficiency of its existing City-owned landscapes and all new landscapes so they will meet the latest specification and standards, which include the use of smart irrigation controller technology, xeriscaping principles, and other sustainable landscape practices.
- Study the cost effectiveness of implementing a toilet rebate replacement or incentive program based on the new voluntary federal High Efficiency Toilet (HET) standard.
- Become an EPA Water Sense Program partner and make related information available through its Web links, bill stuffers and other methods.
- Provide a list of qualifying toilets that meet the various flush standards along with the creation of a toilet efficiency fact sheet.

Reuse, Recycling, and Non-Potable Water Opportunities

- Continue to look for opportunities to increase the use of recycled water.

Other Measures

- **Irrigation Restrictions** - Evaluate adoption of modified irrigation restrictions based on time of day (hours that promote efficient water use).
- **City Standards and Specifications** - Continue to implement current landscape standards through related approval processes.
- **WaterWise Partnerships** - Continue to seek appropriate partnership opportunities based on current project priorities, budget, and staff time.
- **Collaboration Among City's Water Utilities** - Continue to look for coordination opportunities to more efficiently communicate and implement related programs.
- **Hydrant Meter Program for Temporary and Permanent Water Uses** - Continue to implement the hydrant meter program and related fill station.
- **Review and Implementation of Water Conservation Analysis Project** - Work with the City Council and the City's Engineering Department to develop capital improvement and conservation budgets to identify which conservation measures to fund and implement.

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1. Municipal Water Supplier Plan Elements

This section satisfies the requirements of OAR 690-086-0125.

This rule requires a list of affected local governments to whom the Plan was made available, and a proposed date for submittal of an updated Plan.

Introduction

The City of Bend (City) is located in Central Oregon at the eastern foothills of the Cascade Range. The City is noted for its scenic setting, year-round recreational activities, and growing economy. City residents benefit from a reliable supply of high-quality water for public health and sanitation, fire protection, recreation, and economic development. In recent years, the City has experienced significant growth, which has increased its demands for water. Effective water management and dedicated implementation of conservation measures can reduce water consumption, delay the need to develop additional water supplies, and reduce the volume of new water needed for municipal purposes.

The City completed its first Water Management and Conservation Plan (WMCP or the "Plan") in August 1998. Development of this Plan was required by the City's Permits G-11379 and G-11380. The Oregon Water Resources Department (OWRD) issued a final order approving the City's Plan in May 1999, and required an update in 2004. The City submitted an updated WMCP on December 30, 2004. On February 28, 2005, OWRD issued a final order approving the updated Plan and requiring the next update by January 10, 2010.

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Plan Organization

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Affected Local Governments

OAR 690-086-0125(5)

The following governmental agencies may be affected by this WMCP:

- Deschutes County

Thirty days before submitting this WMCP to OWRD, the City made the draft Plan available for review by the affected local government listed above along with a request for comments related to consistency with the local government's comprehensive land use plan. The letter requesting comment and any comments received are in **Appendix A.**

Plan Update Schedule

OAR 690-086-0125(6)

The City anticipates submitting an update of this Plan within 10 years of the final order approving this Plan. As required by OAR Chapter 690, Division 86, a progress report will be submitted within 5 years of the final order.

Time Extension

OAR 690-086-0125(7)

The City is not requesting an extension of time to implement metering or a benchmark established in a previously approved Plan.

2. Municipal Water Supplier Description

This section satisfies the requirements of OAR 690-086-0140.

This rule requires descriptions of the City's water sources, service area and population, water rights, and adequacy and reliability of the existing water supply. The rule also requires descriptions of the City's customers and their water use, the water system, interconnections with other water suppliers, and quantification of system leakage.

Water Sources

OAR 690-086-0140(1)

The City's primary water sources are groundwater from the Deschutes Aquifer and surface water from Bridge Creek and Tumalo Creek. The City also obtains water from the Arnold Irrigation District (AID) for irrigation use within the former Juniper Utility service area.

Surface Water

The City's surface water intake is located 11.5 miles west of the city limits on Bridge Creek in the Bridge Creek watershed. This watershed lies within the Deschutes National Forest, which is owned by the U.S. Forest Service (USFS). The City has a 1926 agreement with the U.S. Department of Agriculture that designates municipal use as the highest and best use of the watershed. In addition, the City has a memorandum of understanding with the USFS that provides clear communication channels between signatories, controls human activity, and protects water quality through regulations and restrictions.

The City's surface water supply system was developed in the 1920s as an unfiltered, gravity-operated system. It provides approximately half of the City's annual water supply. Water diverted at the Bridge Creek intake facility consists of flows from the Bridge Creek watershed and flows from natural springs within the Tumalo Creek watershed that are conveyed into Bridge Creek. The City's Bridge Creek intake facility consists of a diversion structure that spans Bridge Creek and diverts water into two transmission mains, one of which was built in the 1920s and the other was built in the 1950s. The current combined capacity of these two mains is 18.2 cubic feet per second (cfs). The diverted water then is conveyed to the City's Outback site, which sends the water to the onsite disinfection facility and into the City's water service area and distribution system.

As a result of new U.S. Environmental Protection Agency (EPA) regulatory requirements, the City must begin to treat its surface water by October 2012. Consequently, the City must build a new surface water treatment facility. In addition, the pipes that supply the City's surface water are deteriorating and must be replaced. The City has completed a water supply alternatives analysis and now is entering the design phase of this project.

Groundwater

The City currently appropriates groundwater from the Deschutes Aquifer using 21 production wells associated with water rights. The City's records show that groundwater levels in the City's wells are stable.

Other Supply

The AID provides a portion of the water used for irrigation within the former Juniper Utility service area. Water from AID is delivered to ponds and mixed with groundwater supplied by the City. The City delivers the water to the irrigation customers. This irrigation water is non-potable and is transported in pipes separate from the drinking water supply system.

Avion Water Company (Avion) provides water to the Bend Municipal Airport, which is owned by the City, but is 8 miles outside of the current urban growth boundary (UGB). Avion provides water for this small water supply system, which provides water for domestic, commercial, fire protection, limited irrigation, and other typical municipal water uses within the Airport planning area. This system is not connected to the rest of the City's water supply system.

Interconnections with Other Systems

OAR 690-086-0140(7)

The City's drinking water system has one interconnection with the Roats Water System (Roats), which is located at the southern boundary of the City's system. Although this connection originally allowed Roats to serve domestic water in the former Juniper Utility service area, the City no longer purchases water from Roats. The interconnection is now considered for emergencies only.

The City also has one interconnection with Avion, which is located at the intersection of 27th Street and Bear Creek Road. The purpose of this interconnection is for emergencies only. It allows either utility to provide water to the other. Construction of the interconnection occurred in 2003. The City has yet to convey water through this interconnection except for flow testing purposes and will not rely on Avion to supply water to the City's customers on a day-to-day basis.

Water Supply Contracts

OAR 690-086-0140(1)

The City has a wholesale water supply contract with Avion. Under this contract, Avion provides wholesale water service only to the Bend Municipal Airport. The airport has a small isolated water system, which the City operates with water supplied by Avion.

The City does not have exchange agreements or intergovernmental cooperative agreements.

Current Service Area Description

OAR 690-086-0140(2)

The City's current service area appears in **Exhibit 2-1**. For purposes of making demand projections for this WMCP, the area shown is also the projected future service area. The City's service area includes the City's current UGB, which includes most of the City, as well as the Tetherow Development and the Juniper Ridge Development, Phases 1 and 2. Two private water utilities, Avion and Roats, serve the portions of the area within the UGB not served by the City's water system. According to 2009 billing data, the City's water system had approximately 22,000 meters serving residential and non-residential customers.

Although Certificate 85414 includes a place of use at the Bend Municipal Airport, and Airport Well #2 as an authorized point of appropriation, as described above, Avion provides water to the airport. Further, the water supply system at the airport does not connect with the City's municipal supply system because it is approximately 8 miles outside of the City's current UGB and the water service area. As a result, the water demands at the airport are not considered as part of this WMCP.

The City's 2009 service area population was estimated to be approximately 62,791. This population figure was developed using the following methodology. The estimated population for the City was obtained from Portland State University (PSU). Next, the populations for the Avion and Roats service areas within the City were determined as follows. The number of residential units was determined using county tax rolls plus approved 2008 building permits. The estimated number of residential units within these areas was multiplied by the occupancy rate of 94 percent and the average household size of 2.4 persons, which is based on 2000 census information. The City's service area population figure was reduced by these estimated populations residing in the Avion or Roats service areas within the City. For 2009, the PSU population estimate for the City is 82,280. The population within the City that is served by Avion or Roats was estimated to be 19,489. As a result, the estimated 2009 service area population for the City is 62,791 (82,280 – 19,489 = 62,791).

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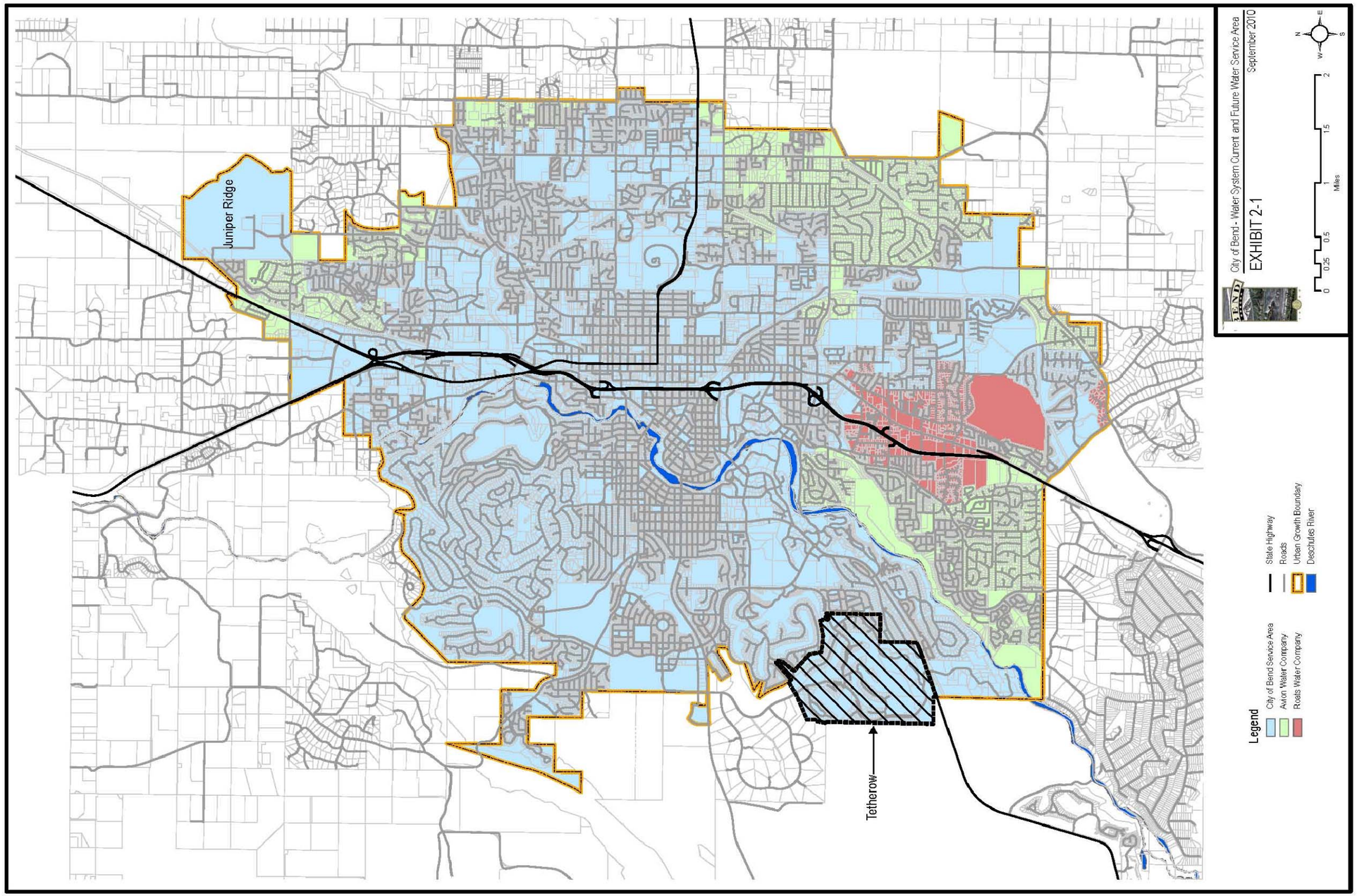
City of Bend - Water System Current and Future Water Service Area
September 2010
EXHIBIT 2-1
N
E
W
S
0
0.25
0.5
1
1.5
2
Miles
Juniper Ridge
Tetherow
Legend
City of Bend Service Area
Avion Water Company
Roats Water Company
State Highway
Roads
Urban Growth Boundary
Deschutes River

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Records of Water Use

OAR 690-086-0140(4) and (9)

Methodology

The International Water Association (IWA) and the American Water Works Association (AWWA) have published and promoted a water audit methodology that has been widely recognized and adopted throughout the water industry.[2] This method provides definitions and classifications for annual water production and consumption as shown in **Exhibit 2-2**. Knowing the magnitude of each category can assist a utility in estimating the financial impact of production, billing, and leak detection practices.

System input, shown in Column A of Exhibit 2-2, refers to the total quantity of water delivered to a distribution system from all sources: for example, water treatment plants or wells. The quantity of water generally is measured using large master meters located at key entry points into the distribution system. System input also is known as "production" and "demand." The system input volume must equal the sum of the authorized consumption and water losses that occur in the system (Column B of Exhibit 2-2).

EXHIBIT 2-2
Components of the IWA/AWWA Water Balance

A	B	C	D	E
System Input Volume = Production = System Demand (measured at Master Meters)	Authorized Consumption	Billed Authorized Consumption	Billed metered consumption (including water exported to another system). Billed unmetered consumption.	Revenue Water
		Unbilled Authorized Consumption	Unbilled metered consumption. Unbilled unmetered consumption.	Non-Revenue Water
	Water Losses	Apparent Losses	Unauthorized consumption. Data handling error. Metering Inaccuracies.	
		Real Losses	Leakage from transmission and/or distribution mains. Leakage and overflows at storage tanks. Leakage from service connections up to a point of customer metering.	

*AWWA. Manual of Water Supply Practices M36. *Water Audits and Loss Control Programs, Third Edition*, 2009.

Authorized consumption is divided into billed and unbilled categories. Billed authorized consumption is equivalent to revenue water. Unbilled authorized consumption contributes to

[2] AWWA. Manual of Water Supply Practices M36. *Water Audits and Loss Control Programs, Third Edition*, 2009.

non-revenue water and includes uses such as hydrant flushing and system flushing. Unbilled authorized consumption can be either metered or unmetered.

Water losses include both apparent losses and real losses. Apparent losses result from meter inaccuracies, errors introduced by data entry or manipulation, and unauthorized consumption (such as illegal connection to the system). Real losses result when water is lost because of leaks, reservoir overflow and evaporation. All water systems have some degree of real losses. OWRD's Water Management and Conservation Planning rules set a goal for municipal systems to have "system leakage" (real losses) equal to or less than 15 percent of total system input or demand, and if feasible less than 10 percent.

Terminology

Production refers to the quantity of water delivered to a distribution system. By definition, production equals system demand.

Generally, demands and consumption in municipal systems are summarized in units of million gallons per day (mgd), but also may appear as cfs or gallons per minute (gpm). Annual or monthly values typically are reported in million gallons (MG). Water use per person or per capita typically is expressed in gallons per capita per day (gpcd).

The following terms are used to describe system demands:

- Average day demand (ADD) equals the total annual demand divided by 365 days.
- Maximum day demand (MDD) equals the highest system demand that occurs on any single day during a calendar year. It is also called the 1-day MDD or peak day demand.
- The 3-day maximum day demand (3-d MDD) equals the average of the daily demands that occurred on the day before, the day of, and the day after the MDD.
- Monthly demand refers to demand during a calendar month. This demand can be expressed as the total volume of water produced in a month, or as a daily demand value by dividing the total monthly volume by the number of days in the month.
- Maximum monthly demand (MMD) equals the highest monthly demand during a calendar year.
- Peaking factors are the ratios of one demand value to another. The most common and important peaking factor is the ratio of MDD to ADD.

Historic Water Demands

Water demands for the City's system from 2004 through 2009 appear in **Exhibit 2-3**. The data illustrate an increasing trend from 2004 through 2008, with a decline in demand during 2009.

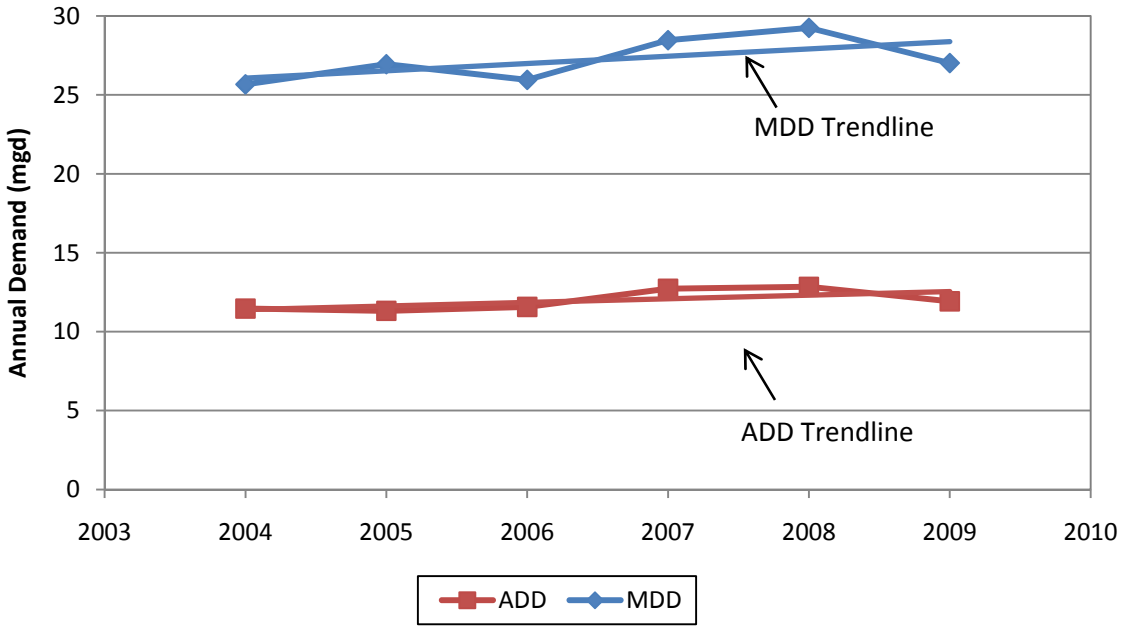
EXHIBIT 2-3
Historical Average Day, Maximum Day, 3-day Maximum Day Demands, and Peaking Factors

Year	Annual Volume Produced (MG)	ADD (mgd)	MDD (mgd)	3-d MDD (mgd)	Peaking Factor MDD:ADD
2004	4,195	11.5	25.7	25.5	2.2
2005	4,131	11.3	26.9	26.3	2.4
2006	4,222	11.6	26.0	25.8	2.2
2007	4,643	12.7	28.5	27.3	2.2
2008	4,700	12.8	29.2	27.9	2.3
2009	4,353	11.9	27.0	26.2	2.3
Average	**4,374**	**12.0**	**27.2**	**26.5**	**2.3**
Maximum	**4,700**	**12.8**	**29.2**	**27.9**	**2.4**

MG = million gallons
ADD = average day demand
mgd = million gallons per day
MDD = maximum day demand

Exhibit 2-4 displays the historic data and linear trends of the ADD and MDD from 2004 to 2009 for the system.

EXHIBIT 2-4
Historic and Trend Line ADD and MDD

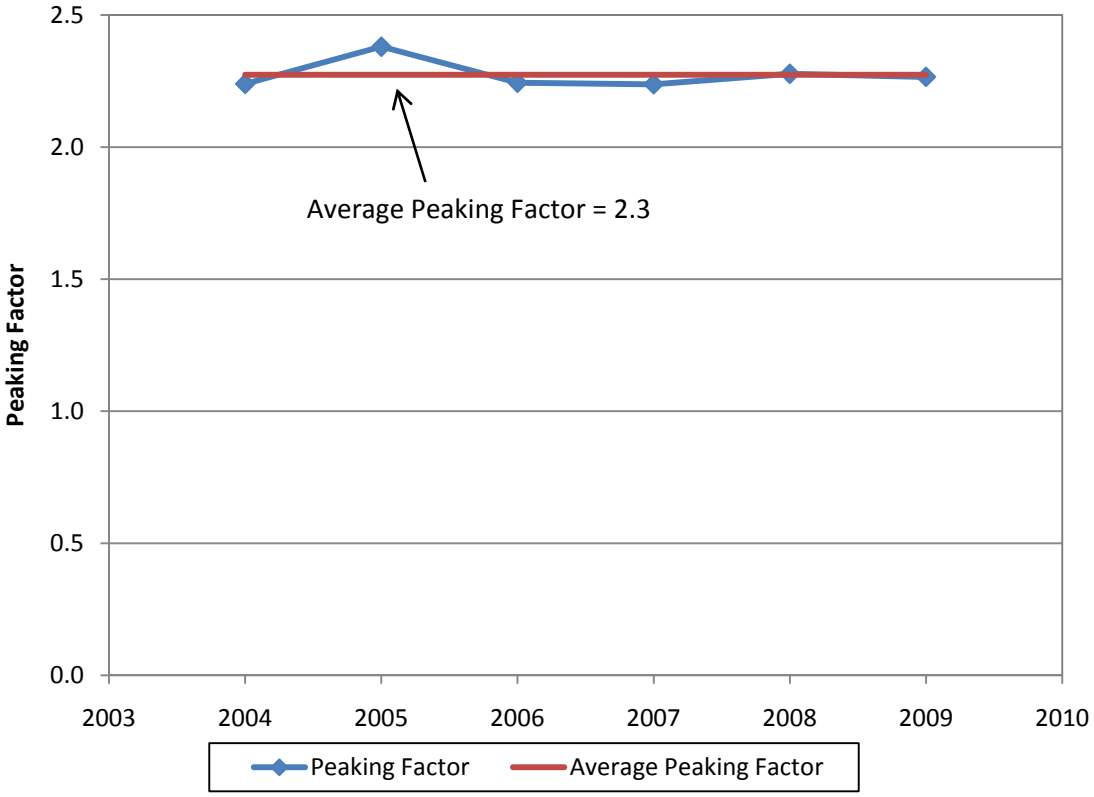


From 2004 to 2009, the ADD ranged from 11.3 to 12.8 mgd, with an average of 12.0 mgd. For the same period, the MDD ranged from 25.7 to 29.2 mgd, with an average of 27.2 mgd. As anticipated with municipal water systems, there is greater variation in the MDD than the ADD because of the sensitivity of the MDD to weather patterns. Hot and dry weather often results in more outdoor irrigation during that period, resulting in higher MDD values. Similarly wet, cool weather can cause the MDD to drop for a particular year.

If production approaches capacity for a short period of time, such as a single day, systems generally can use storage to meet demand. However, if high demand continues for a longer period, water shortages may result. The 3-day MDD gives an indication of the duration of the maximum demand period. From 2004 to 2009, the 3-day MDD ranged from 95 percent to 99 percent of the single MDD with an average 3-day MDD that was 97 percent of the single MDD. This indicates that periods of high demand typically last longer than a single day and that in its water supply planning efforts the City should make preparations to address maximum demand for multiple days.

Exhibit 2-5 graphically represents the ratio of the MDD to ADD for the years 2004 to 2009, which are the peaking factors from Exhibit 2-3. The peaking factor ranged from 2.2 to 2.4 with an average of 2.3. For use in projecting future demand in Section 5 of this WMCP, a peaking factor of 2.25 is used; this is a typical peaking factor for Central Oregon municipal water providers.

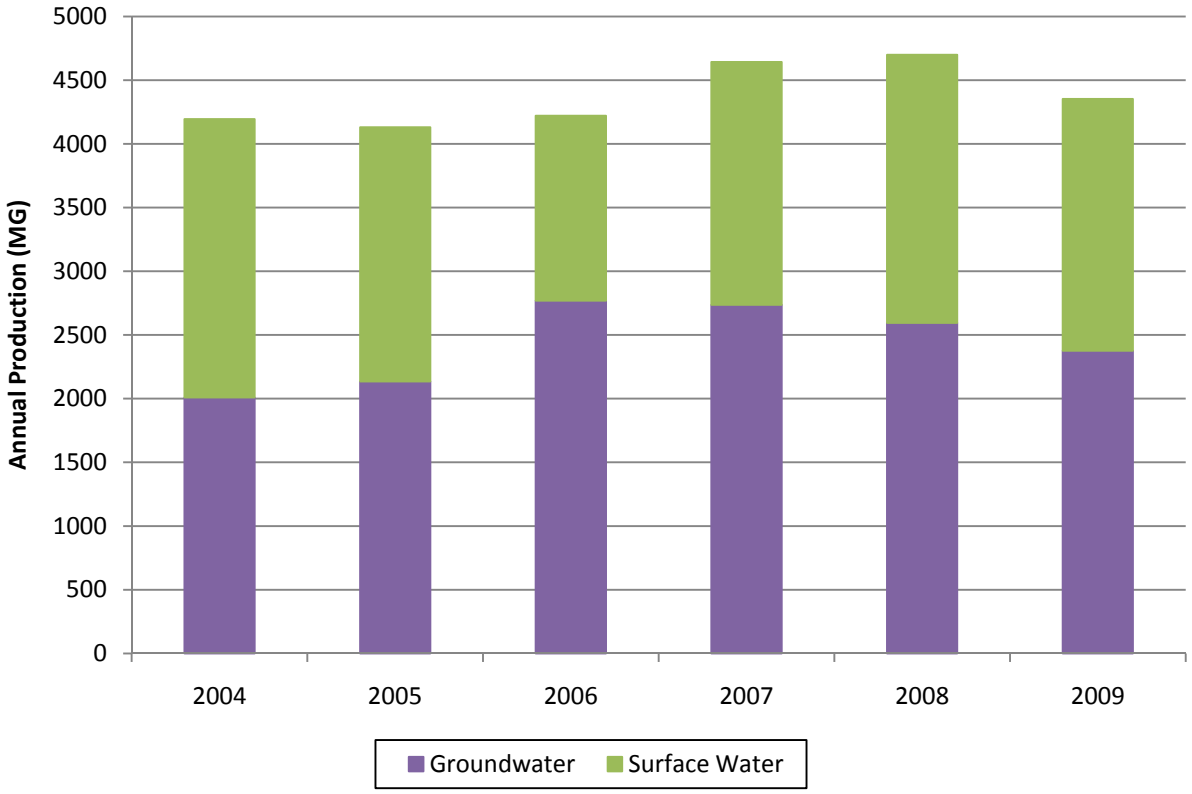
EXHIBIT 2-5
Historic Peaking Factor (MDD to ADD Ratio)



Annual and Monthly Production

Exhibit 2-6 illustrates the annual production of surface water and groundwater. On average from 2004 through 2009, groundwater represented 56 percent of production, and surface water provided the remaining 44 percent. However, the ratio of groundwater to surface water production varies by time of the year.

EXHIBIT 2-6
Annual Production of Surface Water and Groundwater



As previously described, the City's surface water and groundwater sources each provide about one-half of the City's annual water supply. Surface water is used year-round to meet the City's base water demands, and groundwater is used when sufficient surface water supplies are not available. **Exhibit 2-7** illustrates the monthly production volumes from 2004 through 2009. Surface water provided the majority of the water supply during the fall and winter months. The percent of groundwater use increased substantially during the spring and summer months because of the rise in turbidity of the surface water, which limits usability; low flows in the surface water sources; and higher overall demand. As expected, the overall demand peaks in the summer months as a result of outdoor uses such as irrigation. The average MMD during the period from 2004 through 2009 was 732 MG.

EXHIBIT 2-7
Monthly Production of Surface Water and Groundwater

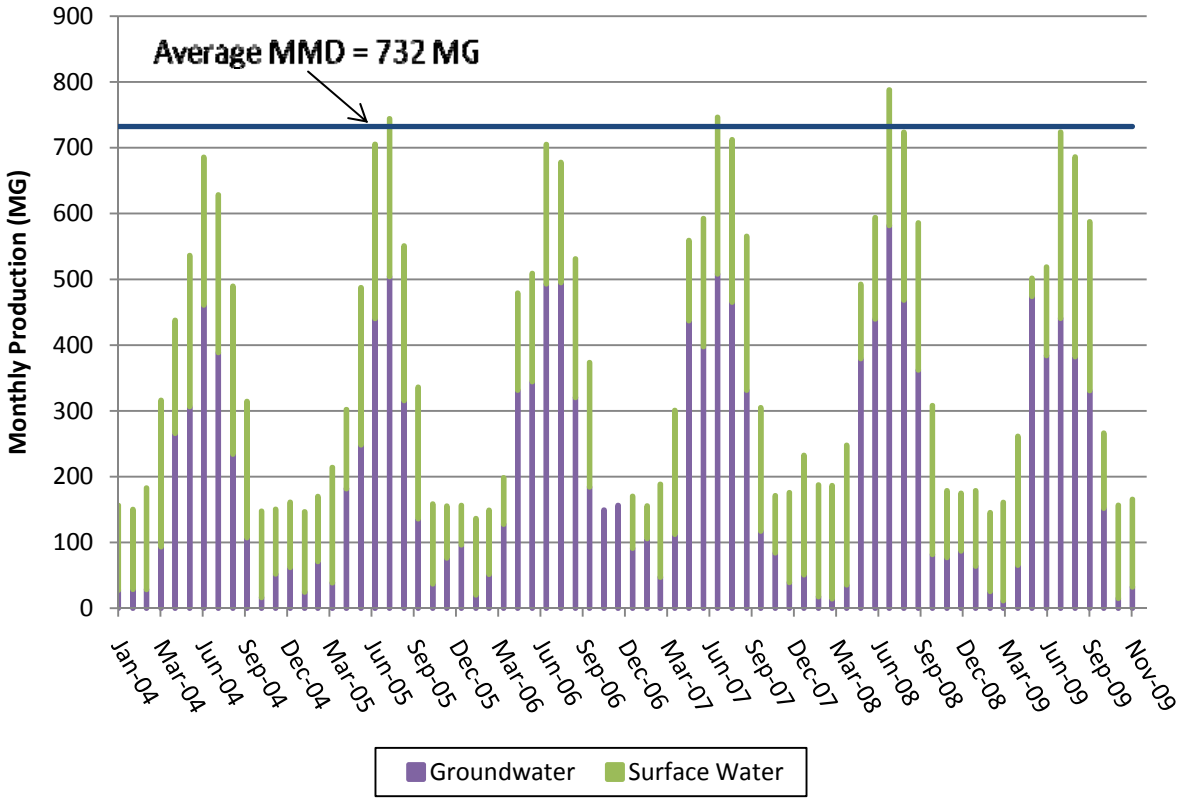
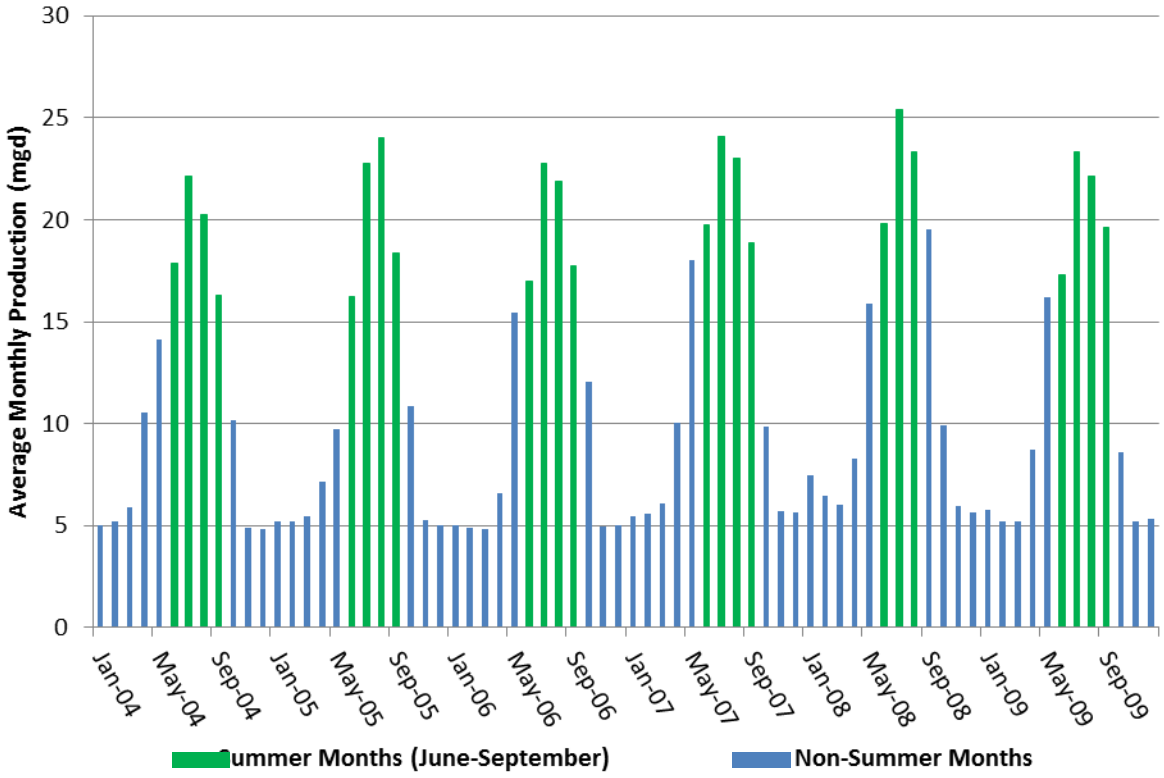


Exhibit 2-8 shows the average monthly demand, with the peak water use months from June through September highlighted in green. The average MMD was 23.6 mgd (732 MG) during the 6-year period and the peak month occurred in July every year except 2005, when it occurred in August. The peak summer period accounted for an average of 57 percent of demand, with the remaining demand spread across the other 8 months of the year.

EXHIBIT 2-8
Average Monthly Production



Per Capita Demands

Exhibit 2-9 shows the estimated ADD per capita demand within the City's water service area. The ADD represents use by all customer categories. Because the per capita demand includes all use by commercial, industrial, and municipal customers as well as residential customers, the calculated per capita demand values exceed the amounts of water actually used by a typical individual. Because of this fact, per capita demand calculations may show year-to-year trends, but are a poor metric to compare customers' water use to that of other communities. Moreover, per capita demand may not accurately portray year-to-year water use because the calculation does not take into account the difference in customer mix, climate, rainfall, current economic conditions, or specifics such as changes in hotel occupancy or large commercial or industrial uses that may not have any relationship to population or actual efficiency of use.

EXHIBIT 2-9
ADD Per Capita Demand

Year	ADD (mgd)	Population Served by City System	ADD per Capita (gpcd)
2004	11.5	51,535	222
2005	11.3	54,525	208
2006	11.6	57,443	201
2007	12.7	59,198	215
2008	12.8	61,736	207
2009	11.9	62,791	190

ADD = average day demand
mgd = million gallons per day
gpcd = gallons per capita per day

Authorized Consumption

Authorized consumption is equal to the metered and certain unmetered water use within the system. All customers are metered, however, authorized water consumed for activities such as fighting fires and system maintenance currently are not metered by the City. Maintenance use and water used for water quality purposes such as system flushing are tracked informally by the operations staff. To obtain a more accurate determination of revenue and non-revenue water, the City intends to review and develop a program to calculate and track unbilled authorized consumption as part of its water audit program, as further described in Section 3.

The City currently has two major customer categories – residential and non-residential. For 2008 and 2009, 86 percent of accounts were residential with the remaining 14 percent classified as non-residential. Residential customers include single-family and multi-family accounts, and non-residential customers include commercial, laundry, park, and school accounts. The City is working to improve the accuracy of its data and changes have been made to improve the 2008 and 2009 billing record data. The use of detailed consumption data before 2008 or with more customer class specificity was not used in developing this WMCP. The City understands the current shortcomings of its detailed consumption data and is making this a point of emphasis in its water management and conservation benchmarks regarding annual water audits. (See Chapter 3 for more details.)

Customer Characteristics and Water Use Patterns

OAR 690-086-0140(6)

Understanding the characteristics of customers within the system is important when analyzing water use and forecasting future demand and consumption patterns. **Exhibit 2-10** shows the number of meters by customer category for 2008 and 2009. The annual metered consumption by retail accounts during this period is shown in **Exhibit 2-11.** Although the quality of the City's data is not sufficient for detailed evaluation of water use by customer class, note that the City's *2005 Housing Needs Analysis City of Bend Residential Lands Study* indicated that 72 percent of households were single-family, leaving 28 percent that were multi-family.

The percent of total water used by the two major customer categories in 2009 is illustrated in the pie chart in **Exhibit 2-12.** Residential use comprised 61 percent of consumption with 31 percent of use by non-residential customers.

EXHIBIT 2-10
Number of Meters by Customer Category

	2008	**2009**
Residential	19,318	19,033
Non-residential	3,253	3,211
Total	**22,571**	**22,244**

EXHIBIT 2-11
Annual Consumption by Customer Category

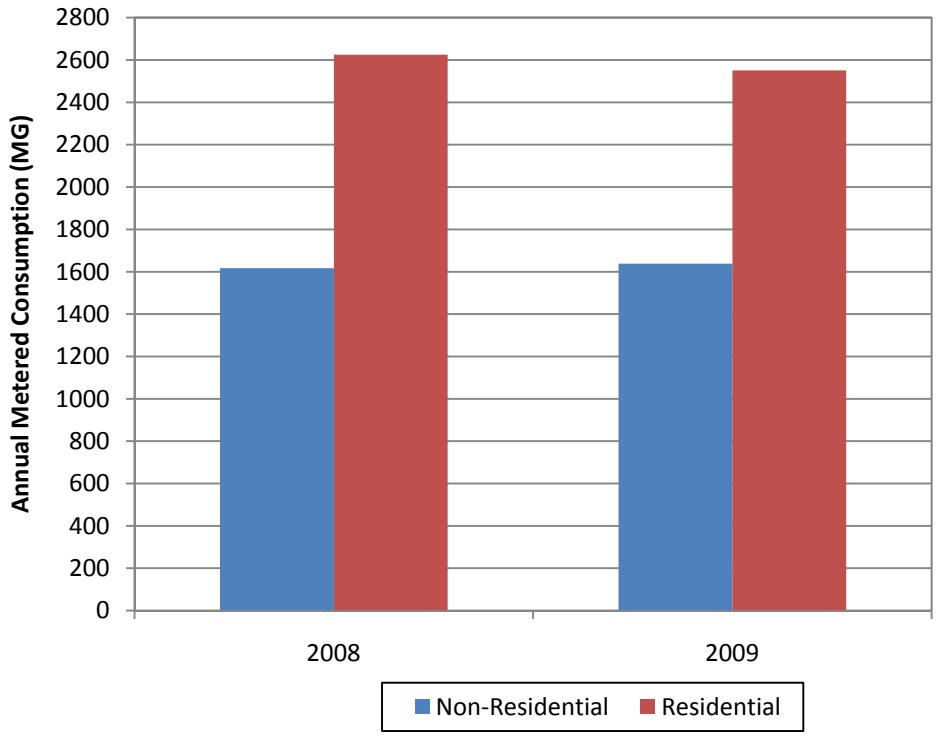
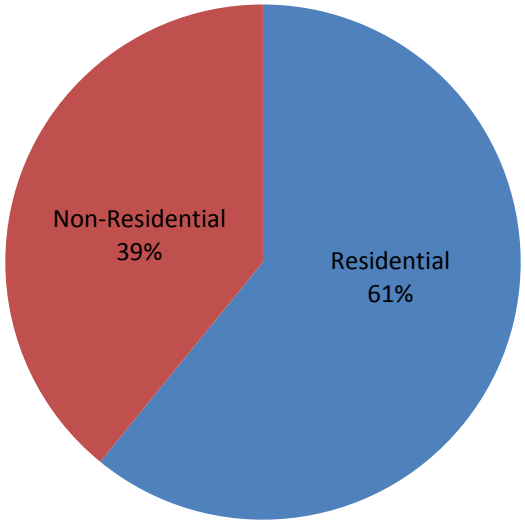


EXHIBIT 2-12
Percent Annual Consumption by Customer Category, 2009



The average monthly consumption by customer category for 2008 and 2009 is shown in **Exhibit 2-13.**

EXHIBIT 2-13
Monthly Water Consumption, 2008-2009

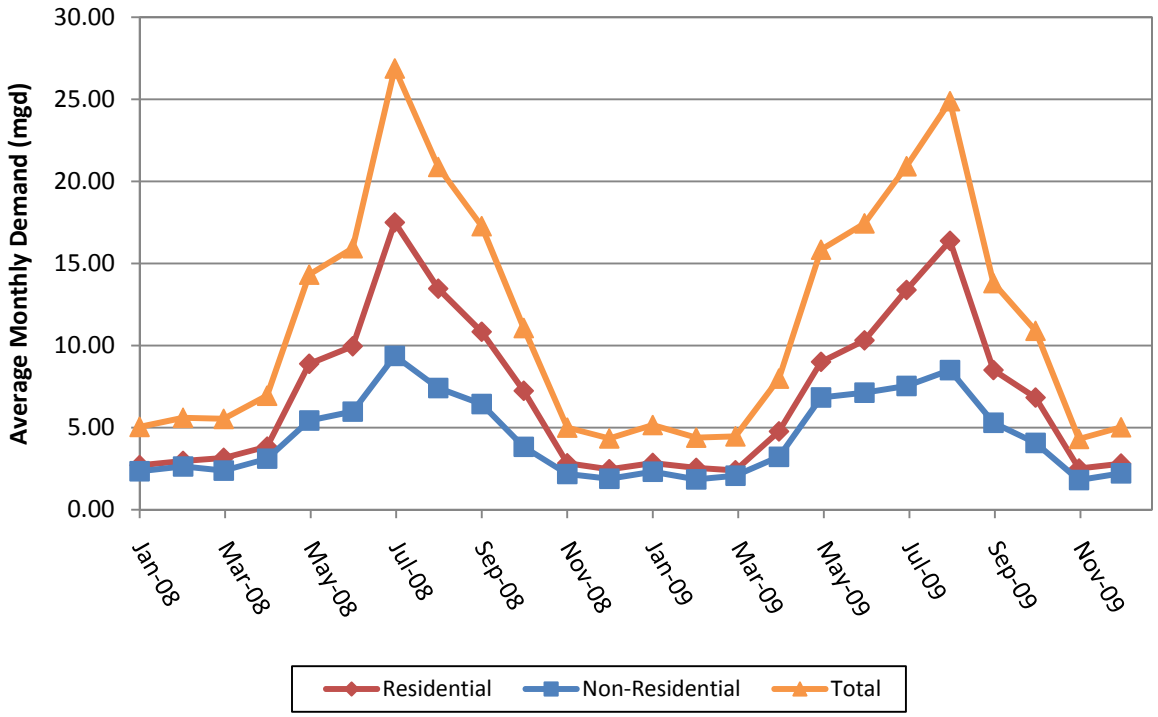


Exhibit 2-14 provides a comparison of the ADD for the residential customer category and for the non-residential customer categories during the last year of the analyzed period for this Plan and the City's previous Plan.

EXHIBIT 2-14
Current and Historic ADD by Customer Category

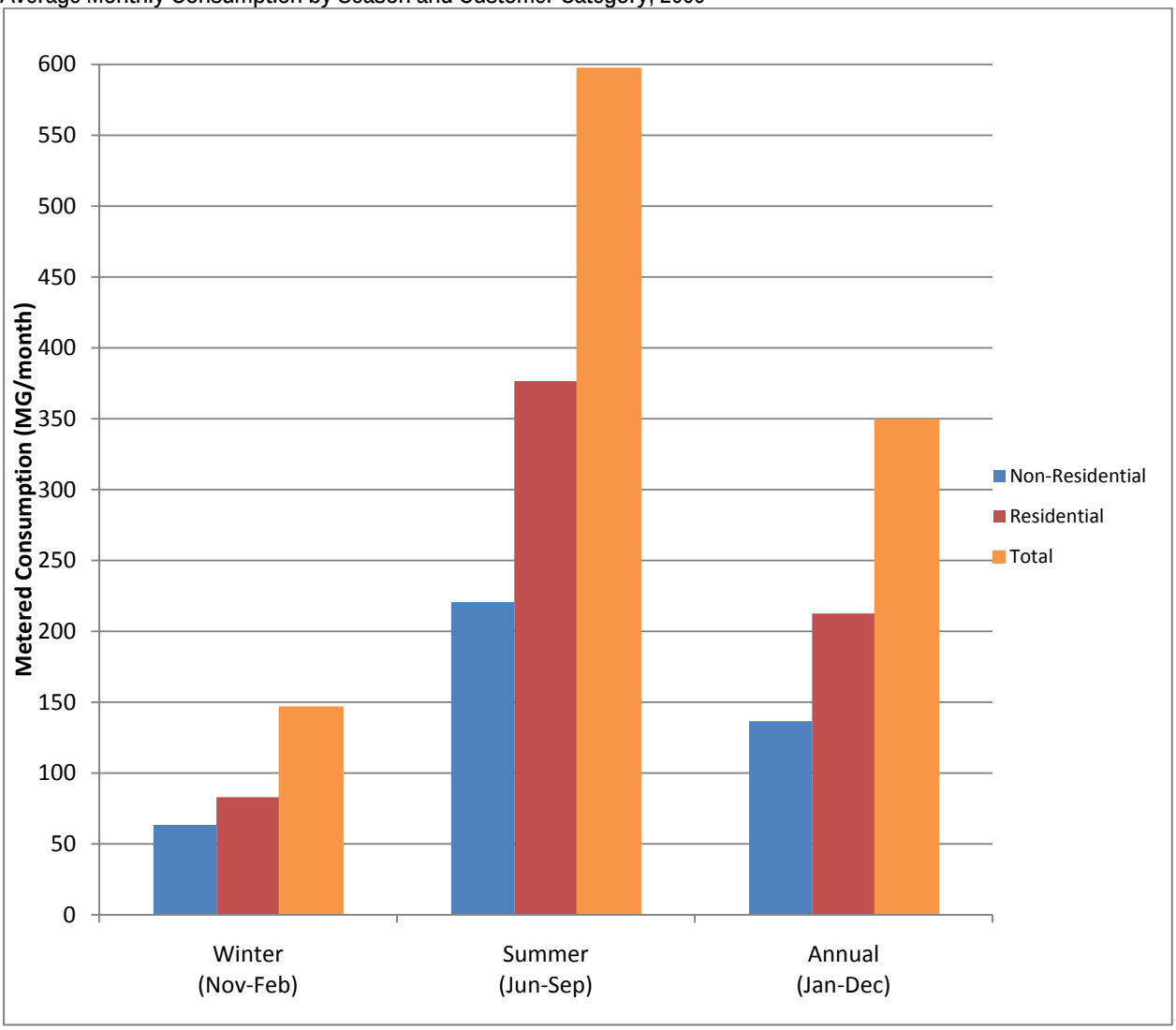
Customer Category	Average Day Demand (mgd)	
	2003[1]	**2009**
Residential	5.7[2]	7.0
Non-residential	5.7	4.9

[1] As provided in the City's 2004 approved WMCP. Since that time, continual refinements to customer categories have been made. In addition, the City was not fully metered until December 2004.
[2] Includes 0.35 mgd that was the estimated demand for non-metered residential use.
mgd = million gallons per day

The ADD for the residential category during 2009 was 12.6 mgd during summer months (June through September) and 2.8 mgd during winter months (November through February.) The ADD for non-residential categories during 2009 was 7.4 mgd during summer months and 2.1 mgd during winter months.

Exhibit 2-15 presents the average monthly consumption for the two major customer categories by season for 2009. For the purposes of this analysis, the summer months are defined as June through September and winter months are defined as November through February. The total average monthly consumption was 597 MG per month for summer months, and 146 MG per month for the winter months. The overall monthly average for the entire year was 349 MG per month. The summer season to winter season use ratio was 4.1.

EXHIBIT 2-15
Average Monthly Consumption by Season and Customer Category, 2009

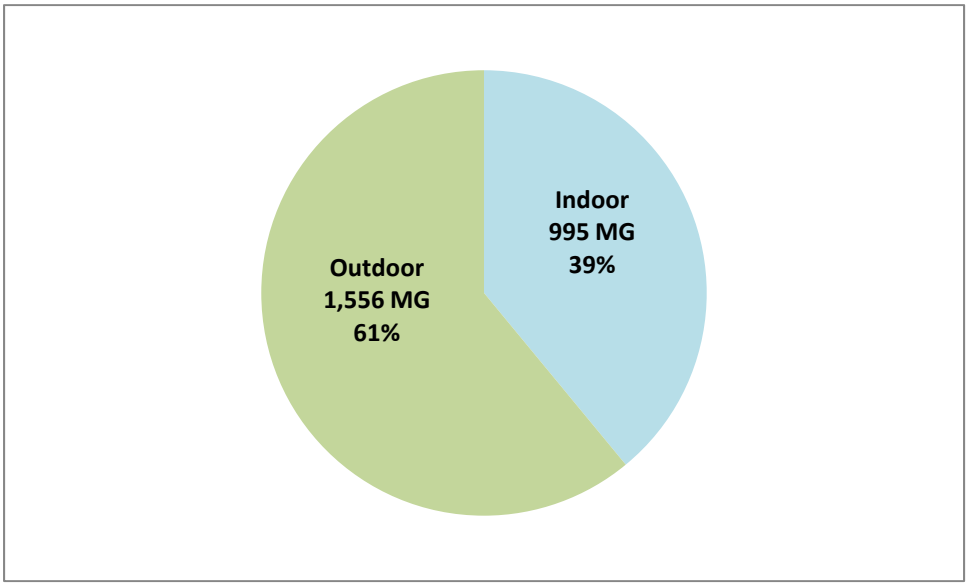


Indoor and Outdoor Water Use

To estimate indoor versus outdoor use, wintertime consumption was assumed to be representative of indoor water use (or at least to exclude outdoor irrigation) for residential customers. Non-residential customers were not included in the analysis because of the variability of types of customers within the non-residential category. The wintertime monthly average of 83 MG for residential users was multiplied by a 12-month period to determine the average annual indoor use of 996 MG. The outdoor use by residential customers was assumed to be the difference between total use and the calculated indoor use, resulting in outdoor annual average use of 1,556 MG. The results appear in **Exhibit 2-16.**

Indoor water use represented approximately 39 percent of annual water use by residential customers. Because outdoor use represents the majority of residential use, conservation measures focused on reducing outdoor use could substantially reduce average demand and peak season demand. Conservation efforts targeting indoor residential water use could have some impact on reducing overall average demands.

EXHIBIT 2-16
Estimated Annual Residential Indoor and Outdoor Use, 2009



Non-Revenue Water

The difference between production and authorized consumption is equivalent to a system's non-revenue water, which includes both apparent and real water losses. Apparent losses result from meter inaccuracies, error introduced by data entry or manipulation, and unauthorized consumption (illegal connection to the system or unauthorized use of a fire hydrant). Positive apparent losses would reduce the volume attributed to real losses. Conversely, because of the nature of these types of errors, apparent losses may have negative values. If apparent losses are negative, real losses are underestimated. Apparent and real water losses often are expressed as a percentage of system production. Non-revenue water is equal to system losses plus any authorized but unbilled water use within a system.

Exhibit 2-17 presents the annual non-revenue water for 2008 and 2009. The exhibit also lists total production and consumption as well as the percent of non-revenue water. These percentages ranged from 4 percent to 10 percent, with an average of 7 percent. A valve maintenance and hydrant flushing program is completed about every 2 years and occurred in 2008, which likely contributed to a higher percentage that year. The City is not aware of any leaks in its system or significant losses of water.

The City currently does not have a systematic leak detection program; however, leakage is not believed to be a significant loss. Authorized unbilled water use for flushing, water quality testing, reservoir cleaning and draining, as well as reservoir leakage is calculated and tracked by the City's Operations staff, but not precisely metered so the exact percent contributed to the overall non-revenue water cannot be determined. This is a benchmark activity the City intends to include in its "water audit" improvements.

EXHIBIT 2-17
Historic Annual Non-revenue Water

Year	Production (MG)	Metered Consumption* (MG)	Water Losses (MG)	Percent
2008	4700	4242	458	10%
2009	4353	4189	164	4%
Average			**311**	**7%**

*Does not include unbilled authorized consumption such as hydrant flushing, water quality testing, etc.
MG = million gallons

City of Bend Water Rights

OAR 690-086-0140(5)

The City holds 12 groundwater rights that authorize the use of groundwater at a rate of up to 68.2 cfs (44.1 mgd) for municipal purposes: 7 certificates and 5 permits. In addition, the City holds six surface water rights that authorize a total use of up to 36.1 cfs (23.3 mgd) from Bridge Creek and Tumalo Creek for municipal purposes. **Exhibit 2-18** summarizes the City's water rights. The exhibit includes the priority date, source, type of use, and maximum instantaneous rate of use to date for each water right. The City provided the total maximum annual volume of use, because the volume of use is recorded by well, not water right, and each well is typically an authorized point of appropriation for multiple water rights. For the same reason, the City has provided the total average daily and monthly quantities of water diverted, rather than providing this information for each water right. However, **Exhibit 2-19** describes the monthly volume of water diverted from each well.

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EXHIBIT 2-18
City of Bend Water Rights

Application Number	Permit Number	Certificate or Transfer Number	Authorized Wells	Priority Date	Authorized Rate (cfs)	Authorized Rate (mgd)	Type of Beneficial Use	Maximum Withdrawal To Date	2009 Average Withdrawal		5-Year Average Withdrawal (2005-2009)		Authorized Date for Completion	Mitigation Credits	Notes
								Instantaneous (cfs)	Daily (MG)	Monthly (MG)	Daily (MG)	Monthly (MG)			
Groundwater															
G-12226	G-11380	85414	Outback Well #1 Outback Well #2 Outback Well #3 Outback Well #4 Bear Creek Well #1 Airport Well #2	9/7/1990	10	6.5	Municipal	10					N/A - Certificated	N/A	
G-5644	G-4946	68702	River Well #1 River Well #2	10/31/1971[1]	0.9	0.6	Municipal	0.9					N/A - Certificated	N/A	
G-5644	G-4946	85415	River Well #1 River Well #2	10/13/1971	2.7	1.7	Municipal	2.7					N/A - Certificated	N/A	
G-5644	G-4946	85412	River Well #1 River Well #2 Copperstone Pilot Butte Well #1	10/13/1971	7.57	4.9	Municipal	7.57					N/A - Certificated	N/A	
G-5644	G-4946	85413	River Well #1 River Well #2 Pilot Butte Well #1 Bear Creek Well #1 Bear Creek Well #2	10/13/1971	4.87	3.1	Municipal	4.87					N/A - Certificated	N/A	
G-8695	G-8565	85411	A Well (Westwood)	12/22/1978	1.51	1.0	Quasi-Municipal	1.51					N/A - Certificated (Partial perfection of Permit G-8565)	N/A	
G-8695	G-8565		A Well (Westwood) Pilot Butte Well #4 Shiloh Well #3 Hole Ten Well #1 Hole Ten Well #2	12/22/1978	0.94	0.6	Quasi-Municipal						10/1/2020	N/A	Permit Amendment T-10941
G-11942	G-11379	85559	Rock Bluff Well #1 Rock Bluff Well #2 Rock Bluff Well #3	6/30/1989	4.16	2.7	Municipal	4.16					N/A - Certificated (Partial perfection of Permit G-11379)	N/A	
G-11942	G-11379		(Rock Bluff) Well #1 (Rock Bluff) Well #2 (Rock Bluff) Well #3 Pilot Butte Well #3	6/30/1989	3.84	2.5	Municipal						10/1/1998 - extension application pending	N/A	Permit Amendment T-8342
G-13097	G-16177		Bear Creek Well #3 Bear Creek Well #4 Bear Creek Well #5 [2]Outback #7 [2]Shiloh #3 [2]Hole Ten 1 [2]Hole Ten 2	8/27/1992	12	7.8	Municipal	0	6.51	198.02	6.91	210.19	4/26/2027	Obligation: 1,611.5; Assigned: 4.9	Limited by Maximum annual volume of 3223 AF and corresponding mitigation provided. Permit Amendment T-11138.
G-13098	G-16178		Pilot Butte Well #3 Pilot Butte Well #4 Pilot Butte Well #5 [2]Outback #7 [2]Shiloh #3 [2]Hole Ten 1 [2]Hole Ten 2	8/27/1992	12	7.8	Municipal	0					5/2/2027	Obligation: 1,611.5; Assigned: 174.05	Limited by Maximum annual volume of 3223 AF and corresponding mitigation provided. Permit Amendment T-11138.
G-4677	G-4435		Lava Island Well #1 Lava Island Well #2 Lava Island Well #3 Lava Island Well #4 Lava Island Well #5 Lava Island Well #6 Lava Island Well #7 Lava Island Well #8 Bear Creek Well #2 Outback Well #3 Outback Well #4 Outback Well #5 Outback Well #6 Pilot Butte Well #4 Shiloh Well #3 Hole Ten Well #1 Hole Ten Well #2	11/8/1968	7.75 cfs total; 0.935 0.98 0.98 0.97 0.97 0.97 0.97 0.975 N/A N/A N/A N/A N/A N/A N/A N/A N/A	5 mgd total; 0.60 0.63 0.63 0.63 0.63 0.63 0.63 0.63 N/A N/A N/A N/A N/A N/A N/A N/A N/A	Municipal						10/1/2020	N/A	Permit Amendments T-8783, T-10351, & T-10941
				Total Authorized	68.2	44.1									
				Total Certificated	31.7	20.5									

[1] Priority date day is likely a typo. Application G-5644 and Permit G-4946 had priority dates of 10/13/1971.

[2] Permit amendment in process.

City of Bend Water Rights Continued

Application Number	Permit Number	Certificate or Transfer Number	Facility/ Location Name	Priority Date	Authorized Rate (cfs)	Authorized Rate (mgd)	Type of Beneficial Use	Maximum Withdrawal To Date	2009 Average Withdrawal		5-Year Average Withdrawal (2005-2009)		Authorized Date for Completion	Mitigation Credits	Notes
								Instantaneous (cfs)	Daily (MG)	Monthly (MG)	Daily (MG)	Monthly (MG)			
Surface Water															
S-67983	S-49823	85713	Bridge Creek & Unnamed Tributary of Middle Fork Tumalo Creek	12/12/1983	12.2	7.9	Municipal	12.2	5.42	164.71	5.17	157.27	N/A - Certificated (Partial perfection of Permit S-49823)	N/A	
S-67983	S-49823		Bridge Creek & Unnamed Tributary of Middle Fork Tumalo Creek	12/12/1983	2.8	1.8	Municipal						10/1/1999 -extension application pending	N/A	
Decree: Vol. 1, Page 153		85526	Tumalo Creek	This right is senior to all other rights on Tumalo Creek	6	3.9	Domestic, Municipal	6					N/A - Certificated	N/A	
Decree: Vol. 1, Page 135		31411	Tumalo Creek	8/5/1900	2	1.29	Municipal	2					N/A - Certificated	N/A	Period of use: 4/15-10/15; Not to exceed 6.52 cfs and 821.7 AF/year
				9/1900	4.5	2.91		4.5						N/A	
				6/1/1907	0.02	0.01		0.02						N/A	
Decree: Vol. 1, Page 135		31665	Tumalo Creek	9/1900	1.314	0.85	Municipal	1.314					N/A - Certificated	N/A	Period of use: 4/15-10/15; Not to exceed 2.603 cfs and 328.14 AF/year
				4/28/1905	0.186	0.12		0.186						N/A	
				6/1/1907	1.103	0.71		1.103						N/A	
Decree: Vol. 1, Page 135		Transfer B-112	Tumalo Creek	10/29/1913	4/1-5/1: 2.43 cfs 5/1-5/15: 3.23 cfs 5/15-9/15: 5.99 cfs 9/15-10/1: 3.23 cfs 10/1-11/1: 2.43 cfs	4/1-5/1: 1.57 mgd 5/1-5/15: 2.09 mgd 5/15-9/15: 3.87 mgd 9/15-10/1: 2.09 mgd 10/1-11/1: 1.57 mgd	Municipal	0					10/1/2019	N/A	Period of use: 4/1-11/1; Not to exceed 5.99 cfs and 1923.5 AF/year.
				Total Authorized	36.1	23.3									
				Total Certificated	27.3	17.7									

EXHIBIT 2-19
2009 Monthly Water Use by Well

Well	January	February	March	April	May	June	July	August	September	October	November	December
	Volumes in Million Gallons (MG)											
Bear Creek 1	0	0	0	9.93	34.57	34.86	44.29	44.15	43.10	14.54	0	0
Bear Creek 2	0	0	0	0	5.83	7.34	22.34	21.97	15.30	0.55	0	0
Outback 1	0.04	0.01	0	6.88	31.24	20.71	0	0	0.41	8.83	1.18	4.57
Outback 2	10.27	3.04	0	8.47	31.11	23.12	0	0	0.88	13.36	1.19	6.52
Outback 3	12.46	6.11	0	1.22	36.82	16.64	20.77	18.64	14.53	6.25	0	4.72
Outback 4	11.47	2.36	0	3.73	43.66	39.58	50.27	49.88	49.37	23.73	0	3.74
Out back 5	4.74	0.82	0	11.82	44.75	33.59	41.18	40.56	27.02	18.50	2.13	1.95
Outback 6	0.94	0	0	1.81	35.47	6.04	11.21	10.70	4.06	15.00	1.23	1.32
Outback 7	0	0	0	0	0	0	0	0	0	0	0	0
Outback 8	0	0	0	0	0	0	0	0	0	0	0	0
River Well 1	0	0	0	1.61	16.35	39.59	43.10	7.60	2.63	0	0	0
River Well 2	0	0	0	0	77.70	11.21	16.98	0	1.71	0	0	0
Westwood	1.77	0	0.003	0	3.76	7.87	15.90	17.79	9.06	0.15	0	0
Copperstone	0	0	0	0	27.06	43.68	45.34	41.66	44.07	1.46	0	0
Pilot Butte 1	0	0	0	0	0	13.04	37.36	37.95	36.43	8.39	0	0
Pilot Butte 2	0	0	0	0	0	0	0	0	0	0	0	0
Pilot Butte 3	0	0	0	0	23.54	43.76	37.38	37.40	36.37	15.37	0	0
Rock Bluff 1	0.01	0	0	0.41	4.53	6.34	13.90	9.40	8.41	0.31	0	0
Rock Bluff 2	0	0	0	0	0	0	0	0	0	0	0	0
Rock Bluff 3	9.11	0.4	0.50	9.29	45.70	25.24	30.27	31.29	25.25	14.90	0	1.37
Hole 10 North	6.86	7.5	6.21	8.05	6.79	6.52	8.07	10.39	8.94	6.66	4.81	4.39
Hole 10 South	6.41	5.7	6.25	5.77	6.78	6.68	7.49	9.42	8.04	6.26	4.93	4.62
Shilo 1	0	0	0	0	0.02	0	0	0	0	0	0	0
Shilo 2	0	0	0	0	0.02	0	0	0	0	0	0	0
Shilo 3	0	0	0	0	0	0	0	0	0	0	0	0

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Groundwater

The City's seven water right certificates for the use of groundwater authorize the use of up to 31.7 cfs. The City's most senior groundwater right certificates (68702, 85415, 85412, and 85413), have a priority date of October 13, 1971[3] and authorize the use of up to 0.9 cfs, 2.7 cfs, 7.57 cfs, and 4.87 cfs, respectively.

The City also holds water right Certificate 85411, which has a priority date of December 22, 1978, and authorizes the use of up to 1.51 cfs. This certificate was issued as the result of the partial perfection of Permit G-8565, which authorized the use of up to 2.45 cfs. The remaining portion (0.94 cfs) of Permit G-8565 continues to be in the water right development process as a permit. OWRD approved an application for an extension of time that extends the development timeline for Permit G-8565 to October 1, 2020.

In addition, the City holds water right Certificate 85559, which has a priority date of June 30, 1989, and authorizes the use of up to 4.16 cfs. This certificate was issued as the result of the partial perfection of Permit G-11379, which authorized the use of up to 8.0 cfs. The remaining 3.84 cfs portion of Permit G-11379 continues to be in the water right development process as a permit. The City filed an application for an extension of time with OWRD on October 31, 2003. That extension application is pending.

The City's most junior water right certificate is Certificate 85414, which has a priority date of September 7, 1990, and authorizes the use of up to 10 cfs.

Finally, the City holds three additional municipal water use permits that authorize the use of groundwater: Permits G-4435, G-16177, and G-16178. Permit G-4435 authorizes the use of up to 7.75 cfs of groundwater. OWRD extended the development timeline for Permit G-4435 until October 1, 2020. Permits G-16177 and G-16178 each have a priority date of August 27, 1992, and each authorizes water use at a rate of up to 12.0 cfs and volume of up to 3,223 acre-feet. OWRD issued these permits after the inception of the Deschutes Basin Mitigation Program and, accordingly, the City must provide mitigation credits to offset the impacts on surface water from use of groundwater under these permits. OWRD determined that each permit has a total mitigation obligation of 1,611.5 credits based on a consumptive use estimate of 50 percent. To date, 4.9 credits have been assigned to Permit G-16177 and 229.15 credits have been assigned to Permit G-16178.

Surface Water

The City's six surface water rights authorize the use of up to a total of 36.1 cfs (23.3 mgd) from the Bridge Creek and Tumalo Creek watersheds. The City's surface water rights are evidenced by four certificates, one permit, and one transfer.

The City's most senior surface water right is Certificate 85526, which authorizes the use of up to 6.0 cfs from Tumalo Creek. The certificate evidencing this water right does not provide a date of priority, but states instead that the "right is senior to all other rights on Tumalo Creek." The City acquired this water right as the result of a judgment of the Deschutes County Circuit Court in a case between the City of Bend and the Deschutes County Municipal Improvement District.

[3] Certificate 68702 appears to include a scrivener's error stating that its priority date is October 31, 1971, rather than October 13, 1971, as provided in Permit G-4946, from which the certificate was issued.

The City holds two additional surface water right certificates for the use of water from Tumalo Creek: Certificate 31411, which authorizes the use of up to 6.52 cfs; and Certificate 31665, which authorizes the use of up to 2.603 cfs. Both rights originated as multiple decreed rights for irrigation purposes, which were acquired by the City and transferred to municipal purposes. As a result, these certificates each have three different priority dates with a maximum authorized rate associated with each date. These rights also carry an annual volume limitation and a season of use limitation stemming from their origins as irrigation water rights.

The City's most junior municipal water right certificate is Certificate 85713, which authorizes the use of up to 12.2 cfs from Bridge Creek and an unnamed tributary of Middle Fork Tumalo Creek. This certificate was issued as the result of the partial perfection of Permit S-49823, which authorized the use of up to 15.0 cfs. The remaining 2.8 cfs portion of Permit S-49823 continues to be in the water right development process as a permit.

Finally, the City holds a water right evidenced by Transfer B-112. Under this transfer, the maximum authorized rate of diversion from Tumalo Creek varies by season from up to 2.43 cfs to 5.99 cfs. The right also has an annual volume limitation and a season of use because it was originally an irrigation right. Transfer B-112 changed the place of use, point of diversion, and character of use of two certificates for irrigation and domestic use. On May 18, 2009, OWRD approved an extension of time allowing until October 1, 2019 for the City to complete this transfer.

Juniper Utility Water Right

The City has possession of water right application G-13809, which was held by the former Juniper Utility, based on a condemnation proceeding. Title to the application and other Juniper Utility system property will not transfer until the case is complete; the judgment is entered and the City pays the award of just compensation into court. As a result, the Juniper Utility water rights are not considered as part of the discussion of the City's water rights or listed in Exhibit 2-18.

Aquatic Resource Concerns

The City's water supply is from both groundwater and surface water. Groundwater in the Deschutes Basin is not an OWRD-designated Critical Groundwater Area or Groundwater Limited Area. The City's surface water sources are Bridge Creek and Tumalo Creek to the west of Bend. **Exhibit 2-20** shows the listed fish species that occur in Bridge Creek and Tumalo Creek. Tumalo Creek is listed on Oregon Department of Environmental Quality's (DEQ) 303(d) list of impaired water bodies for the following parameters: alkalinity, ammonia, chloride, chlorophyll a, dissolved oxygen, pH, phosphate phosphorous, flow modification, habitat modification and temperature. Bridge Creek is 303(d) listed for temperature.

EXHIBIT 2-20
Native Fish Species that Occur in Bridge Creek and Tumalo Creek that are Listed as Sensitive, Threatened, or Endangered Under the Oregon or Federal Endangered Species Acts

Species	Evolutionarily Significant Unit (ESU)	Federal Listing	State Listing
Inland Columbia Redband Trout (*Oncorhynchus mykiss gairdneri*)	Range-wide	Sensitive	Sensitive – Vulnerable

- Federal ESA listed species (threatened and endangered) were obtained from http://www.nmfs.noaa.gov/pr/species/esa/fish.htm and http://ecos.fws.gov/tess_public/pub/stateListingIndividual.jsp?state=OR&status=listed
- Federal sensitive species were obtained from the Interagency Special Status/Sensitive Species Program (Oregon and Washington) at http://www.fs.fed.us/r6/sfpnw/issssp/agency-policy/
- State ESA listed species (threatened and endangered) were obtained from http://www.dfw.state.or.us/wildlife/diversity/species/threatened_endangered_candidate_list.asp
- State sensitive species were found at http://www.dfw.state.or.us/wildlife/diversity/species/docs/SSL_by_taxon.pdf

Evaluation of Water Rights/Supply

OAR 690-086-0140(3)

As previously described, the City's water supply is provided by its surface water and groundwater rights. The City holds water rights authorizing use of up to approximately 68.2 cfs (44.1 mgd) of groundwater from the Deschutes Aquifer and 36.1 cfs (23.3 mgd) of surface water from Bridge Creek and Tumalo Creek. The City's existing water right capacity is sufficient to meet its current peak water demands. The City's current water supply is, however, limited by stream flow, surface water right regulation, surface water quality events, volume limitations on water rights, system capacity, and mitigation requirements in the Deschutes Groundwater Study Area.

Surface Water

The amount of water available to satisfy the City's surface water rights is a function of water right priority date (seniority) and stream flow, as further described below.

A. Watermaster Distribution

Most of the City's surface water rights were originally irrigation water rights that the City acquired for municipal purposes. As a result, these rights have annual volume limitations and limit the use of water to the irrigation season. The City's surface water rights authorize the use of up to 36.1 cfs during the irrigation season and 21.0 cfs during the remainder of the year. Further, because these rights share priority dates with other irrigation water rights held by the Tumalo Irrigation District (TID), streamflows in Tumalo Creek are distributed between the City, TID, and the instream water rights that also originated from a TID irrigation water right during times of low flow.

For demonstration purposes, **Exhibits 2-21 and 2-22** describe the amount of water to which the City is entitled at different streamflows, as well as the amounts to which TID and the instream water rights are entitled.

EXHIBIT 2-21
Tumalo Creek Water Rights Distribution during Irrigation Season

Total stream flow	BEND	TID	INSTREAM
40	11.1	22.3	6.5
60	14.2	38.7	7.0
80	16.3	56.1	7.6
100	17.5	74.7	7.8
120	18.0	94.2	7.8
140	18.6	113.6	7.8
160	19.2	133.0	7.8
180	19.7	152.5	7.8
200	20.3	171.9	7.8
220	20.9	191.3	7.8
240	21.1	206.4	12.4

TID = Tumalo Irrigation District

EXHIBIT 2-22
Tumalo Creek Water Rights Distribution during Irrigation Season

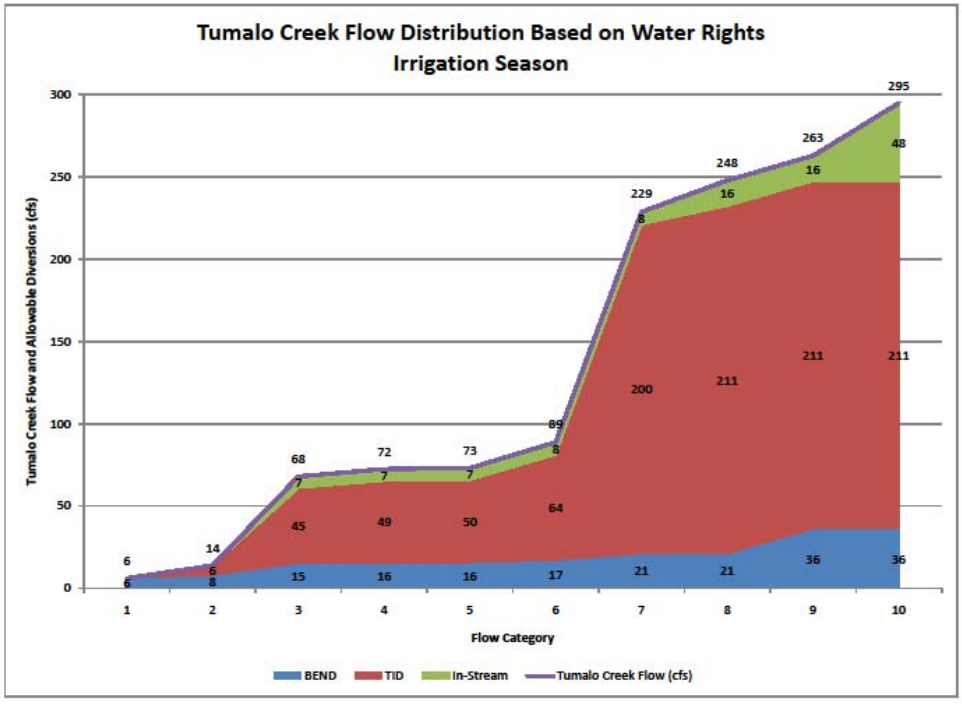

Exhibit 2-23 breaks down the water rights used by the City, TID, and instream water right by rate and priority date.

Exhibit 2-23
Tumalo Creek Water Rights Distribution by Priority Date

PRIORITY	MAX RIGHT IN CFS		
	BEND	TID	Instream
Unrestricted	6.000	0.000	0.000
August 5, 1900	2.000	5.645	0.178
September 1900	7.434	39.593	7.065
April 28, 1905	0.186	4.178	0.131
May 27, 1907	0.000	0.585	0.018
June 1, 1907	1.513	13.750	0.431
October 29, 1913	3.981	136.000	0.000
December 8 1961	0	11.3	7.800
December 12 1983	15.000	0.000	0.000
TOTAL	**36.114**	**211.051**	**15.623**

CFS = cubic feet per second

Flows in Tumalo Creek are influenced by snow melt. The flows typically peak during May and June, and are the lowest during September. Based on historic flow information provided by OWRD, the 80 percent exceedance flows (flows expected to be available 80 percent of the time, or 8 years out of 10) in Tumalo Creek above the Tumalo Feed Canal during September are calculated to be 52 cfs. At this flow, the City would be entitled to up to approximately 13 cfs under the watermaster's distribution schedule, which distributes water according to priority date among the City, TID, and the instream water rights. During July, which is typically the month during which the City has the highest maximum monthly demand, the 80 percent exceedance flows in Tumalo Creek are calculated to be 72 cfs. At this flow, the City would be entitled to up to approximately 15.6 cfs.

Under low-flow conditions in Tumalo Creek, the City's water use would be limited even further. Historic (7-day rolling average) stream flows of 42.5 cfs were observed in September 1945. Under such conditions, the City could expect to be limited to as little as 11.5 cfs (7.4 mgd).

B. Water Quality

Water quality also can affect the reliability of the City's surface water rights. Because the City currently does not filter its surface water, its use of surface water is vulnerable to turbidity events during spring melt and thunderstorms, and to other water quality problems that can result from forest fires or other causes. These events have the potential to degrade water quality to the point where some water quality standards are exceeded,

limiting the City's ability to use its surface water source. The City is currently in the process of addressing this problem by planning for installation of surface water treatment facilities.

C. Instream Water Rights

Three instream water rights have been established on Tumalo Creek. The two senior instream rights resulted from TID allocation of conserved water projects. The instream water right evidenced by Certificate 81332 has a priority date of December 8, 1961, and protects flows ranging from 1.7 cfs to 7.8 cfs from April through October at the Tumalo Feed Canal diversion. Because of its priority date, this instream right affects only the reliability of the City's Permit S-49823 and Certificate 85713, which have priority dates of December 12, 1983. The instream water right evidenced by Certificate 84351, however, has multiple priority dates ranging from August 5, 1900 to June 1, 1907. These priority dates are identical to several of the priority dates for the City's surface water rights. This right protects up to 2.0 cfs from April 15 to October 15 from the Tumalo Feed Canal diversion to Lake Billy Chinook. The third instream water right is evidenced by Certificate 73222 and has a priority date of October 11, 1990. This right protects flows year-round from the confluence of South Fork Tumalo Creek to the mouth. Because of its junior priority date, this instream rights does not affect the reliability of the City's water rights.

D. Over-all Reliability

Based on its priority, the City's water right Certificate 85526 is highly reliable. The certificate authorizes the use of up to 6 cfs (3.9 mgd) from Tumalo Creek year-round and is senior to all other water rights on the creek. As a result, this right is not subject to regulation when the streamflow falls below levels necessary to meet the needs of other existing water rights.

The City's water rights evidenced by Certificates 31411 and 31665 and Transfer B-112 have a number of limitations. First, water use under these rights, which originated as irrigation rights, is limited to the irrigation season (April 15 to October 15 for the certificates and April 1 to November 1 for Transfer B-112). Further, these rights have annual volume limitations: 821.7 acre-feet for Certificate 31411; 328.14 acre-feet for Certificate 31665; and 1923.5 acre-feet for Transfer B-112. Finally, as previously described, these rights are subject to regulation according to the watermaster's distribution schedule when streamflows are insufficient to meet the needs of existing water rights with the same or senior priority dates. In a typical year, regulation may occur in late summer (late July into September). As a result, the City is generally unable to divert water at the full rates authorized by these rights during the peak demand time of the year.

The City's Permit S-49823 and Certificate 85713, which resulted from partial perfection of this permit, have a priority date of December 12, 1983. Although these rights do not have a season of use or annual volume limitations, they are not reliable during the irrigation season because of their junior priority date. These rights will be the first to be regulated to meet the needs of senior consumptive water rights and instream water rights evidenced by Certificates 81332 and 84351. Because of the above-described limitations on the City's surface water rights, the City depends on its groundwater rights to help meet peak day demand during the summer and other times when sufficient surface water is not available to meet the City's water needs.

Groundwater

The City holds groundwater rights authorizing use of up to approximately 68.2 cfs (44.1 mgd) of groundwater. According to the City's 2010 Optimatics study (*February 2010 Design Data Summary Report*), the total in-service groundwater well capacity is 41.5 cfs (approximately 26.8 mgd). Consequently, the City's use of its maximum authorized rate is limited by the current capacity of its wells.

The City holds seven certificated groundwater rights: Certificates 85414, 68702, 85415, 85412, 85413, 85411, and 85559. They authorize the use of a combined total of up to 31.71 cfs. These water rights provide the City with a reliable groundwater supply.

In addition, the City holds Permit G-8565, which authorizes the use of up to 0.94 cfs, and Permit G-4435, which authorizes the use of up to 7.75 cfs of groundwater. The City has obtained extensions of time allowing it until October 1, 2020 to complete development of both permits. These permits are expected to provide the City with a reliable water supply.

The City also holds Permit G-11379, which authorizes the use of up to 3.84 cfs. The current development timeline for this permit was October 1, 1998. An extension application for this permit is pending. The reliability of this permit could be reduced as a result of conditions included through the extension process.

Finally, the City holds groundwater Permits G-16177 and G-16178, each of which have a priority date of August 27, 1992 and authorize the use of water at a rate of up to 12.0 cfs and a volume of up to 3,223 acre-feet annually. Permits G-16177 and G-16178 each have a total mitigation obligation of 1,611.5 credits. To date, 234 credits have been assigned to Permits G-16177 and G-16178, which allows the use of up to 468 acre-feet of groundwater. To increase the volume of water appropriated for beneficial use under these permits, the City will need to secure additional mitigation credits. The need to mitigate for the use of water under these permits limits their reliability to some extent. The second increment in the City's incremental mitigation plan calls for the City to obtain an additional 1,126 acre-feet of mitigation. Further, the administrative rules implementing the mitigation program are scheduled to "sunset" on January 2, 2014. The City will be able to maintain the mitigation established before that date, but it is unclear how, or if, mitigation can be established after the program sunsets.

Summary

The City's groundwater rights appear to be reasonably reliable at present. The City's ability to increase its appropriation of groundwater, however, will be limited by its ability to obtain additional mitigation credits and the need for additional groundwater production capacity. The City's surface water Certificate 85526 is the most senior water right on Tumalo Creek and, accordingly, is highly reliable. The City's remaining surface water rights typically are regulated according to the watermaster's distribution schedule and the City is not able to divert the maximum rate authorized by its water rights. Currently, the City's surface water supply is vulnerable to water quality concerns.

System Description

OAR 690-086-0140(8)

The City operates a public drinking water system (Public Water System Identification Number 4100100) that supplies water to its customers from both surface and groundwater sources. **Exhibit 2-24** provides a schematic of the City's existing distribution system. **Exhibit 2-25** provides a schematic of the City's existing surface water diversion and conveyance system in the Tumalo Creek watershed. The surface water supply originates from Tumalo Creek and Bridge Creek, approximately 12 miles west of the City at the Bridge Creek Intake Facility. Tumalo Creek water is conveyed through two parallel transfer pipes to a canal flowing to Bridge Creek. The water is diverted at the Bridge Creek Intake Facility and the raw water is conveyed approximately 11.5 miles via two parallel pipes to the City's Outback site. The water is disinfected at the Outback site with the addition of chlorine and then flows through the CT Basin and Outback Reservoir 1. Four finished water transmission pipes transmit water from the Outback site to the City's distribution system. The groundwater supply originates from 21 existing wells associated with water rights.

The City's distribution system is comprised of 423 miles of pipe, 15 storage reservoirs, and 6 pump stations as well as associated appurtenances such as control valves, pressure reducing valves, isolation valves, meters, and fire hydrants. The system has nine primary pressure zones serving customers ranging in elevation from approximately 3,430 to 4,160 feet above mean sea level. Summaries of the pipelines, reservoirs, wells, and pump stations are presented in **Exhibits 2-26, 2-27, 2-28, and 2-29**, respectively.

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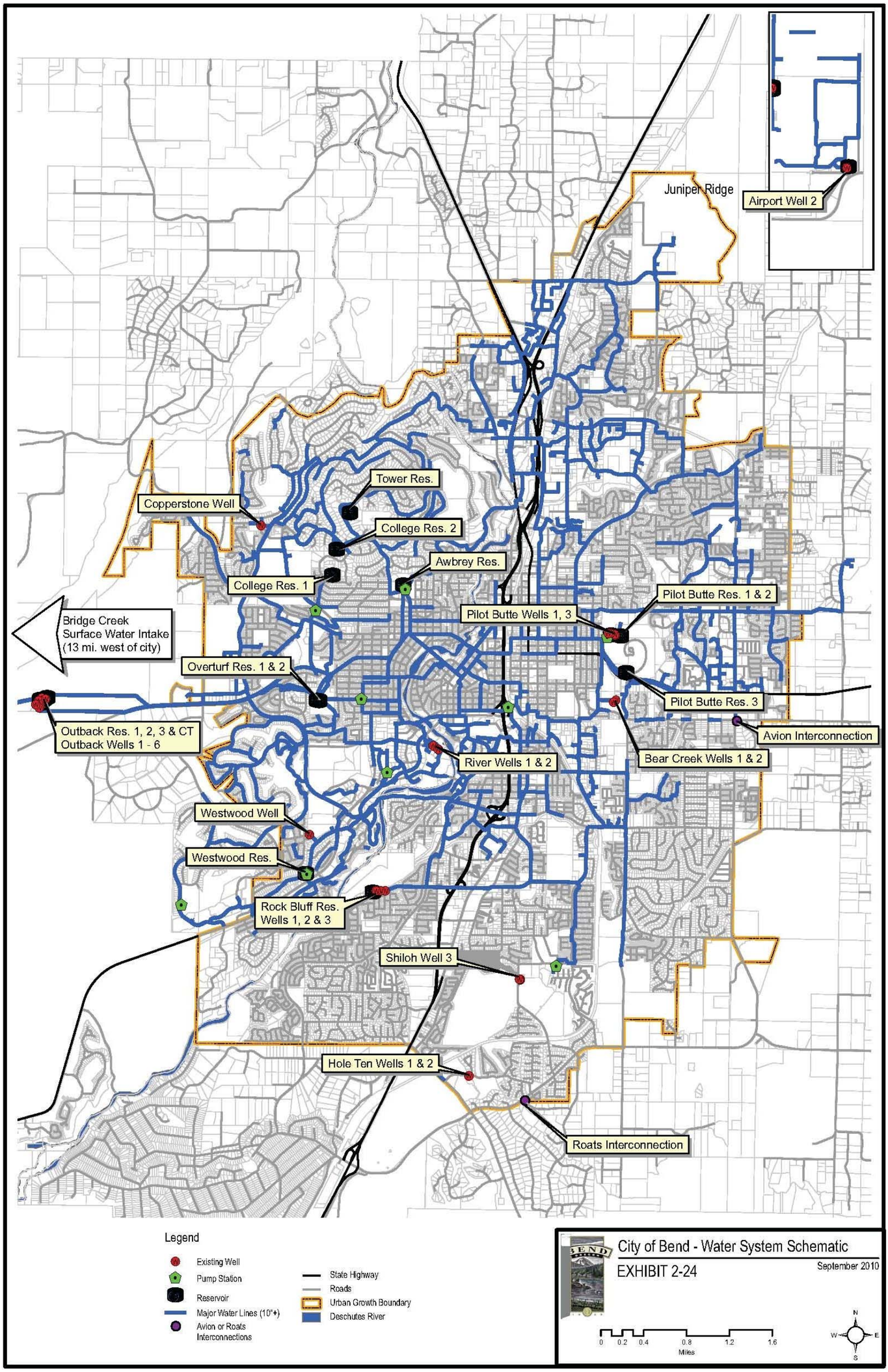
Juniper Ridge
Airport Well 2
Tower Res.
Copperstone Well
College Res. 2
Awbrey Res.
College Res. 1
Pilot Butte Res. 1 & 2
Pilot Butte Wells 1, 3
Bridge Creek
Surface Water Intake
(13 mi. west of city)
Overturf Res. 1 & 2
Pilot Butte Res. 3
Avion Interconnection
Outback Res. 1, 2, 3 & CT
Outback Wells 1 - 6
River Wells 1 & 2
Bear Creek Wells 1 & 2
Westwood Well
Westwood Res.
Rock Bluff Res.
Wells 1, 2 & 3
Shiloh Well 3
Hole Ten Wells 1 & 2
Roats Interconnection
Legend
Existing Well
Pump Station
Reservoir
Major Water Lines (10"+)
Avion or Roats Interconnections
State Highway
Roads
Urban Growth Boundary
Deschutes River
City of Bend - Water System Schematic
EXHIBIT 2-24
September 2010
0 0.2 0.4 0.8 1.2 1.6
Miles
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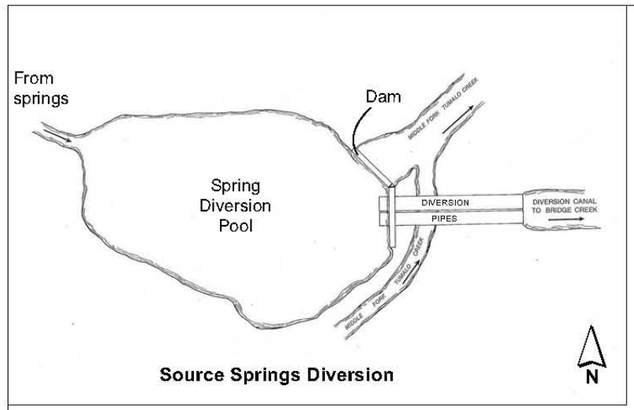

EXHIBIT 2-25

Bridge Creek/Tumalo Creek Schematic

City of Bend

LEGEND

- Existing Conduit
- Existing Bend City Limits
- Rivers, Creeks, and Streams

N

0 0.75 1.5 2.25

Miles

MAP NOTES:

Date: October 28, 2010

Data Sources: Deschutes Co. GIS, City of Bend, HDR

GSI Water Solutions, Inc.

File Path: P:\Portland\222 - HDR\005 - City of Bend\Project_GIS\Project_mxds\FigureX_BridgeCr_TumaloCr_Schematic.mxd, Date: October 28, 2010 3:42:27 PM

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EXHIBIT 2-26
Summary of Pipeline Sizes

Pipe Diameter (in)	Total Length (mi)	Percent of Total Pipeline
2	6	1.4%
4	5	1.1%
6	68	16.0%
8	188	44.3%
10	32	7.6%
12	79	18.7%
14	2	0.4%
16	34	8.1%
18	3	0.6%
24	3	0.7%
30	2	0.6%
36	3	0.6%
Total	**423**	**100%**

EXHIBIT 2-27
Summary of Reservoirs

Name	Volume (MG)	Elevation (ft)	Max Height (ft)
Awbrey	5.0	3,775	20.5
College 1	0.5	4,095.8	23.3
College 2	1.0	4,087.9	31.5
Outback 1	2.0	3,976	40.1
Outback 2	3.0	3,976	35.4
Outback 3	3.6	3,982	29.4
Outback Contact Basin	1.5	3,980	31
Overturf East	1.5	3,844	28
Overturf West	1.5	3,844	28
Pilot Butte 1	1.5	3,750	31.5
Pilot Butte 2	1.0	3,840.5	39.5
Pilot Butte 3	5.0	3,757.3	24.3
Rock Bluff 1	1.5	3,840	39
Tower Rock	1.0	4,213	31
Westwood	0.5	3,842	28

EXHIBIT 2-28
Summary of Existing Wells Associated with Water Rights for Bend's Municipal System

Well Description	Current Operational Capacity (gpm)
Bear Creek Well 1	1,050
Bear Creek Well 2	1,150
Copperstone Well	1,050
Hole Ten 1	800
Hole Ten 2	800
Outback Well 1	650
Outback Well 2	650
Outback Well 3	1,200
Outback Well 4	1,300
Outback Well 5	1,000
Outback Well 6	1,250
Pilot Butte Well 1	900
Pilot Butte Well 3	900
River Well 1	1,900
River Well 2	2,200
Shiloh Well 3	1,300
Airport Well 2[1]	285
Rock Bluff Well 1	750
Rock Bluff Well 2	700
Rock Bluff Well 3	900
Westwood Well	600

[1] Although Airport Well 2 is included in Certificate 85414 and this exhibit, this well is now used exclusively for fire flow events only as a backup to the wholesale water supply from Avion Water Company. The well does not provide water to the City's municipal water supply system.

EXHIBIT 2-29
Summary of Existing Pump Stations

Pump Description	Flow Rate* (gpm)	Total Capacity (gpm)	Firm Capacity (gpm)**
Awbrey Pump 1	950	3,490	2,150
Awbrey Pump 2	1,340		
Awbrey Pump 3	1,200		
College Pump 1	1,050	1,950	900
College Pump 2	900		
Murphy Road Pump 1	300	1,500	1,200
Murphy Road Pump 2	300		
Murphy Road Pump 3	300		
Murphy Road Pump 4	300		
Murphy Road Pump 5	300		
Scott Street Booster Pump 1	530	1,590	1,060
Scott Street Booster Pump 2	530		
Scott Street Booster Pump 3	530		
Tetherow Pump 1	150	3,650	2,950
Tetherow Pump 2	700		
Tetherow Pump 3	700		
Tetherow Pump 4	700		
Tetherow Pump 5	700		
Tetherow Pump 6	700		
Westwood Pump 1	390	2,390	1,490
Westwood Pump 2***	550		
Westwood Pump 3	900		
Westwood Pump 4	550		
* Flow rates indicate typical flow rates based on available SCADA data and model results if available to the nearest 50 gallons otherwise they are based on pump curves which may or may not be accurate.			
** Firm capacity is defined as the total installed capacity remaining with the largest pump at a facility out of service.			
*** Flow includes some recirculation through the Westwood Reservoir and pump station.			

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3. Municipal Water Conservation Element

This section addresses the requirements of OAR 690-086-0150(1) – (6).

This rule requires a progress report on conservation measures in the City's existing Plan, and a description of any additional conservation measures. The rule also requires descriptions of specific required conservation measures and benchmarks.

Current Conservation Measures

OAR 690-086-0150(1) and (3)

The City submitted a WMCP in 2004 that was approved by the OWRD on February 28, 2005 (Special Order Vol. 63, Pg. 279). **Exhibit 3-1** shows the required and additional conservation measured required by OAR 690-086-0150(4)-(6) that were included in the previously approved WMCP. Exhibit 3-1 also provides a progress report for each conservation measure.

EXHIBIT 3-1
City of Bend Previously Approved 5-year Benchmarks

Conservation Measure	2004 5-year Benchmark	Progress Report
System metering	• Fully meter Juniper Utility customers. • Install permanent metered fill stations and develop portable metered hydrant program.	• System is fully metered. • All hydrant use within the Bend service area requires metering. • Permanent water fill stations and portable "card lock," accessed units attached to fire hydrant ports for use by contractors, were installed for construction and water hauling use.
Meter testing and maintenance	• Periodic verification of all commercial meters exceeding 3-inch size. • Replace all small meters on a rolling 15- to 20-year cycle, or as needed based on billing data indicating inaccuracies. • Periodic verification of all source meters.	• The City is testing and rebuilding all meters that exceed 2 inches. Each of these meters is checked and calibrated every 2 years or checked through computer analysis of customer usage each month. • Small meters are replaced on a 15- to 20- year cycle, or as needed. • Several source meters have been replaced or upgraded.
Annual water audit	• Perform water audit accounting for uses and potential losses of water.	• The City approximated water produced vs. water sold in the recent Optimatics study (2010).

Conservation Measure	2004 5-year Benchmark	Progress Report
Leak detection and pipeline repair or replacement	• Periodic leak detection surveys—at least 10 miles of water mains. • Provide brochure to customers on using meters for leak detection; and distribute toilet tank leak detection dye tablets. • Perform flow audit calculations to verify inflows match outflow, for each Bridge Creek transmission line.	• Leak detection surveys have occurred for 45-50 miles of water mains since 2004. • The City distributed toilet leak tablets to more than 2,500 customers per year during the past few years. • A flow audit on Bridge Creek transmission lines occurred in 2009 and the City installed a new master meter at the end of the line.
Rate structure and billing practices	• Continue to expand and refine water use data collection and analysis, and expand breakdown of customer classes. • City Council to decide on whether/how to modify rate structure. • Continue to utilize customer bills to communicate water conservation messages and incentive programs.	• Customer classes and service coding remain to be reorganized and updated pending a software analysis and establishment of a process to replace antiquated utility billing software and related accounting modules. • At the beginning 2008, the City Council decided to reduce the quantity allowance for metered customers from 6 ccf to 4 ccf. Customers pay a volume-based rate for monthly water use exceeding the allowance. • The City continues to provide information to the public with bill stuffers and new e-mail alerts. WaterWise is mentioned in almost every bill stuffer (monthly) and alert with at least one key message about water efficiency and conservation.
Public education	• Upgrade the website to more fully convey the City's WaterWise Program • Continue sponsorship and participation in approximately 3 to 5 annual events attended by the public • School tours and speakers bureau • Print and radio advertising with focus on the irrigation season • Periodically review and upgrade printed handouts and related materials	• The City is updating its entire website, as well as the WaterWise website (www.waterwisetips.org). • The City sponsored or participated in at least 4 events per year. • Public speaking events requests vary each year. The City has sponsored or participated in school events and tours. • The City continues to provide information to the public using fact sheets, publications, its website, bill stuffers, City Edition Videos, and related outreach in partnership with the City Communications Manager. The "Signs You Might Be Wasting Water" campaign, included radio, print, and video messages. • The City continues to review and upgrade outreach materials.

Conservation Measure	2004 5-year Benchmark	Progress Report
	• Continue funding Customer Field Representative position, to provide customer outreach and enforce irrigation restrictions	• The City discontinued the Customer Field Representative position in 2005 due to budget and management decisions.
Technical and financial assistance programs	• Review even-odd day irrigation restrictions.	• Even-odd irrigation restrictions and time of day water restrictions are still in place awaiting optimization and engineering analysis to better understand potential peak day effects.
	• City-managed Greenwood Cemetery: install a Maxicom irrigation control system.	• The City completed a total retrofit of Greenwood and Pilot Butte Cemeteries. It installed smart irrigation controller timers, replaced sprinkler heads, and updated system piping.
	• City Landscape Retrofit Project: Budget for replacement of the landscape irrigation system at one site per year.	• The City Landscape Retrofit Project resulted in completion of at least 14 retrofits. A total of 66 City landscape sites are now retrofitted with smart irrigation controllers.
	• City Landscape sites: Complete maintenance and management plan.	• The City completed 136 maintenance and management plans for City landscape sites.
	• Bend-La Pine School District Irrigation Agreement: Partner with school districts to provide technical assistance to implement weather-based watering control at all new and existing sites.	• The City is providing technical assistance to the Bend-La Pine School District to fully meter sites, move off of irrigation district water, and upgrade and retrofit its irrigation systems.
	• Oregon State Parks Irrigation Agreement: At Pilot Butte State Park, City to provide technical assistance to implement weather-based watering control and operation of irrigation system.	• The Oregon State Parks Irrigation Agreement recently expired, but the State is still using the smart irrigation controller system at the park and incorporating native landscape design to decrease irrigation demand.
	• Water audits for selected large customers. Audits of turf fields will be completed as part of partnership described above.	• Water audits of large use customers were discontinued because of staffing, budget, coordination, and prioritization issues. However, the City still funded the Irrigation Association to provide training for Certified Landscape Irrigation Auditors and audited two schools in the Bend-La Pine School District.
	• Irrigation audits will also become part of standard contracts for City-funded irrigation improvement projects. Contracts will include performance standards and correction actions.	• Water auditing of City contracts decreased because of staffing, budget, coordination, and prioritization issues. The City's specifications and standards currently are being upgraded, and they still need to be included in City contracts.

Conservation Measure	2004 5-year Benchmark	Progress Report
	• Continue to expand water partnerships using weather-based irrigation technology including new large landscape partners.	• The City created WaterWise partnerships to install smart irrigation controllers with large use customers, but drastically scaled back the program in 2005 to address only a few cases.
Retrofit /replacement assistance	• Toilet retrofit program feasibility survey.	• The City decided not to conduct the survey because of staffing and budget limitations.
Water reuse, recycling, and non-potable water opportunities	• Perform a feasibility study of delivery of Level 4 effluent to irrigation canal system, with attendant exchange of water rights. Will be done in conjunction with ongoing discussion of water supply options between City and regional irrigation districts.	• The City completed a scope of work for the feasibility study in July 2010.

Additional Conservation Measures

OAR 690-086-0150(3)

In addition to the above-described conservation measures, the City has implemented the following conservation measures.

- The City's water utility and related "WaterWise" programs have become more integrated with other water-related utilities, such as stormwater and water reclamation.
- Significant efforts have been made to increase regional recognition that conservation is ongoing and important through participation in the Central Oregon Cities Organization, Bend 2030 process, and the Deschutes Water Alliance and its related work plans.
- The City maintains a display in the main lobby area at City Hall related to water use during the irrigation season.
- Since 2006, the City has distributed an estimated 1,500 shower timers to save water and energy.

Use and Reporting Program

OAR 690-086-0150(2)

The City has a water use measurement and reporting program that complies with the measurement standards in OAR Chapter 690, Division 85. The City's water use records can be found on the OWRD Web site (http://apps.wrd.state.or.us/apps/wr/wateruse.) The City currently measures surface water entering the distribution system at its Outback facility, and records surface water use daily. The City measures groundwater entering the distribution system at its pumps using meters and the SCADA system, and records groundwater use monthly.

Required Conservation Programs

OAR 690-086-0150(4)

OAR 690-086-0150(4) requires that all water suppliers establish 5-year benchmarks for implementing the following required conservation measures:

- Annual water audit
- System-wide metering
- Meter testing and maintenance
- Unit-based billing program
- Leak detection and repair (if system leakage exceeds 10 percent)
- Public education

5-year Benchmarks for Required Existing or Expanded Conservation Measures

The City currently addresses all of the required conservation measures. A summary of the 5-year benchmarks for required and additional conservation measures is provided below. During the next 5 years, the City plans to implement the following conservation measures required of all municipalities:

1. **Annual water audits.** A water audit involves an accounting of all water entering and leaving the water distribution system to identify system leakage, as well as authorized or unauthorized water uses. The City conducted basic water audits in the past, but these audits were difficult because the City was not fully metered, it did not closely track non-revenue water, and its customer classes and service codes needed to be revised because of inaccuracies. The City is working to remove these obstacles to its ability to conduct meaningful water audits. For example, the City does not have a system to track unbilled authorized consumption and its billing by customer class is unreliable. To address these issues, the City has established the following benchmarks.

   5-year Benchmarks:

   - The City will develop and implement an annual water audit program within the next 5 years. As part of this effort, the City will develop a method to calculate and track unbilled authorized consumption, which may include development of additional measurement methodology, to more accurately determine revenue and non-revenue water.
   - The City also will reorganize and update customer classes and service codes, as well as work toward equipping all water meters with automated metering infrastructure (AMI) meters.

2. **System-wide metering.** The City's water system became fully metered in December 2004. In addition, all hydrant use within the Bend service area now requires metering, resulting in better tracking of non-fire-related hydrant water use.

5-year Benchmark:

- The City will continue to install meters at all new service connections.

3. **Meter testing and maintenance.** The City is testing and rebuilding all meters that exceed 2 inches. Each of these meters is checked and calibrated every 2 years or checked through computer analysis of customer usage each month. The City tests meters if requested by customers, and if the tested meter is found to be 3 percent above or below the proper reading, the meter is repaired or replaced.

   Most residential meters are relatively new because of recent efforts to meter all residences. The City is also working to update its meters and expects to install 12,500 AMI meters by December 2010. Residential meters typically are replaced on a 15- to 20-year basis in accordance with AWWA guidelines. The City is eliminating the 5/8 x ¾ inch meter so that base meters for residential units will be ¾ inch.

   In 2008, the City installed a new master meter at the end of the Bridge Creek transmission line to measure the amount of surface water that it conveys into the distribution system.

   Source meters are verified when reservoirs are drained and filled each year, and their accuracy is verified using flow rates, pump curve data, and fill rates. Another verification of source meter accuracy occurs indirectly with daily chlorine testing throughout the system. Chlorine disinfection calculations rely on source meter accuracy; chlorination can stop or be reduced if a source meter fails or reads incorrectly. Inlet chlorine analyzer alarms are triggered by reduced chlorination levels, which notify on-call staff to address the problem. Several source meters have been replaced or upgraded within the past 5 years, but these new meters did not include the most advanced technology. However, the City now has a better understanding of the new technology available for metering, accordingly as certain wellfields are upgraded and refined, replacement meters will use improved technology and measure water use more accurately.

   5-year Benchmarks:

   - The City will continue to replace all existing meters with the new AMI standard within the next 5 years.
   - The City will use improved technology when upgrading or replacing existing source meters during the next 5 years.

4. **Unit-based billing program.** The City's customers are billed on the basis of the quantity of water use metered and a base fee. Customers pay a base fee according to meter size, which includes a quantity allowance of up to 4 ccf (ccf = 100 cubic feet). Customers also pay a per ccf unit rate for their monthly water use exceeding 4 ccf.

   In July 2008, the City Council decided to reduce the base quantity allowance for metered customers from 6 ccf to 4 ccf. At the same meeting, City staff also proposed a tiered rate structure, based on recommendations from the City's Water Rate Community Advisory

Committee. The City Council decided not to adopt this rate structure because of numerous concerns.

5-year Benchmarks:

- The City will continue to bill customers based, in part, on the quantity of water metered.
- The City intends to reduce the base quantity allowance from 4 ccf to zero ccf within the next 5 years.

5. **Leak detection and repair.** The City's average non-revenue water in 2008-2009 was 7 percent. Therefore, system leakage did not exceed 7 percent. Although the OWRD requires a leak detection and repair program only when leakage exceeds 10 percent, the City has a program to repair and replace water mains that leak.

   Most of the distribution system water mains are relatively new ductile iron pipe with low potential for excessive leakage that were put in place during the City's recent period of rapid growth. Since 2004, City staff and contractors have conducted leak detection surveys of 45 to 50 miles of water mains. During 2005-2006, contractors conducting leak detection surveys found no sizable leaks, but did discover and repair two meters with small leaks. City staff have conducted leak detection using in-house electronic equipment and tested for leaks during valve and hydrant maintenance activities. In February 2009, the City tested the Bridge Creek transmission line for leakage. The City also works cooperatively with customers when leaks are discovered on the customer side of the meter, typically in the older galvanized service lines.

   5-year Benchmarks:

   - The City will continue to conduct leak detection surveys to monitor changes in pipe integrity over time.
   - The City will continue to monitor customer consumption records for evidence of leaks and to work cooperatively with customers when leaks are discovered.
   - The City will install AMI data technology at all of its meters, which will record hourly consumption and radio transmit that information to the City. This "real-time" information will help the City find and address leaks in the system on the customer side of the meter.

6. **Public education.** The City provides water conservation information through numerous media and programs.

   Web site. The City as a whole has been working to upgrade its Web site and to continuously update the online information. The Water Division Web site includes information on billing, lawn and garden irrigation regulations, water service and billing, water meters, forms and documents related to water use, water system master plans, and links to the WaterWise Web site that addresses water conservation. The same upgrading and updating

work has been occurring with the City's WaterWise Web site (www.waterwisetips.org), which focuses on water conservation. The WaterWise Web site includes information on indoor water use, xeriscaping, rain gardens, and landscape watering. Publications have been continuously added to the Web sites and links have been changed regularly, added, or dropped as part of Web site management.

Public Outreach Through Events. The City sponsored or participated in at least four events per year during the last 5 years. Staffed events included: school events, various summer fairs, and outdoor events throughout the spring summer and fall. Water conservation materials provided to the public at these events have included publications, shower timers, and toilet leak detection tablets. Public speaking event requests vary each year. In addition, the City has sponsored or participated in school events and tours, but classroom visits and outreach at other events have been reduced because of staffing issues. Total contacts are estimated at 1,500 customers per year, based on literature taken by customers.

Furthermore, the City is increasing regional recognition that conservation is a priority by participating in the Central Oregon Cities Organization, Bend 2030 process, and the Deschutes Water Alliance.

Public Outreach Publications and Media. The City continues to provide information to the public using fact sheets, publications, its Web site, bill stuffers, City Edition Videos, and related outreach in partnership with the City Communications Manager. However, the creation of new or updated outreach materials has been significantly downscaled because of budget, staffing, and project priority changes.

The City continues to focus its water conservation outreach efforts on outdoor uses. The City maintains a display in the main lobby area at City Hall related to water use during the irrigation season. The City also developed an outdoor-oriented packet for its customers that includes WaterWise program handouts and rain gauges.

WaterWise Program. The City had to significantly reduce the WaterWise Program in 2005. This resulted in cuts in program staffing. The 2010 fiscal year budget re-established a new position at the program manager level to manage the City's water conservation benchmarks and to help develop, implement, and track related projects.

Customer Field Representative. The City discontinued the Customer Field Representative position in 2005 because of budget and management decisions. This position enforced the even-odd day watering restrictions and time-of-day watering restrictions, as well as addressed violations for wasting water. This work was based on drive-by monitoring and complaints to the City.

5-year Benchmarks:

- The City will continue to provide water efficiency and conservation outreach information to the public using print materials, radio, and video.
- The City will continue to update its Web site and outreach materials as needed.
- The City will explore the potential for development of cost-share partnerships between the City's three water utilities: water, stormwater, and wastewater. The

water and stormwater utilities have the potential to jointly hire an employee that can serve both programs.

Expanded Use under Extended Permits

OAR 690-086-0150(5)

This rule applies to municipal water suppliers that propose to expand or initiate diversion of water under an extended permit with a resource issue. The City has an extended permit (Permit G-8565), but this permit does not have resource issues as defined under 690-086-0140(5)(i). Furthermore, the City's average non-revenue water in 2008-2009 was 7 percent, and consequently, its system leakage is less than the 15 percent target specified by this rule. Nonetheless, the City has a leak detection and repair program under which City staff and contractors have conducted leak detection surveys of 45 to 50 miles of water mains since 2004.

Expanded Use under Extended Permits

OAR 690-086-0150(6)

Under OAR 690-086-0150(6), a water provider that serves a population greater than 7,500 must establish 5-year benchmarks for implementing a number of listed conservation measures or document that the measures are neither feasible nor appropriate. A summary of the 5-year benchmarks for additional conservation measures is provided in this section.

5-Year Benchmarks for Additional Conservation Measures

1. **Leak detection and pipeline repair and replacement.** The City's average non-revenue water in 2008-2009 was 7 percent. Therefore, system leakage does not exceed 10 percent. Although the OWRD only requires a leak detection and repair program to reduce leakage to 15 percent, or if feasible to 10 percent, the City has a program to repair and replace water mains that leak. The City's program is detailed in Leak Detection and Repair under OAR 690-086-0150(4).

   5-year Benchmark: As stated in Leak Detection and Repair under OAR 690-086-0150(4), the City will continue to conduct leak detection surveys to monitor changes in pipe integrity over time. The City will continue to monitor customer consumption records for evidence of leaks.

2. **Technical and financial assistance.** The City's technical and financial assistance program has had three components: large landscape program partnerships, large customer water audits, and indoor water use, which includes toilet tank leak detection and shower timers. Each of these previously used components and their related activities and accomplishments during the previous planning period is described in detail below.

City of Bend Large Landscape Program Partnerships

The City has developed partnerships with customers that have large landscapes requiring irrigation to help them improve their water conservation. The City helps these partners by providing technical and financial assistance in a variety of formats.

Bend Metro Parks & Recreation District

The City partnered with the Bend Metro Parks & Recreation District on various water conservation efforts. The City provided support to the district and included the district in its efforts to continue to move toward full use of new smart irrigation technologies.

Bend-La Pine School District

The City provided technical assistance to the Bend-La Pine School District to help fully upgrade and retrofit the district's irrigation systems after completion of a partial system audit. The City also provided technical assistance with development of new landscape standards and practices that the district recently adopted. When the district passed a recent bond levy, it used the new information to retrofit all major landscapes within the district.

Northwest Crossing Development, Palmer Homes

Like the Bend-La Pine School District, the Northwest Crossing development and Palmer Homes have adopted irrigation efficiency standards, such as the installation of smart irrigation controllers, use of pressure compensating irrigation sprinkler heads, and proper design and layout. These entities also advertised the use of smart irrigation controllers and efficient landscapes in their marketing materials. This included education efforts with preferred contractors and licensed landscapers doing work for their projects.

Oregon State Parks: Pilot Butte State Park

Through a now-expired agreement to deliver water to a large turf area at Pilot Butte State Park, the City was able to educate state staff and complete the first installation of a smart irrigation controller. The City provided Pilot Butte State Park with technical assistance and the required design standard information to implement use of the smart irrigation controller system at the park.

Water Audits for Large Use Customers

Water audits analyze a customer's water use and identify ways to make water use more efficient. The City funded the Irrigation Association to provide training for Certified Landscape Irrigation Auditors and more than 30 landscape professionals participated. The City invested approximately $5,000 on audit of sites at two schools in the Bend-La Pine School District. The district adopted some of the recommendations, including the use of smart irrigation controllers, proper nozzles, and head–to-head coverage. In addition, the schools now consider system zoning and pressure, have improved soil preparation, and use different turf varieties.

However, the City and water conservation studies[4] have found that audits generally were not cost-effective because customers are reluctant to pay for the audits or recommended improvements. As a result, the expense did not materialize into actual water savings.

Indoor Water Use
The Indoor Water Use component of the City's technical and financial assistance program has two components: toilet tank leak detection dye tablets and shower timers.

Toilet Tank Leak Detection Dye Tablets
To decrease leaks that occur on customer premises, the City distributes toilet tank leak detection dye tablets. The City has distributed toilet leak tablets to more than 2,500 customers per year during the past few years.

Shower Timers
Shower timers are small plastic devices that have a 5-minute sand-filled timer mounted to a rotating base. They are designed to adhere to the wall inside a shower using the attached suction cup and are rotated to start and restart the timer. The goal is to reduce both water and energy use by making shower users aware of their time in the shower. The City distributed more than 1,500 timers at schools and public events, and in the display booth set up in City Hall. Timers are also available by phone and e-mail request.

5-year Benchmarks:

- The City will continue efforts to develop and maintain WaterWise partnerships with large use customers during the next 5 years.
- The City will continue to distribute toilet tank leak detection dye tablets, shower timers, and related information to customers during the next 5 years.
- The City will conduct cost analysis aimed at the creation of cost-effective rebate programs within the next 5 years.
- The City will develop a pilot program for creation of water budgets for targeted customer groups, based on evapotranspiration data.
- The City will continue to fund and promote the use by all customers of the Agrimet weather station and its Web site, including a pilot project to place real time evapotranspiration data on the City Web site for use in creation of outdoor water use budgets.

3. Retrofit/replacement of inefficient fixtures.

City of Bend Landscapes
The City manages and maintains 136 landscape sites covering 439 acres, many of which require irrigation, and maintenance and management plans have been completed for all of

[4] HDR Technical Memorandum, *Conservation Program for Water Management and Conservation Plan,* December 8, 2010.

these landscape sites. Of these 136 landscape sites, 66 sites have been retrofitted with smart irrigation controllers. The City recently retrofitted 14 of those 66 sites as part of the City Landscape Retrofit Project. The sites of the 14 retrofits had their irrigation systems and/or landscapes altered or completely rebuilt to decrease maintenance and meet irrigation water savings goals, which often included reducing the area irrigated and xeriscaping. The City also completed a total retrofit of two cemeteries, including Greenwood and Pilot Butte Cemeteries. It replaced the original irrigation system with smart irrigation controlled timers and replacing sprinkler heads and related piping.

Toilet Efficiency

Many homes and business in the City were built before the federal high efficiency toilet (HET) standard of 1.6 gallons per flush was put in place in 1994. As a result, the need for a special program addressing toilet efficiency is reduced. The City considered conducting a retrofit program feasibility survey, but this did not occur because of staffing and budget limitations.

5-year Benchmarks:

- The City will continue to pursue greater irrigation efficiency of its existing City-owned landscapes and all new landscapes so they will meet the latest specification and standards, which includes the use of smart irrigation controller technology, xeriscaping principles, and other sustainable landscape practices.
- The City will study the cost effectiveness of implementing a toilet rebate replacement or incentive program based on the new voluntary federal HET standard.
- The City will become an EPA Water Sense Program partner and make related information available through its Web links, bill stuffers, and other methods.
- The City will provide a list of qualifying toilets that meet the various flush standards along with the creation of a toilet efficiency fact sheet.

4. **Water rate structure and billing schedule.** The City's water rate structure is related in part to its customers' water use. Customers pay a monthly base charge, which currently is based on meter size and includes a quantity allowance of 4 ccf before the quantity rate applies. Customers also pay a per unit rate for monthly water use exceeding 4 ccf.

   The City sends monthly bills to customers and supports water conservation by providing customers timely information about their water consumption. The City also includes water efficiency and conservation information with the bills. WaterWise is mentioned in almost every bill stuffer and content emphasizes at least one key message about water efficiency and conservation.

   5-year Benchmarks:

   - As stated in Unit-based Billing Program under OAR 690-086-0150(4), the City will continue to bill customers based, in part, on the quantity of water metered.
   - The City intends to reduce the base quantity allowance from 4 ccf to zero ccf within the next 5 years.

- The City also will continue to send monthly bills and to provide water efficiency and conservation information to the public with periodic bill stuffers and electronic messaging with related conservation information and links to the City's conservation Web site.

5. **Reuse, recycling, and non-potable water opportunities.** The Resort at Pronghorn, located down-gradient of the wastewater treatment plant, obtains recycled water from the City. Level 4 treated effluent from the wastewater treatment plant enters infiltration ponds and a spray irrigation system that waters two golf courses during the irrigation season. The City recently renewed its Water Pollution Control Facility permit with the DEQ that allows recycling of that City water. Pronghorn is not within the City's existing drinking water service area.

   In July 2010, the City completed a scope of work for a full-scale feasibility study that will investigate increasing the use of recycled water both inside and outside the City's service area.

   5-year Benchmark: During the next 5 years, the City will continue to look for opportunities to increase the use of recycled water.

6. **Other measures.**

   Irrigation Restrictions
   The City currently has even-odd irrigation restrictions and time of day water restrictions in place. Even house numbers water on even-numbered days and odd house numbers water on odd-numbered days. Irrigation hours are 5 a.m. to 10 a.m. and 4 p.m. to 10 p.m. No watering is allowed on the 31st day of the month. For a period of time, these policies were waived if someone installed an approved smart irrigation controller. These policies were put in place many years ago when the City used a flat rate water billing system and were designed to keep reservoirs from being drained by unlimited water use.

   Code changes are now under consideration in the next fiscal year and may include a recommendation to move away from the even-odd day irrigation restriction system, which is not currently enforced. The City would like to move exclusively to a time-of-day restriction that aims to provide an enforceable program that incentivizes smart water use, as well as off-peak irrigation time periods, to prevent or reduce the need for costly engineering improvements necessary to meet maximum demands in the morning and evening peaking periods.

   5-year Benchmark: Within the next 5 years, the City will evaluate adoption of modified irrigation restrictions based on time of day (hours that promote efficient water use).

   City Standards and Specifications
   The City recognizes that conservation and water efficiency standards need to be included in City contracts with landscaping and irrigation work, so the City currently is upgrading its related standards and specifications. The City also created a landscape standard, which is explained in an article in Water Efficiency Magazine called "There is no Silver Bullet" (available on the City's Web site).

5-year Benchmark: The City will continue to implement current landscape standards through related approval processes during the next 5 years.

Other WaterWise Partnerships

The City has also partnered on water conservation-related efforts with: Oregon Department of Energy, Local Area Water Network, Palmer Homes, Earth Advantage, High Desert Green Industry Conference, Upper Deschutes Watershed Council, AWWA, Building Green Council and 3E Strategies, Central Oregon Builders Association, ReSource, Rebuild America, Oregon State University (OSU) Extension, Central Oregon Community College (COCC), Bend Garbage and Deschutes County, Oregon Landscape Contractors Association, irrigation districts, Central Oregon Cities Organization, Deschutes Coordination Group, Deschutes River Conservancy, Oregon Association of Water Utilities, and Oregon Water Utility Council. While the City has created successful partnerships, the City's WaterWise program was drastically scaled back in 2005 to address only a few cases, such that an emphasis on building partnerships needs to be re-incorporated into the WaterWise campaign efforts.

5-year Benchmark: The City will continue to seek appropriate partnership opportunities based on current project priorities, budget, and staff time.

Collaboration Among the City's Water Utility Programs

The City has three water-related utilities (water utility, water reclamation, and stormwater programs) and several areas of regulatory responsibilities that are related to more efficient use of water and the benefits of conservation. The City has implemented a communication effort encompassing all of these areas and has promoted it as "WaterWise" programs. Collaborations include exploring how to combine funds from different programs to hire staff and present information on stormwater, safe drinking water, water conservation, and industrial pretreatment programs within the homepage of the City's WaterWise Web site and related efforts.

5-year Benchmark: The City will continue to look for coordination opportunities to more efficiently communicate and implement related programs.

Hydrant Meter Program for Temporary and Permanent Water Uses

Use of drinking water through typical unmetered locations, such as fire hydrants, for construction and other public uses, now comes under the authority of the Hydrant Meter Program. Use of hydrants now requires a permit and use of a temporary metered fill station that also includes backflow protection. All water is measured and billed. In addition, the City has installed one permanent fill station that has the added feature of a card-lock billing system to address the use of multiple users at one location. Contractors have the option of bringing their own water trucks to the fill stations to fill up with water as needed, or using the hydrant meter boxes.

5-year Benchmark: The City will continue to implement the hydrant meter program and related fill station.

Review and Implementation of Water Conservation Analysis Project

In December 2010, HDR Engineering (HDR) completed a water conservation analysis project for the City to examine opportunities to enhance its existing water conservation program. HDR is a national architectural, engineering, and consulting firm with strong expertise in water utility planning, including water conservation planning, and has performed water conservation work for numerous Pacific Northwest utilities. HDR used its proprietary Water Conservation Measure Analysis Model to analyze conservation opportunities for the City. The model is an Excel-based tool that estimates water savings and costs for various pre-loaded conservation measures based on specific information about the municipality. HDR's Water Conservation Opportunities memorandum, which is provided in **Appendix B**, presents more detailed information about HDR's modeling process and results.

HDR compiled demographic information for the City's service area, applied assumptions for customer participation rates for each conservation measure, calculated the savings achieved by shifting to more efficient hardware or behavior, and calculated the direct costs for those shifts. HDR established customer participation rates using professional judgment based on its experience with other communities.

HDR developed four "conservation packages." These packages included: (1) a conservation potential assessment of 37 of the 49 analyzed measures that were not mutually exclusive, which included both behavioral and "hardware" based measures; (2) hardware measures for both indoor and outdoor water conservation; (3) hardware measures for outdoor water conservation only; and (4) hardware measures for indoor conservation only.

5-year Benchmark: During the next 5 years, the City will work with the City Council and the City's Engineering Department to develop capital improvement and conservation budgets to identify which conservation measures to fund and implement.

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4. Municipal Water Curtailment Element

This section satisfies the requirements of OAR 690-086-0160.

This rule requires a description of past supply deficiencies and current capacity limitation. It also requires inclusion of stages of alert and the associated triggers and curtailment actions for each stage.

Introduction

Curtailment planning is the development of proactive measures to reduce demand during supply shortages as the result of prolonged drought or system failure from unanticipated events including catastrophic events (flooding, landslides, earthquakes, and contamination), mechanical or electrical equipment failure, or events not under control of the City (for example, localized or area-wide power outages and intentional malevolent acts).

History of System Curtailment Episodes

OAR 690-086-0160(1)

Within the last decade, the City has not experienced water shortages resulting from system failure related to catastrophic events or mechanical or electric equipment failure. The City, however, routinely has experienced a reduction in its access to surface water during the peak-demand season because of reduced stream flows. As described in Section 2, most of the City's surface water rights share priority dates with water rights held by TID and instream water rights established by TID in the allocation of conserved water process, and OWRD regulates these rights according to its distribution schedule when flows in the Tumalo Creek Basin are insufficient to meet all of the existing water demand. In these circumstances, the City has increased its reliance on its groundwater sources. Consequently, the City has not been required to implement curtailment measures.

The City is currently able to use its groundwater rights as needed to meet its water demands. Future groundwater use may be limited by system (well) capacities and groundwater restrictions in the Deschutes Study Area.

The City also has experienced occasional short-duration interruptions to normal service delivery as a result of pipe or water main breaking, lightening striking wells, and other mechanical or electrical malfunctions of its water supply and delivery system. In these events, the City has relied on its unaffected water sources, either surface water or groundwater, during the service interruption.

Curtailment Stages and Event Triggers

OAR 690-086-0160(2) and (3)

Depending on the nature of the event that results in a water supply shortage and considering predecessor and successor conditions, this curtailment plan for the City is designed to be initiated and implemented in progressive stages.

Events causing this curtailment plan to be activated would include, but not be limited to, the following:

- Abnormal weather conditions preceding the peak summer supply season that present a high likelihood for below normal summer streamflows in Bridge and Tumalo Creeks
- Declaration of a drought for Deschutes County by the Governor pursuant to ORS 536.720
- Catastrophic natural disaster that damages individual critical facilities or extensive portions of the City's distribution system
- Mechanical or electrical malfunction of critical pumping facilities at the City's surface water intake or wells
- Interruption of local utility electrical service
- Terrorist act perpetrated on any of the City's critical facilities or storage reservoirs, or contamination of source water

The current major risk to the City's surface water supply is fire within the Tumalo Creek watershed. A fire would elevate turbidity levels in the creek above applicable water quality standards, and preclude the City from using its surface water supply until the water quality improved. The City currently is working to mitigate this risk by developing a water treatment plant which, depending on the design of the system, may enable the City to continue to use surface water during high-turbidity events.

The City's curtailment plan has four distinct stages, each of which is triggered by one or more of the events listed above and is grouped as shown in **Exhibit 4-1**.

EXHIBIT 4-1
Curtailment Stages 1 through 4

Curtailment Stages	Initiating Conditions
Stage 1: **Water Shortage Alert**	• Forecasts of below normal summer streamflows • Forecasts of above normal temperatures • Minor damage to transmission mains or distribution system • Minor mechanical or electrical malfunction at one to three wells
Stage 2: **Mild Water Shortage** **Demand Reduction Target:** **10 percent of MDD**	• Supply capacity is 91 to 100 percent of demand • Mechanical or electrical malfunction at four to seven wells • Extended periods of above normal temperatures or below normal streamflows • Declaration of drought by Governor pursuant to ORS 536.720 • Extensive damage to water supply infrastructure
Stage 3: **Serious Water Shortage** **Demand Reduction Target:** **20 percent of MDD**	• Supply capacity is 81 to 90 percent of demand • Mechanical or electrical malfunction at 8 to 12 wells • Imminent terrorist threat against supply system • Multiple failures to transmission mains or distribution system
Stage 4: **Severe Water Shortage** **Demand Reduction Target:** **40 percent of MDD**	• Supply capacity is less than 81 percent of demand • Loss of utility electrical service to wells • Fire in Bridge Creek watershed or near wells • Contamination of source of supply • Extensive damage to transmission, pumping, or treatment processes caused by natural disaster or any other event • Intentional acts or fire, contamination of source, or any other event resulting in an immediate, sustained deprivation of water supply

Authority

The City Manager is authorized to determine the need for water curtailment and to declare a water curtailment stage. Plan provisions will remain in effect until the City Manager terminates the curtailment requirement. Actions may be applied to the entire system, or only to those water use sectors, or in those geographic areas that are directly affected by any water supply shortage. The City Manager is responsible for execution of the curtailment plan provisions after a water curtailment stage is declared.

Curtailment Plan Implementation and Enforcement

OAR 690-086-0160(4)

Stage 1: Water Shortage Alert

Triggers for Stage 1 include minor damage to the City's distribution system, and minor malfunctions at one to three wells. Stage 1 will activate a program to inform customers of the potential for drought or the need for temporary reductions in consumption because of reasons other than drought. The City Manager will issue a general request for voluntary reductions in water use by all water users. The request will include a summary of the current water situation, the reasons for the requested reductions, and a warning that mandatory cutbacks will be required if voluntary measures do not sufficiently reduce water usage. Stage 1 public information program elements would include the following:

- Contact local media outlets and request that the public be informed about the potential for summer water shortages or temporary interruptions to normal service delivery.
- Post prepared public service announcements, including conservation tips, on the City's Web page.
- Provide notices on water bills or through utility bill inserts.

Stage 2: Mild Water Shortage

Triggers for Stage 2 include supply capacity of 91 to 100 percent of demand, and extensive damage to water supply infrastructure. Stage 2 status will activate a program to reduce nonessential water use. In addition to Stage 1 voluntary measures, Stage 2 elements would include the following:

- Prohibit filling swimming pools and ponds.
- Prohibit washing sidewalks, driveways, and patios.
- Prohibit pressure washing roofs, decks, or home siding unless such uses were contracted before implementation of this curtailment action and are demonstrated to the City Manager's satisfaction to be necessary for painting, repair, remodeling, or reconstruction.
- Prohibit using water for dust control unless it is shown to the City Manager's satisfaction that water used for dust control is needed to meet public health or safety requirements including, but not limited to, abatement of fire or sanitation hazards, or to meet air quality standards mandated by DEQ.
- Encourage customers to refrain from washing cars except at commercial washing establishments that recycle or reuse water.

Stage 3: Moderate Water Shortage

Triggers for Stage 3 include supply capacity of 81 to 90 percent of demand, and multiple failures in the joints of the City's transmission mains. The voluntary measures in Stage 2 become mandatory in Stage 3. In addition to Stage 2 measures, Stage 3 elements would include the following:

- Prohibit washing vehicles except by commercial establishments or fleet washing facilities that recycle the water in their washing process, except where health, safety, and welfare of the public are contingent on frequent vehicle cleaning, such as for garbage trucks, and vehicles that transport food, or otherwise required by law.
- Prohibit water line testing and flushing in connection with construction projects, except for critical water facilities.

Stage 4: Severe Water Shortage

Triggers for Stage 4 include supply capacity of less than 81 percent of demand, and extensive damage to transmission, pumping or treatment processes. In addition to the elements included in Stage 3, the City Manager may impose any other restrictions on water use or activities that may require the need for water supplies. Under Stage 4, all water use, except uses necessary for human consumption and sanitation needs, may be prohibited if necessary.

If the event renders water in the system unsafe to drink, the City will activate appropriate response protocols, notify the local news media to solicit their assistance in notifying customers, and contact law enforcement officials, as appropriate.

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5. Municipal Water Supply Element

This section satisfies the requirements of OAR 690-086-0170.

This rule requires descriptions of the City's current and future service area and population projections, demand projections for 10 and 20 years, and the schedule for when the City expects to fully exercise its water rights. The rule also requires comparison of the City's projected water needs and the available sources of supply, an analysis of alternative sources of water, and a description of required mitigation actions.

Delineation of Service Areas

OAR 690-086-0170(1)

The City's existing water system serves the current UGB and the Tetherow Development, excluding those areas served by Avion and Roats. The areas currently served within the UGB and Tetherow Development, including 294 acres in the Juniper Ridge planned area, were used in calculating the 10-year demand projection for this Plan. The same area, in addition to the remaining 221 acres of the Juniper Ridge planned area, was used to develop the 20-year demand projection for this Plan. The current and future service areas are shown in **Exhibit 5-1.**

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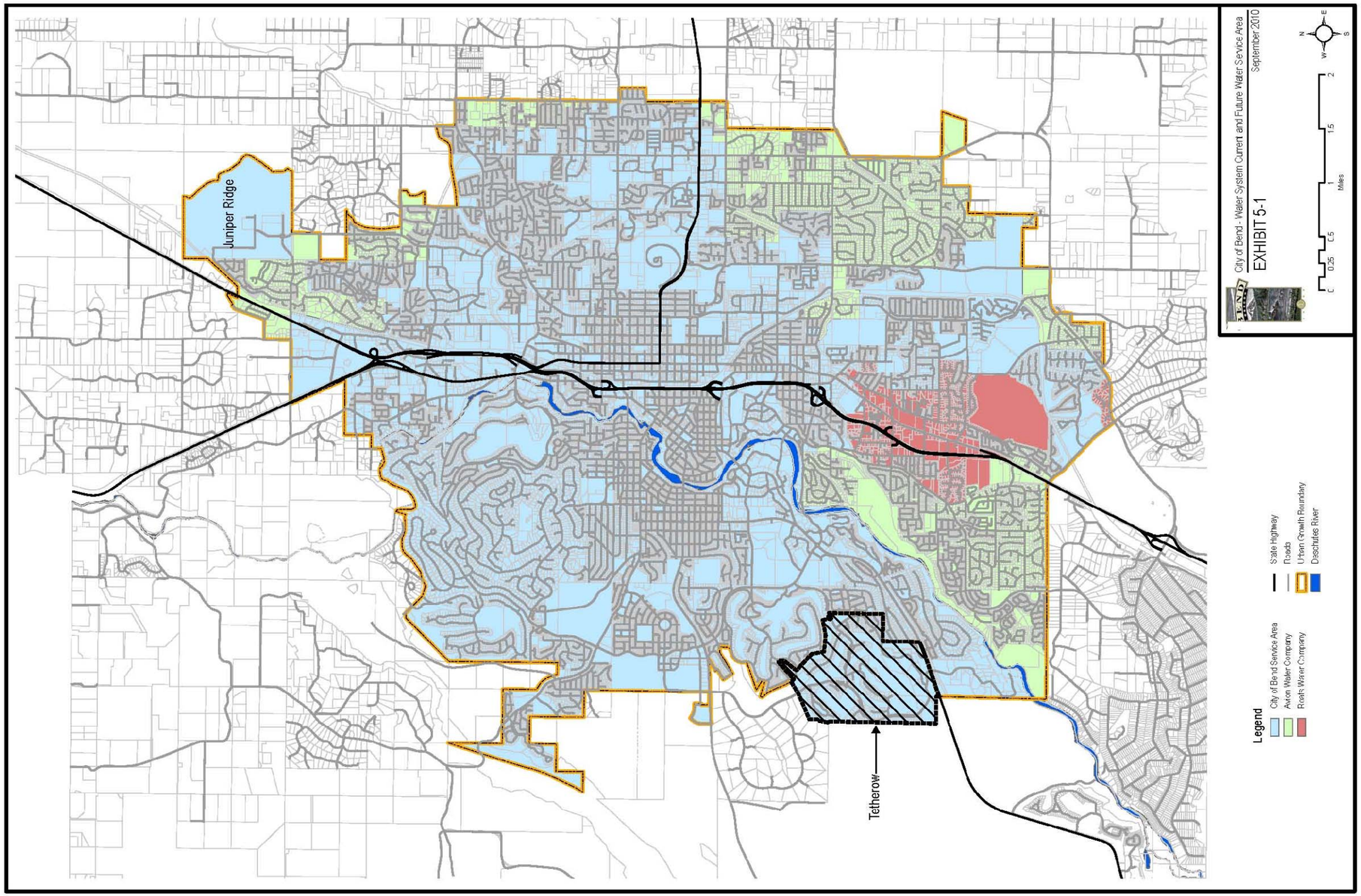
Juniper Ridge
Tetherow
City of Bend - Water System Current and Future Water Service Area
September 2010
EXHIBIT 5-1
N
E
W
S
0
0.25
0.5
1
1.5
2
Miles
Legend
City of Bend Service Area
Avion Water Company
Roats Water Company
State Highway
Roads
Urban Growth Boundary
Deschutes River

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Population Projections

OAR 690-086-0170(1)

The 2004 to 2009 population for the City's water service area was estimated using the method described in Section 2. Future populations (2010 to 2030) within the City's service area were developed by increasing the service area population according to the annual growth rate for the City population as a whole. The annual growth rates for the City were those the City adopted from the Office of Economic Analysis' (OEA) April 2004 average annual growth rates for Deschutes County for 2000 to 2040. OEA bases its population forecast on demographic data, and assumptions about projected age-specific birth and age and sex-specific death rates for the existing population and in-migrants to the state and counties. (These growth rates were included in the *Deschutes County Coordinated Population Forecast 2000-2025*.)

Exhibit 5-2 summarizes the projected populations for 2020 and 2030**.**

EXHIBIT 5-2
Population Projections for the City of Bend and Bend Water Service Area

	2020	2030
City of Bend	104,501	123,567
Bend Water Service Area	79,748	94,298

These population projections were not used to develop the City's water demand forecasts. As described in detail below, demand forecasts were developed on the basis of projected land use development.

Demand Forecast

OAR 690-086-0170(3)

Future growth and water demand projections were calculated for the 2020 and 2030 planning horizons using growth rates from historical average water production records, as described in more detail below.

The specific spatial and water use data sets used in the development of demand projections for the City include:

- The Buildable Lands Inventory (BLI) database
- Planning and Land Use Information for the Tetherow Development
- Planning and Land Use Information for the Juniper Ridge Development
- 2008 water billing records for the City
- 1998-2008 production data for the City
- 2004 Deschutes County Coordinated Population Forecast

The City's BLI database indicates the total potential for, and spatial distribution of, residential growth based on low, medium, and high development densities; however, it does not indicate when it will occur. It also does not provide information on the density or rate of development for non-residential lands.

Build-out projections were generated for sizing ultimate water system infrastructure requirements as part of the City's Water System Master Plan Update Optimization Study; however, the date at which build-out occurs was not identified. Ten-year projections also were created as part of that project to assist in prioritizing the near-term improvements. To initially generate the 10-year projections, the following assumptions were made:

- Growth would be limited to the current urban growth boundary and Tetherow Development between 2010 and 2020.
- There would be a linear growth rate between 2010 and 2020.
- The BLI data would be used to spatially allocate demand.
- The ratio of residential to non-residential demand would remain constant through 2020.

The annual historic growth rate between 1998 and 2008 was calculated as shown in **Exhibit 5-3**, which illustrates that the City's growth in water demand has been highly variable during the past 10 years. At times, the City experienced rapid growth while at other times, a decline in water demand occurred. Overall, an average growth rate between 1998 and 2008 of more than 4 percent was measured.

EXHIBIT 5-3
Historical ADD and Percent Growth

Year	Historical ADD (mgd)	Annual % Growth
1998	8.6	
1999	10.2	18.60%
2000	10.7	4.90%
2001	10.6	-0.93%
2002	11.5	8.49%
2003	11.4	-0.87%
2004	11.5	0.88%
2005	11.3	-1.74%
2006	11.55	2.21%
2007	12.7	9.96%
2008	12.84	1.10%
Average		**4.3%**

ADD = average day demand

One of the primary challenges that the City faces in projecting future water demand is the lack of a precise service area population. An overall City population number is available; however, as previously described, the City does not serve water to the entire population. Therefore a per capita water usage number is difficult to calculate with certainty.

To calculate future demands using dwelling units identified in the BLI data, a gallons per capita per day per capita (gpcd) number was required. For planning purposes, the City assumes 2.4 people per household. A current per capita water usage was estimated by multiplying the number of active residential meters within the City's service area by 2.4 people per residential household and dividing by current water use for those meters. The per capita usage was calculated to be 172 gpcd, which includes a 10 percent peaking factor for non-revenue water (based on non-revenue water for 2008).

As described in the assumptions above, future non-residential water demand growth also was required. The basic assumption was made that the ratio of residential to non-residential water usage would remain constant through 2020. In 2008, non-residential demand accounted for 4.6 mgd of the 12.84 mgd overall demand in the City's service area, or 36 percent, based on customer billing records. Future non-residential water use rates were calculated at 4,000 gallons per acre per day, by using the existing calculated future non-residential demand divided by the non-residential acres to be developed. The one exception to this is the Juniper Ridge Development, where higher per acre water usage rates (4,500 gallons per acre per day) were used to accommodate the potential opportunity for water-intensive industry to develop there. While it is difficult to predict the water needs of future customers, the City has a duty to serve water within its service area. As a result, the City must be prepared to serve water to large industrial users with high water use needs should such water users locate within its service area.

To calculate the 2020 projections, the historical water demand growth rate of 4.3 percent was used as an overall 10-year target. To identify where the growth in the City is going to occur, the City's BLI data was used. The key was to identify a BLI-based development density that provided a 2020 demand similar to the 4.3 percent system-wide growth rate. For 2020 calculations, 2.4 people times 172 gpcd was multiplied by the number of parcels within the current UGB at medium density. Then the demand for the non-residential areas along with Tetherow Development and Phase 1 of the Juniper Ridge Development were included. The midpoint of demand between the median density developments value and existing demand yielded a spatial distribution of 2020 demand within the service area that was close to the total water demand target based on historical growth. The resulting demand is 21.7 mgd, compared to the 21.3 mgd generated by using a 4.3 percent per year growth rate. This yields a yearly increase in ADD of 0.74 mgd between 2010 and 2020.

Through discussions with City staff, it was determined that projecting the 4.3 percent per year growth through 2030 would generate demand numbers that were too aggressive. Lacking other information on when growth would occur, the 0.74 mgd per year growth through 2030 was determined to be the best available projection. This yields a 2030 ADD of 29.1 mgd, or 3.1 percent growth per year between 2010 and 2030.

Demand Projection Summary

Historical MDD factors also were developed for use in projecting future peak demands. The City's water system is designed so that the sources of supply equal or exceed MDD. Demands in excess of MDD are provided by storage tanks. Factors of 2.25 (MDD/ADD) for MDD were determined from historical data. The 2010, 2020, and 2030 ADD values and peaking factors were used to determine the future MDD projections.

See **Exhibits 5-4 and 5-5** for future ADD and MDD.

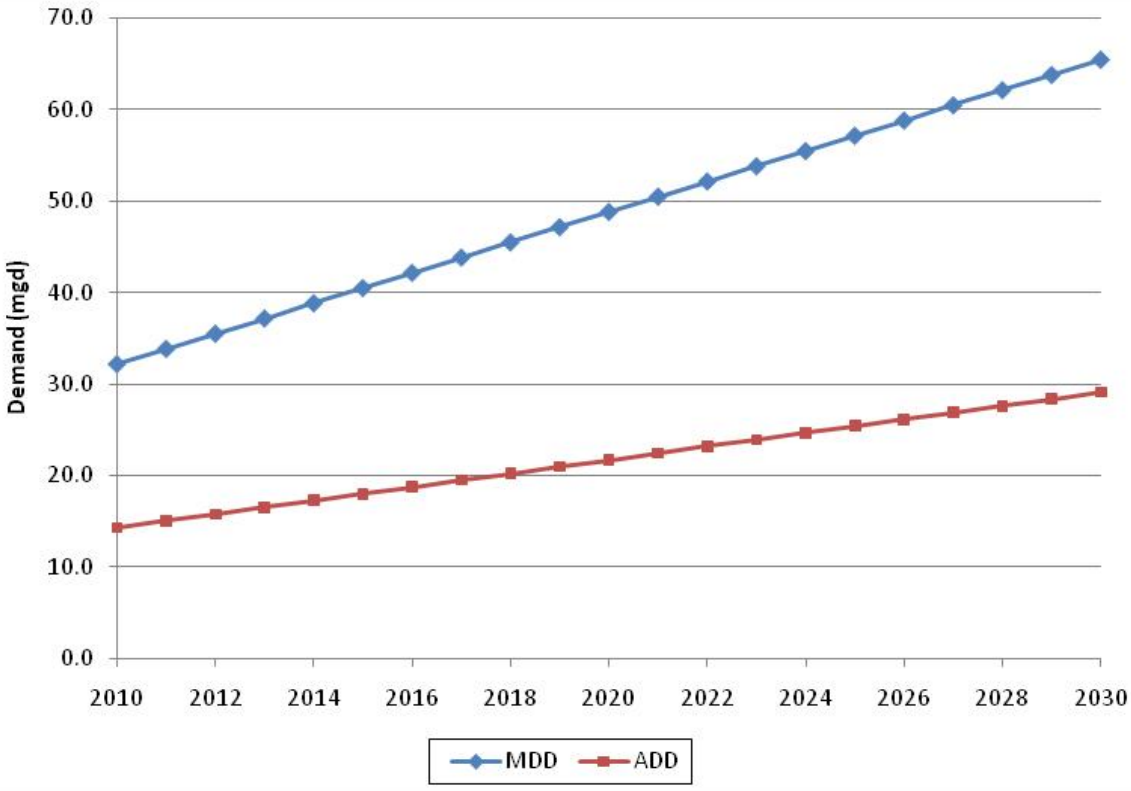
EXHIBIT 5-4
Future Demands for the City's Water Service Area (mgd)

Year	ADD	MDD
2010	14.3	32.2[1]
2020	21.7	48.8
2030	29.1	65.5

[1] The City's actual 2010 MDD was approximately 20 percent less than the projected MDD for that year. The reduced demand compared to the projections is likely due to the cool, wet weather during the spring and summer of 2010, the City's recent efforts to optimize system operations, as well as less demand due to the current economic downturn.

Using this annual growth rate of 0.74 mgd per year, the ADD values for each year from 2010 through 2030 were calculated and the peaking factors for MDD were used to obtain the values in **Exhibit 5-5.**

EXHIBIT 5-5
2010 to 2030 Projected Demands



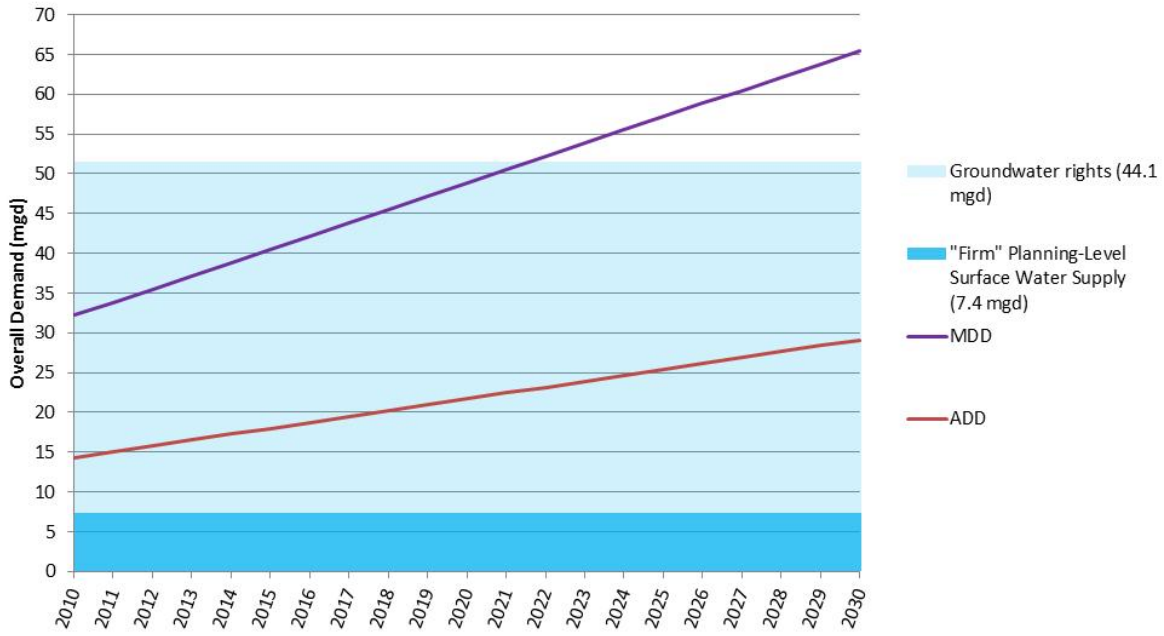
Schedule to Exercise Permits and Comparison of Projected Need to Available Sources

OAR 690-086-0170(2) and (4)

The City holds surface water rights that authorize the use of up to 36.1 cfs (23.3 mgd). As described in Section 2, the amount of surface water available to the City is directly related to the amount of flow in Tumalo Creek and the proportional distribution of that water between TID, instream water rights established as part of TID's conserved water projects, and the City. For the purposes of planning for the amount of surface water available to meet peak needs, the City evaluated historic stream flows in Tumalo Creek to establish a likely low-flow scenario. Under that evaluation it was determined that a stream flow of 42.5 cfs and a proportional share for the City of 11.5 cfs (7.4 mgd) should be the "firm" planning-level peak demand surface water supply. The City also holds groundwater rights authorizing use of 68.2 cfs (44.1 mgd). The City's surface water and groundwater rights combined provide a planning-level reliable water supply of 79.7 cfs (51.5 mgd).

Exhibit 5-6 shows the City's "firm" surface water and groundwater rights superimposed on the City's projected ADD and MDD. As shown in Exhibit 5-6, the City may need up to approximately 65.5 mgd to meet its MDD by 2030. The water supply provided by the City's existing water rights, however, currently can be relied on in a low-streamflow, high demand scenario to provide approximately 51.8 mgd of supply. Consequently, the City will need to fully exercise its existing water rights and may need additional water supply to meet its projected 2030 MDD.

EXHIBIT 5-6
Projected Demands and Reliable Supply under the City's Existing Water Rights



Based on projected water demand growth, the City anticipates fully exercising all of its existing surface water and groundwater rights during the next 20-year planning period.

As part of its effort to meet projected demand, the City will need access to the full amount of its Permit G-8565. Therefore, the City is requesting access to the 0.72 cfs of "green light water" under "extended permit" G-8565.

Alternative Sources

OAR 690-086-170(5)

OAR 690-086-0170(5) requires an analysis of alternative sources of water if any expansion or initial diversion of water allocated under existing permits is necessary to meet future water demand. During the next 20-year planning period, the City intends to expand or initiate diversion of water under existing Permits G-8565, G-11379, G-16177, and G-16178 to meet future water demands described above. (Groundwater permit G-4435 is fully developed and will be certificated in the near future.)

During the past several years, the City has spent significant resources evaluating its water supply needs and supply alternatives. Through a series of extensive water supply planning efforts, associated with the City's Watershed Source Water Improvements project, the City has affirmed its commitment to a dual source supply: gravity-fed surface water from Bridge and Tumalo Creeks under its existing water rights to meet base demands; and groundwater to meet current and future peak needs. As part of this process, the City has evaluated these supply sources in terms of cost, availability, reliability, feasibility, and likely environmental impacts.

Meeting future demand during the 20-year planning period from "new" surface water rights is not feasible. Surface water in the Deschutes Basin is fully appropriated and not available.

With respect to groundwater, obtaining a "new" groundwater right currently appears unlikely for the following reasons. In 2001, the U.S. Geological Survey (USGS) published a hydrologic study for the Deschutes Basin[5] and concluded that virtually all groundwater not consumptively used in the Upper Deschutes Basin discharges to surface water near Pelton Dam. Further, much of the Deschutes River is protected under the Oregon Scenic Waterways Act, which requires maintenance of the "free-flowing character of the scenic waterway in quantities necessary for recreation, fish and wildlife." The conclusions of the USGS study raised concern that new groundwater withdrawals could "measurably reduce" mandated scenic waterway flows. Therefore, OWRD adopted special rules providing for mitigation of stream flow impacts as a condition of granting new groundwater rights in the Deschutes Basin to address the scenic waterway concerns and the potential for substantial interference with other surface water rights.

OWRD's rules close the Deschutes Ground Water Study Area to further appropriation except for a cumulative total of 200 cfs maximum rate for final orders approving groundwater permit

[5] Gannett, M.W., Lite, Jr., K.E., Morgan, D.S., and Collins, C.A., 2001, Ground-water hydrology of the upper Deschutes Basin, Oregon: U.S. Geological Survey Water-Resources Investigations Report 00-4162 ("USGS Study"): http://pubs.usgs.gov/wri/wri004162/.

applications issued after the effective date of the rules. OWRD estimates that all 200 cfs of the "cap" have been claimed, meaning that other than applications already in the queue and under the 200 cfs cap, no new groundwater permits will be issued in the Deschutes Basin Ground Water Study Area. It is unclear whether this cap will be modified.

Further, OWRD's mitigation program rules are set to expire on January 2, 2014. It is difficult to predict whether legislation to extend the program (and perhaps to increase the cap) would be enacted. Without the legislation, and without an administrative program, it is unclear how OWRD would evaluate new groundwater permit applications in the Deschutes Basin.

Therefore, the full exercise of the City's existing permits is the most feasible and reliable alternative in the near term. Additionally, because the City must provide mitigation to offset the impacts of this groundwater use on surface water for its two newest and biggest permits, the likely environmental impacts of this water use are limited.

The following discussions analyze the extent to which the City can meet its projected water need through other alternatives.

Conservation Measures

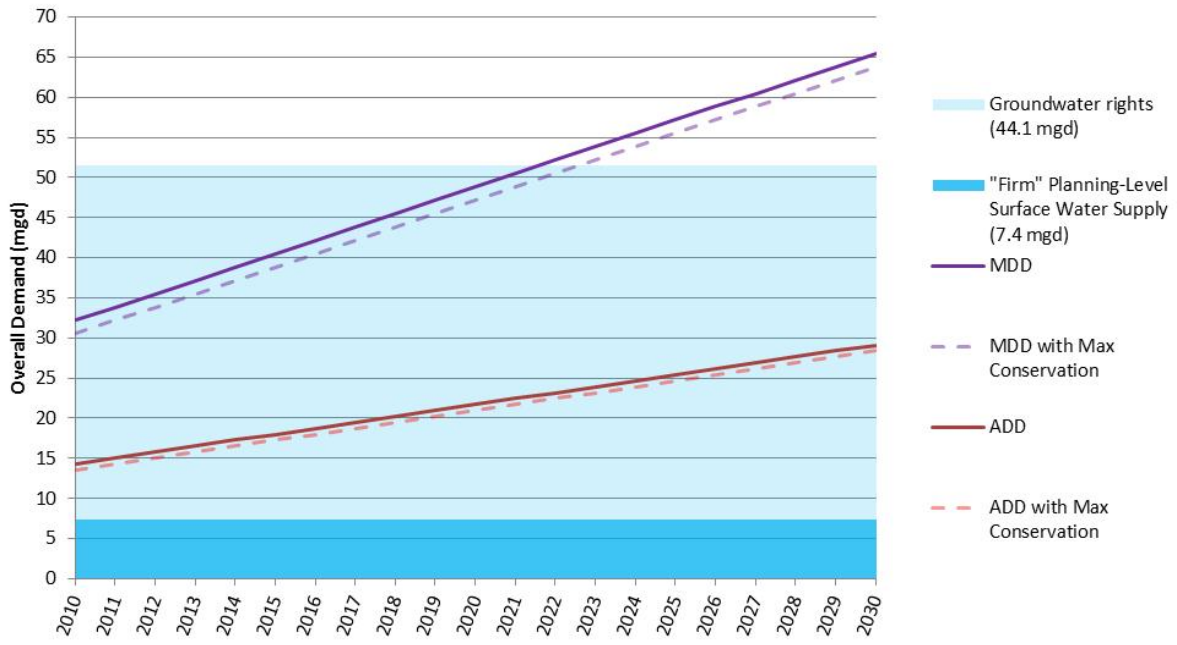
OAR 690-086-170(5)(a)

As described in Section 3, HDR developed a water conservation analysis evaluating 49 conservation measures to determine costs, predict participation rates, and evaluate water savings. HDR's analysis projected that if the City implemented the 37 conservation measures analyzed that were not mutually exclusive, the City could save 740,000 gallons per day (gpd) on an annual average basis, and 980,000 gpd on a peak season (April through October) basis. (Appendix B contains HDR's conservation analysis report.)

Exhibit 5-7 presents the total projected ADD and MDD compared to the City's reliable water rights, as well as the ADD and MDD considering implementation of all of these conservation measures. The latter demand projections were developed on the basis of HDR's conservation analysis. The ADD with conservation was estimated by reducing the projected ADD by 740,000 gpd. The projected MDD with conservation was estimated by multiplying the projected ADD with conservation values by the MDD/ADD peaking factor of 2.25. Although HDR projected these water use reductions to be the maximum savings during the course of a 10-year planning period, for the purposes of Exhibit 5-7, these savings rates were continued throughout the 20-year planning period for this WMCP to represent the maximum savings potential likely to be available through conservation.

HDR estimated the total direct cost for implementing all of these conservation measures to be approximately $3 million. This figure does not include staff and related overhead costs to implement the conservation measures. Because this cost exceeds its current conservation budget, the City will be working with the City Council during the next 5 years to develop capital improvement and conservation budgets and to determine which conservation measures to implement, as further described in Section 3.

EXHIBIT 5-7
Projected ADD and MDD and City of Bend Water Rights, Including Conservation



As shown in Exhibit 5-7, implementing all of the analyzed conservation measures that were not mutually exclusive would provide a slight reduction in the City's MDD. However, this reduction is not sufficient to alleviate the City's need to fully exercise its existing permits within the 20-year planning period.

Interconnections

OAR 690-086-170(5)(b)

The City currently has interconnections with Avion and Roats, as described in Section 2. The interconnections with Avion and Roats are considered only for emergency water supply conditions, so these interconnections are not being included as part of the City's water supply portfolio, and will not alleviate the City's need to fully exercise its existing water use permits described above within the 20-year planning period.

Cost Effectiveness

OAR 690-086-170(5)(c)

OAR 690-086-170(5)(c) requires an assessment of whether the projected water needs can be satisfied through other conservation measures that would provide water at a cost that is equal to or less than the cost of other identified sources. However, as described above, even if the

City implemented all of the non-mutually exclusive conservation measures considered by HDR as part of its Water Conservation Analysis Project (without regard to cost), the conservation savings would be insufficient to alleviate the City's need to fully exercise its existing water use permits during the 20-year planning period.

Quantification of Maximum Rate and Monthly Volume

OAR 690-086-0170(6)

OAR 690-086-0170(6) requires a quantification of the maximum rate of withdrawal and maximum monthly use if expansion or initial diversion of water allocated under an existing permit is necessary to meet demands in the 20-year planning horizon. The City anticipates expanding its use of the following permits: G-8565, G-11379, G-16177, and G-16178 to meet peak demands. As previously noted, groundwater permit G-4435 is fully developed and will be certificated in the near future. When calculating the maximum rate and monthly volume for each permit, the entire portion of the right in permit status was considered, rather than only the currently undeveloped portion of the right.

The City is projected to require the maximum authorized rate of 0.94 cfs for the portion of Permit G-8565 still in permit status within the next 20 years to meet the City's projected water demands. Assuming that this permit is used at the maximum rate 24 hours per day for 30 days during the maximum month, the maximum monthly volume for Permit G-8565 would be approximately 18.2 MG.

The City also anticipates requiring the full 3.84 cfs maximum authorized rate for Permit G-11379 within the next 20 years. Assuming that this permit is used at the maximum rate 24 hours per day for 30 days during the maximum month, the maximum monthly volume for Permit G-11379 would be approximately 74.4 MG.

In addition, the City anticipates requiring the full 12 cfs maximum authorized rate for Permit G-16177 within the next 20 years. Assuming that this permit is used at the maximum rate 24 hours per day for 30 days during the maximum month, the maximum monthly volume for Permit G-16177 would be approximately 232.7 MG. The volume of water appropriated under Permit G-16177 must be accompanied by the required corresponding mitigation.

Finally, the City anticipates requiring the full 12 cfs maximum authorized rate for Permit G-16178 within the next 20 years. Assuming that this permit is used at the maximum rate 24 hours per day for 30 days during the maximum month, the maximum monthly volume for Permit G-16178 would be approximately 232.7 MG. The volume of water appropriated under Permit G-16178 must be accompanied by the required corresponding mitigation.

Mitigation Actions under State and Federal Law

OAR 690-086-0170(7)

Under OAR 690-086-0170(7), for expanded or initial diversion of water under an existing permit, the water supplier is to describe mitigation actions it is taking to comply with legal requirements of the Endangered Species Act, Clean Water Act, and other applicable state or federal environmental regulations. The City currently is not required to take any mitigation actions under federal law. The City must provide mitigation credits as part of the Deschutes Basin Mitigation Program to offset the impacts to surface water of the consumptive portion of its use of groundwater under Permit G-16177 and Permit G-16178. The City has an approved incremental mitigation plan and will continue to use water under these two permits in compliance with the mitigation plan.

Alternative Sources

OAR 690-086-170(8)

OAR 690-086-0170(8) requires an analysis of alternative sources of additional water if acquisition of new water rights will be necessary within the next 20 years to meet the projected water demands. At this time, the City does not have any new water right applications pending. The City is currently engaged in two major projects that could have significant impacts on how the City provides water to meet projected demands. These studies are: (1) the Watershed Source Water Improvements and (2) Water System Master Plan Update Optimization Study – Final Report, Draft December 2010. In addition, the Deschutes Basin mitigation program "cap" of 200 cfs has been met and the program rules are scheduled to sunset January 2, 2014. Whether this program is extended will significantly affect how the City meets its future water demands. Moreover, during the next 5 years, the City will be developing capital improvement and conservation budgets and will be selecting and implementing additional conservation measures. Based on the results of these efforts, the City will reevaluate the supply necessary to meet projected demands, and reassess future water source alternatives. The City anticipates providing an updated water demand and source availability comparison that includes the City's long-term water supply source(s) with its 5-year update to this Plan.

Appendix A

Local Government Letter

GSI
Water Solutions, Inc.

December 1, 2010

Paul Blikstad, Senior Planner
Deschutes County – Planning Division
117 NW Lafayette Avenue
Bend, OR 97701

Subject: Water Management and Conservation Plan for the City of Bend

Dear Mr. Blikstad:

The City of Bend has developed a Draft Water Management and Conservation Plan (WMCP). The City has prepared this plan to fulfill the requirements of Oregon Administrative Rule Chapter 690, Division 86 of the Oregon Water Resources Department (OWRD).

Under these rules, a water supplier is required to make its draft plan available for review by each affected local government and seek comments relating to consistency with the local governments' comprehensive land use plans. Please find enclosed a copy of the City's Draft WMCP. Although we expect to make minor revisions to this document prior to submission to OWRD, any changes will not affect the plan's consistency with Deschutes County's comprehensive land use plan.

Please provide comments to me by no later than December 31, 2010. If the plan appears consistent with your agency's Comprehensive Land Use Plan, a letter response to that effect would be appreciated. You may send your comment to me at the address on this letterhead or e-mail them to me directly at: asussman@gsiwatersolutions.com.

If you have any questions, please feel free to contact me. My telephone number is 541-753-0745, extension 201. Thank you for your interest.

Sincerely,

Adam Sussman
Senior Water Resources Consultant

Enclosure

1600 Western Blvd., Suite 240 Corvallis, OR 97333 P: 541.753.0745 F: 541.754.4211 info@gsiwatersolutions.com www.gsiwatersolutions.com

Appendix B

HDR Water Conservation Opportunities Memorandum

Technical Memorandum

To:	**Patrick Griffiths and Ric Olson; City of Bend**
From:	**Kelly O'Rourke and Joe Miller; HDR, Inc.**
CC:	**Ronan Igloria; HDR, Inc.**
	Adam Sussman and Suzanne Moellendorf; GSI, Inc
Date:	**December 8, 2010 - FINAL**
Subject:	**Conservation Program for Water Management and Conservation Plan HDR Project #139138**

HDR performed a water conservation analysis project for the City of Bend. The purpose of the project was to examine opportunities to enhance Bend's existing water conservation program. The information will be used to potentially refine the City's program and to update portions of its *Water Management and Conservation Plan*. The work was done as a sub-consultant to GSI Water Solutions, Inc. (GSI). The scope of HDR's work focused on demand-side conservation measures.

This technical memorandum includes the following three sections:

1. **Conservation Background:** This section provides an overview regarding water conservation, which provides context for the analysis performed for this specific project. This section also summarizes Bend's current water conservation efforts.

2. **Analysis Methodology:** This section describes the methodology used to analyze the conservation measures, describes the conservation measures analyzed, documents key assumptions, and documents demographic and consumption data inputs.

3. **Results and Conclusions:** This section provides results of the initial analysis for each individual conservation measure, provides results of conservation "packages", and provides conclusions regarding the analysis. ***(Section 3.6 contains the conclusions; for readers interested primarily in the conclusions please refer to that section, which begins on page 25.)***

1 Conservation Background

1.1 Conservation Overview

Water conservation is defined as the management of water resources so as to eliminate waste and maximize efficient use of the resource. Conservation can be divided into many categories, as shown in Table 1. It is important to understand these categories since the cost structure, longevity of savings, certainty of savings, and social impacts vary across the categories.

Table 1 Conservation Categories

Measures *(Saves water)*		Incentives *(Motivates Customers to save water)*		
Hardware	**Behavior**	**Educational**	**Financial**	**Regulatory**
More efficient equipment.	More efficient behaviors.	Explain why and how to save water.	Make saving water financially attractive.	Require conservation actions.
Example: Install high efficiency toilets.	*Example: Take shorter showers.*	*Example: Conservation tips brochure.*	*Example: Use inverted block rate structure.*	*Example: Require retrofit to code upon resale.*

Conservation is first divided into two categories: measures and incentives. Measures save water in and of themselves, while incentives motivate customers to save water. Measures are divided into hardware and behavior. Hardware measures entail using more efficient equipment, while behavioral measures entail promoting behavior changes toward more efficient practices. Hardware measures tend to be more expensive, but have longer lasting savings and a higher certainty of savings, compared to behavioral measures. Incentives can be divided into three categories: educational, financial, and regulatory. Educational incentives explain why and how to save water. Financial incentives make saving water financially attractive. Regulatory incentives are mandatory requirements for conservation actions. Examples for each type of measure and incentive are provided in Table 1.

Conservation can be achieved on both the supply-side and demand-side. Supply-side conservation is associated with a utility's conveyance and distribution infrastructure such as leak detection and repair. Demand-side conservation is associated with the water user such as homeowners installing high efficiency toilets.

A utility's conservation program should reflect the reasons why the utility is implementing conservation and the utility's water use patterns. Typical conservation drivers include: 1) meeting regulatory requirements, 2) demonstrating stewardship, 3) decreasing operating costs, 4) deferring/avoiding capital costs, and 5) extending available supplies. The utility's conservation drivers and water use patterns shape which measures and incentives to implement, the saving goal, the appropriate budget, and whether to focus on supply-side or demand-side efforts.

Table 2 shows how a utility's conservation driver determines the strategy for its conservation program.

Table 2 Conservation Driver Determines Conservation Strategy

Conservation Driver	Conservation Program Strategy
Meet Regulatory Requirement	Implement the required level of conservation.
Demonstrate Stewardship	Implement more than the required level of conservation.
Decrease Operating Costs	Implement conservation that is more cost-effective than the variable cost of supplying water.
Defer/Avoid Capital Costs	Implement the amount of conservation necessary to obtain the savings required to defer/avoid capital costs.
Extend Available Supplies	Implement conservation that is more cost-effective than the cost of developing new traditional supply.

1.2 Bend's Current Conservation Program

Most of the conservation drivers discussed above applies to Bend. The City is committed to meeting all regulatory requirements related to conservation. The City understands the environmental benefit of leaving water instream and in the aquifer and is interested in going beyond regulatory commitments to demonstrate strong stewardship of the resource. Bend is also interested in conservation as a mechanism to defer or avoid capital costs and to extend available supplies.

Bend's current conservation program features both supply-side and demand-side efforts and includes both measures and incentives. A summary of the major elements of the program are listed in Table 3. A more detailed summary of Bend's conservation program will be provided in the *Water Management and Conservation Plan* being prepared by GSI.

Table 3 Major Elements of Conservation Program

Supply-Side Elements	Demand-Side Elements
• Source and customer metering • Meter calibration and replacement • Annual system water audits • Pipeline leak detection	• Public education and outreach • Irrigation programs to promote and/or fund controllers, rain sensors, native plants, and audits • Toilet leak detection tablets

The materials and services budget for the City's conservation program is approximately $50,000 annually for communication and outreach. This does not include staffing costs. The City does not currently have budget allocated for direct costs such as rebates or hardware purchases.

2 Analysis Methodology

2.1 Basic Method

The methodology for determining water savings and costs for Bend is generally the same for all conservation measures. The basic method is to compile demographic information for Bend's service area, apply assumptions for customer participation rates for each conservation measure, calculate the savings achieved by shifting to more efficient hardware or behavior, and calculate the costs for those shifts.

HDR's proprietary Water Conservation Measure Analysis Model was used for this analysis. The model is an Excel-based tool that estimates the water savings and costs for various demand-side water conservation measures. The spreadsheet is pre-loaded with a set of commonly analyzed conservation measures. The spreadsheet is customized for clients by entering client-specific data (e.g., planning period, demographics, and water consumption) and selecting which of the pre-loaded measures should be analyzed. The spreadsheet analyzes the measures and provides summary tables and graphs. Various program "packages" can also be created based on the analyzed measures to represent potential conservation scenarios.

The costs for a conservation program can be divided into the three categories shown below. The HDR model only incorporates the direct costs incurred by the utility.

- **Direct Costs:** This includes rebates paid to customers (e.g., clotheswasher rebates), purchasing fixtures to give to customers (e.g., efficient showerheads), and paying for professional audits (e.g., outdoor irrigation audits).

- **Indirect Costs:** This includes marketing and distribution costs that necessary to implement the measures, such as graphic design, printing, postage, and advertising. The exact nature of the marketing and distribution techniques that will eventually be implemented is often unknown during the measure analysis work. Therefore, the indirect costs are not included in HDR's model. However, Bend should plan to budget for indirect costs, which, as a general rule, can be 10-20% of the direct costs.

- **Staff Costs:** This includes the salary and benefits for City staff assigned to plan, manage, and implement the conservation program. Some water utilities include staff costs in their official conservation budget, while others do not. Regardless of whether staff costs appear in the official conservation budget, the "opportunity cost" should be recognized in that staff time allocated to a conservation program is not available for other utility functions.

The initial results from the model are simply the outcomes of the analysis for every conservation measure, considered independently of the other measures. Those results, by themselves, do not indicate which measures should be implemented. The initial results must be coupled with Bend's conservation driver and screened through various criteria in order to determine which measures and/or groups of measures ("packages") are most appropriate.

2.2 Measures Analyzed

The measures analyzed for this project are described below.

- **Clotheswashers - Efficient Residential Capacity (In Unit)**: Provide partial rebates to replace less efficient residential-capacity clotheswashers (located in housing units) with more efficient models. The participation rate for this measure was set at 25%. The direct cost is a $100 rebate per clotheswasher. The model assumes one rebate per participating household.
- **Clotheswashers - Efficient Residential Capacity (Common Area):** Provide partial rebates to replace less efficient residential-capacity clotheswashers (in common laundry areas) with more efficient models. The participation rate for this measure was set at 25%. The direct cost is a $100 rebate per clotheswasher. The model assumes one rebate for every five multifamily households for participating multifamily accounts.
- **Clotheswashers - Efficient Commercial Capacity:** Provide partial rebates to replace less efficient commercial-capacity clotheswashers with more efficient models. The participation rate for this measure was set at 25%. The direct cost is a $250 rebate per clotheswasher. The model assumes 12 rebates per participating non-residential account.
- **Clotheswashers - Decrease Partial Loads:** Encourage customers to reduce partial loads of laundry, thereby reducing the number of loads by 10%. The participation rate for this measure was set at 10%. There are no direct costs associated with this measure since most behavior measures do not have direct costs. However, this should not be viewed as a "no-cost" measure since the indirect costs for behavior measures can be significant.
- **Faucets - 0.5 gpm Bathroom Aerators (Residential):** Provide free 0.5 gpm bathroom faucet aerators, which for the residential customer category is more efficient than the maximum of 2.5 gpm allowed under the plumbing code. The participation rate for this measure was set at 10%. The direct cost is $1 per aerator. The model assumes 2.5 aerators per participating single family household and 1.5 aerators per participating multifamily household.
- **Faucets - 0.5 gpm Bathroom Aerators (Non-Residential):** Provide free 0.5 gpm bathroom faucet aerators, which for the non-residential customer category is the maximum allowed under the plumbing code. Brings non-code customers up to code. The participation rate for this measure was set at 30%. The direct cost is $1 per aerator. The model assumes 2.1 aerators per participating non-residential account.
- **Faucets - 1.0 gpm Bathroom Aerators:** Provide free 1.0 gpm bathroom faucet aerators, which for the residential customer category is more efficient than the maximum of 2.5 gpm allowed under the plumbing code. The participation rate for this measure was set at 25%. The direct cost is $1 per aerator. The model assumes 2.5 aerators per participating single family household and 1.5 aerators per participating multifamily household.
- **Faucets - 1.5 gpm Bathroom Aerators:** Provide free 1.5 gpm bathroom faucet aerators, which for the residential customer category is more efficient than the maximum of 2.5

gpm allowed under the plumbing code. The participation rate for this measure was set at 25%. The direct cost is $1 per aerator. The model assumes 2.5 aerators per participating single family household and 1.5 aerators per participating multifamily household.

- **Faucets - Decrease Use:** Encourage customers to reduce unnecessary faucet use, such as running the water while brushing teeth, thereby reducing combined bathroom and kitchen faucet use by 10%. The participation rate for this measure was set at 10%. There are no direct costs associated with this measure since most behavior measures do not have direct costs. However, this should not be viewed as a "no-cost" measure since the indirect costs for behavior measures can be significant.
- **Showerhead 1.5 gpm:** Provide free 1.5 gpm showerheads, which is more efficient than the maximum of 2.5 gpm allowed under the plumbing code. The participation rate for this measure was set at 25%. The direct cost is $3 per showerhead. The model assumes 2.0 showerheads per participating single family household, 1.5 showerheads per participating multifamily household, and 10 showerheads per participating non-residential account.
- **Showerhead 2.0 gpm:** Provide free 2.0 gpm showerheads, which is more efficient than the maximum of 2.5 gpm allowed under the plumbing code. The participation rate for this measure was set at 25%. The direct cost is $3 per showerhead. The model assumes 2.0 showerheads per participating single family household, 1.5 showerheads aerators per participating multifamily household, and 10 showerheads per participating non-residential account.
- **Showerheads - Decrease Use:** Encourage customers to reduce showering time by 10%. The participation rate for this measure was set at 10%. There are no direct costs associated with this measure since most behavior measures do not have direct costs. However, this should not be viewed as a "no-cost" measure since the indirect costs for behavior measures can be significant.
- **Spray Valves - 1.25 gpm Pre-Rinse Spray Valve:** Provide free, direct installation of 1.25 gpm pre-rinse spray valves, which is more efficient than the maximum of 1.6 gpm allowed under the plumbing code. Pre-rinse spray valves are used in commercial kitchens to rinse dishes prior to loading into dishwashers**.** The participation rate for this measure was set at 95%. The cost is $130 per spray valve. Due to the direct install nature of this measure, that cost includes both direct and indirect costs. The model assumes 1.5 spray valves per participating non-residential account.
- **Toilets - 1.28 gpf High Efficiency Toilets (HET):** Provide partial rebates to install High Efficiency Toilets (HETs), which is better than the maximum of 1.6 gpf allowed under the plumbing code. HETs are defined as toilets flushing at a maximum of 1.28 gpf. HETs include both dual flush toilets and pressure-assist tank style toilets. The participation rate for this measure was set at 10%. The direct cost is a $100 rebate per residential toilet and a $150 rebate per non-residential toilet. The model assumes 2.3 rebates per participating single family household, 1.8 rebates per participating multifamily household, and 4.2 rebates per participating non-residential account.

- **Toilets - 1.6 gpf Ultra Low Flow Toilets (ULFT):** Provide partial rebates to replace less efficient toilets with 1.6 gpf Ultra Low Flow Toilets (ULFT), which is the maximum allowed under the plumbing code. Brings non-code customers up to code. The participation rate for this measure was set at 30%. The direct cost is a $75 rebate per toilet. The model assumes 2.3 rebates per participating single family household, 1.8 rebates per participating multifamily household, and 4.2 rebates per participating non-residential account.
- **Toilets - Decrease Flushes:** Encourage customers to reduce unnecessary toilet flushing, such as flushing trash, thereby reducing toilet flushes by 10%. The participation rate for this measure was set at 10%. There are no direct costs associated with this measure since most behavior measures do not have direct costs. However, this should not be viewed as a "no-cost" measure since the indirect costs for behavior measures can be significant.
- **Toilets - Leak Detection:** Provide free toilet leak detection dye tablets to determine if toilets leak and provide information on how to fix leaks. The participation rate for this measure was set at 25%. The direct cost is $0.10 per packet of dye tablets. The model assumes 2.3 dye tablet packets per participating single family household and 1.8 dye tablet packets per participating multifamily household. Toilet leak detection dye tablets can be considered both a behavioral and a hardware measure. It fits the definition of a behavioral measure in that customers must take action to repair a found leak; it fits the definition of a hardware measure in that the fix to a leaky toilet is a piece of hardware. Bend staff classify it as a hardware measure and therefore it appears in the "hardware" packages.
- **Urinals - Waterless Models:** Provide partial rebates to install waterless urinals, which is better than the maximum of 1.0 gpf allowed under the plumbing code. The participation rate for this measure was set at 5%. The direct cost is a $150 rebate per urinal. The model assumes 2.1 rebates per participating non-residential account.
- **Urinals - 0.5 gpf Models:** Provide partial rebates to install 0.5 gpf urinals, which is better than the maximum of 1.0 gpf allowed under the plumbing code. The participation rate for this measure was set at 25%. The direct cost is a $100 rebate per urinal. The model assumes 2.1 rebates per participating non-residential account.
- **Urinals - 1.0 gpf Models:** Provide partial rebates to replace less efficient urinals with 1.0 gpf urinals, which is the maximum allowed under the plumbing code. Brings non-code customers up to code. The participation rate for this measure was set at 30%. The direct cost is a $100 rebate per urinal. The model assumes 2.1 rebates per participating non-residential account.
- **Irrigation Controllers - ET Model:** Provide partial rebates for evapotranspiration (ET) based irrigation controllers, which link irrigation to weather conditions. The participation rate for this measure was set at 25%. The direct cost is a $250 rebate per controller for single family customers and a $500 rebate per controller for multifamily and non-residential customers. The model assumes one rebate per participating single family household, multifamily account, and non-residential account.
- **Irrigation Controllers - Rain Sensors:** Provide free rain sensors, which turn off automatic irrigation systems when it is raining. This is only applicable to irrigation

systems that can use rain sensors. The participation rate for this measure was set at 25%. The direct cost is a $100 rebate per rain sensor. The model assumes one rebate per participating single family household, multifamily account, and non-residential account.

- **Lawn Dormant:** Encourage customers to let their lawn go dormant in the summer. It should be noted that allowing lawns to go dormant during the summer does not eliminate lawn watering completely. Dormant lawns still require some water to stay alive. The participation rate for this measure was set at 10%. There are no direct costs associated with this measure since most behavior measures do not have direct costs. However, this should not be viewed as a "no-cost" measure since the indirect costs for behavior measures can be significant.
- **Outdoor Audit:** Provide free irrigation audits to improve the efficiency of irrigation systems. Efficiencies can be achieved through hardware improvements or operational changes. The audits are performed by a contracted professional landscape irrigation auditor. The participation rate for this measure was set at 25%. The direct cost is $250 per audit for residential properties and $1,000 per audit for non-residential properties. The model assumes one audit per participating single family household, multifamily account, and non-residential account.
- **Outdoor Irrigation Kits:** Provide free outdoor irrigation kits with devices and information to improve the irrigation efficiency of manual irrigation techniques. Kits typically include items such as a watering timer and shut-off device, a spring-loaded hose nozzle, a rain gauge, hose washers, and a conservation brochure. The participation rate for this measure was set at 25%. The direct cost is $15 per kit. The model assumes one kit per participating single family household.

2.3 Key Assumptions

There are several key assumptions that are fundamental to the analysis. Those assumptions are explained below.

- **Planning Period:** A planning period of 2011 to 2020 (ten years) was used. The planning period is the period of interest for analyzing water conservation savings and costs. The planning period is different than the initial implementation period (see below). For example, Bend may distribute showerheads for five years (the initial implementation period), but may be interested in seeing how the savings and costs associated with those showerheads play out over 10 years (the planning period).

- **Initial Implementation Period:** An initial implementation period of 2011 to 2015 (five years) was used. The initial implementation period is the period when the conservation program will be implemented (aside from any renewals, see below). The initial implementation period is for the entire conservation program (i.e., all measures), rather than for any individual measure (e.g, just high-efficiency showerheads). Therefore, the last year of the initial implementation period is the last year that any one measure is initially implemented. A multi-year implementation period reflects the budgetary and administrative reality that Bend would most likely not implement all measures immediately.

- **Implementation Schedule:** After a one-year "ramp-up" period, an even-paced implementation schedule was assumed for all measures. The implementation schedule is the rate at which the measures are implemented during the initial implementation period. The measures were implemented to 8% of the potential customers in the first year and to 23% of the potential customers each of the remaining years. Therefore, the program reaches full implementation in the fifth year. This means that the gallons per day savings increase over the first five years, then remain constant. After the first year ramp-up period, an even implementation provides a consistent program budget for each year in the initial implementation period.

- **Renew Measure:** Measures are renewed if necessary to maintain savings over the planning period. Measure renewal is necessary if the measure lifespan is shorter than the planning period and if Bend wants to maintain the savings during the planning period. For example, the outdoor audit measure has a lifespan of five years, which means that since Bend's planning period is 10 years, the savings from the outdoor audits will disappear after five years unless Bend renews the measure and gives customers another outdoor audit in five years. Measure renewal has the benefit of maintaining savings, however it means that Bend pays to implement a measure more than once to the same customer.

- **Participation Rates:** Participation rates were selected to represent moderate program implementation levels. In the modeling analysis, participation rates represent the percent of target customers (those with the applicable hardware or behavior that have not already implemented the measure) that participate in the program. For example, for the HET toilet measure, the participation rate is the percent of customers that do not already have a HET toilet that are assumed to participate in Bend's HET toilet program. Participation rates are dependent on many factors including marketing and distribution techniques. Moderate level marketing and distribution techniques were assumed for the analysis.

  The participation rates are a subjective assessment of the relative attractiveness of the measures to customers. The rates were established using professional judgment based on HDR's experience with other communities. The following participation rates were used for the analysis:
  - 5% = unattractive to customers
  - 10% = not very attractive to customers
  - 25% = fairly attractive to customers
  - 30% = very attractive to customers

- **Free Riders:** The concept of free ridership was addressed in the analysis. Free riders are customers that participate in Bend's conservation program, even though they would have implemented the measure anyway. For example, a free rider is a customer who takes a rebate for an efficient clotheswasher, but who was going to buy that clotheswasher regardless of whether Bend offered a rebate program.

When free ridership is addressed in the analysis, the savings associated with free riders are excluded from the cost-effectiveness calculations, which provide a more accurate representation of the true cost-effectiveness of the conservation program. This impacts two values in the model: 1) "Savings for All Customers Over Measure Life (ccf)" and 2) "Cost per ccf Saved Over Measures Life." Those two numbers do not include water savings from free riders. Aside from those two numbers, all other numbers in the model include effects from free riders.

The free ridership percentages are a subjective assessment of the relative level of free ridership for measures. The percentages were established using professional judgment based on HDR's experience with other communities. The following free ridership percentages were used for the analysis:

- 5% = no reason to assume much free ridership
- 15% = higher level of free ridership is expected
- 25% = measures bringing customers up to current plumbing code

2.4 Demographic and Consumption Data Inputs

Demographic Data

The demographic data required for the model are provided in Table 4. The demographic data did not initially distinguish between single family and multifamily, but rather grouped those categories together as "residential." The model is not structured to accommodate a grouped "residential" category and therefore that category was split into single family and multifamily. As documented in footnote "b" to Table 4, that split was based on the 2005 *Housing Needs Analysis; City of Bend Residential Lands Study* which indicates that 72% of households in Bend are single family. This disaggregation is an approximation, but it is considered the best available data to complete the analysis.

Table 4 Demographics

Demographic Unit	First Initial Implementation Year ("Existing" Demographics)		Last Initial Implementation Year		Change Between First and Last Year ("Future" Demographics)	
Year	2011	a	2015	a	5	g
Single Family Households (SF HH) and Accounts	18,953	b	20,290	b	1,336	g
Persons Per SF HH	2.42	c	2.42	c	0.00	g
Multifamily Households (MF HH)	7,371	b	7,890	b	520	g
Multifamily Accounts	737	h	789	h	52	g
Persons Per MF HH	2.42	c	2.42	c	0.00	g
Non-Residential (NR) Accounts	3,217	d	3,444	d	227	g

Demographic Unit	First Initial Implementation Year ("Existing" Demographics)		Last Initial Implementation Year		Change Between First and Last Year ("Future" Demographics)	
Employees	45,362	e	48,560	e	3,198	g
Employees Per NR Account	14	f	14	f	0	g

a. Provided by client via Measure Selection worksheet.

b. Original numbers from GSI/MSA/City grouped SF and MF together. HDR split HHs between SF and MF based on Table 33 in 2005 *Housing Needs Analysis City of Bend Residential Lands Study,* which indicated 72% of HH are SF. Original footnote from GSI/MSA/City as follows: The City used the buildable lands/parcel inventory clipped to the COB water service area to estimate the number of residential households in 2010 (25,860). The inventory includes building permit applications that were received and approved (not constructed) as of Feb 1, 2008 and the City assumes that these units were built by 2010, thereby provide a good estimate for the 2010 number of residential households. Forecasted units were estimated by first summarizing the average annual number of permits issued over the reporting period for the City of Bend. The yearly average was then multiplied by 0.75 since only 75% of the City of Bend is within the City's water service area. Finally, this number (464 for all residential unit) was added each year to estimate the total number of dwelling units by type for the next 5 years, 2011 to 2015. The percent growth rates were: 1.79% from 2010 to 2011 and 7.05% total from 2011 to 2015.

c. Based on the US Census 2000.

d. Based on data from the utility billing system, MSA determined that the number of Non-residential Accounts in 2009 was 3,211. GSI then applied the residential households percent growth rates of 1.79% from 2010 to 2011 and 7.05% total from 2011 to 2015 (Footnote b) to the number of Non-residential Accounts in 2009 for the 2011 and 2015 projections.

e. Based on employment data from Oregon Employment Department, grown by factors consistent with the City of Bend's Economic Opportunities Analysis, the City estimated that the number of employee in 2008 was 44,564. GSI applied the residential households percent growth rates of 1.79% from 2010 to 2011 and 7.05% total from 2011 to 2015 (Footnote b) to the 2008 employment estimate for the 2011 and 2015 projections.

f. Calculation. Employees/NR Accounts

g. Calculation.

h. Professional judgment assuming 10 MF HH per MF account.

Consumption Data

The water consumption data required for the model are provided in Table 5. Water consumption data are used to calculate the Peak Season Increased Use (PSIU), which is the annual amount of water used in the summer months above the base use (i.e., winter water average use). The PSIU is used in the savings formulas for outdoor measures. Two years of water consumption data (2008-2009) for Bend are provided in Table 5. A graphical representation of that data, including the distinction between base use and the PSIU, is provided in Figure 1, Figure 2, and Figure 3.

Similar to the demographic data, the consumption data did not initially distinguish between single family and multifamily, but rather grouped those categories together as "residential." The consumption data was disaggregated using two main pieces of information: 1) the newly disaggregated Bend demographics separating single family and multifamily households, and 2) professional knowledge that a multifamily household typically uses approximately 85% of the consumption of a single family household. This disaggregation is an approximation and the confidence level of the results is reduced somewhat due to this data limitation. This issue only impacts measures with a "peak only" seasonality, since the consumption data is only used to estimate savings for "peak only" measures.

Table 5 Bend Water Consumption (gallons)

Month	Single Family		Multifamily		Non-Residential	
	2008	2009	2008	2009	2008	2009
Jan	63,061,419	66,253,728	20,845,302	21,900,538	72,549,267	71,806,549
Feb	62,456,394	59,312,417	20,645,308	19,606,049	73,693,802	57,261,091
Mar	73,536,334	55,809,549	24,307,844	18,448,157	73,794,355	64,263,994
Apr	86,620,499	111,083,908	28,632,887	36,719,403	93,245,306	99,878,693
May	207,036,509	209,789,572	68,437,068	69,347,109	168,454,780	211,931,167
June	224,516,421	240,333,592	74,215,150	79,443,604	179,263,127	220,964,837
July	407,803,042	311,850,603	134,801,561	103,083,949	290,600,681	233,671,889
Aug	313,766,104	381,582,191	103,717,129	126,134,113	229,720,447	263,698,319
Sep	244,361,307	198,182,035	80,774,987	65,510,173	193,055,297	164,186,426
Oct	168,694,298	159,110,827	55,762,837	52,594,968	118,701,616	126,121,857
Nov	63,803,523	58,413,802	21,090,609	19,309,007	65,212,374	56,025,527
Dec	57,366,708	65,333,699	18,962,884	21,596,417	58,401,851	68,732,407
Total	**1,973,022,559**	**1,917,055,923**	**652,193,568**	**633,693,486**	**1,616,692,904**	**1,638,542,756**

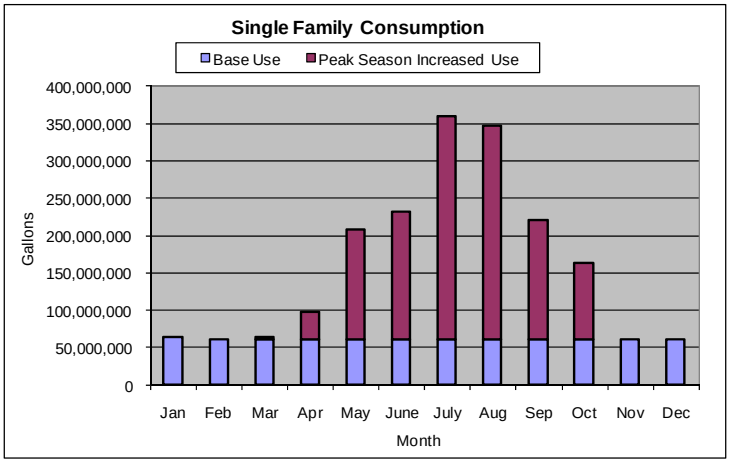


Figure 1 Single Family Consumption (2008-2009)

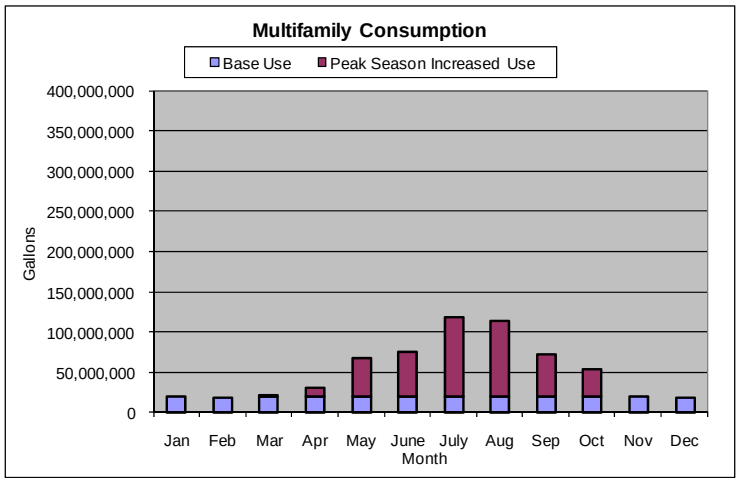


Figure 2 Multifamily Consumption (2008-2009)

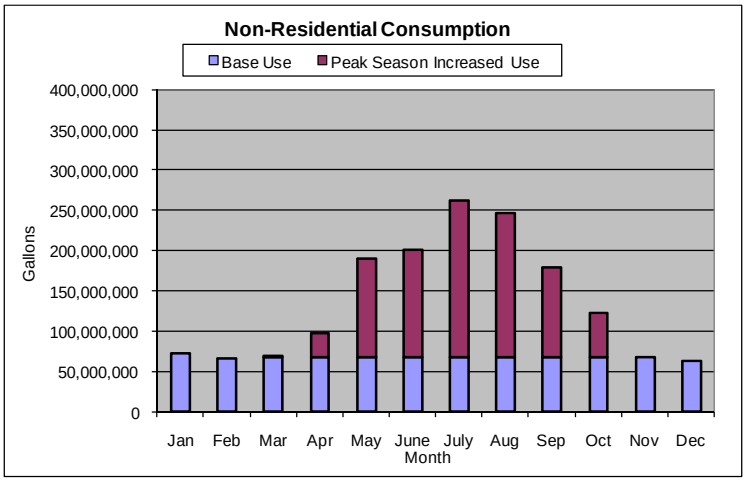


Figure 3 Non-Residential Consumption (2008-2009)

2.5 Developing Packages

The model's "package tool" was used to group subsets of measures that represent potential conservation scenarios for Bend. The decision of which packages to create, and which measures

to include in each package, is dependent on many factors including the following screening criteria:

- **Available Program Budget:** The conservation program budget impacts program choices. Bend has a current conservation budget of approximately $50,000 annually for communication and outreach and no budget for direct costs such as rebates or hardware purchases.

- **Magnitude of Annual Water Savings:** This is the annual savings in gallons per day at full implementation.

- **Magnitude of Peak Season Water Savings:** This is the peak season savings in gallons per day at full implementation. Note that peak season savings are obtained from both measures that obtain year-round savings (e.g. toilet rebates) and measures that only obtain savings during the peak season (e.g., irrigation system controllers).

- **Cost Effectiveness:** The cost-effectiveness of measures can range widely. For Bend, it ranges from $0.01 to $51.63 per ccf of saved water. Typically, indoor measures are more cost-effective than outdoor measures.

- **Customer Categories:** It may or may not be preferable to provide programs for each customer category (i.e., single family, multifamily, non-residential).

- **Certainty of Savings:** Measures that focus on hardware have a higher certainty of savings compared to measures that focus on behavior. Once a customer installs a piece of hardware (e.g., high-efficiency showerhead), the savings are generally assured for the lifespan of that hardware. However, if a customer enacts a water saving behavior (e.g., taking shorter showers), it is easy for the customer to convert back to their non-conserving behavior.

- **Administrative Complexity:** The impact on staff workload should be considered. Measures that could be implemented together (e.g., single family showerheads and single family bathroom faucet aerators) may have added value in workload efficiencies (as well as in cost efficiencies).

- **Customer Acceptance:** Certain measures may have higher customer acceptance. For example, when measures with different flow rates are analyzed, typically the models with higher flow rates have higher customer acceptance.

Examples of conservation packages that are frequently developed for utilities to consider include the following:

- **Savings Package:** Designed to meet a specific saving goal (e.g., saves X gpd).

- **Cost Package:** Designed to meet a specific budgetary constraint (e.g., costs $X per year).

- **Cost-Effectiveness Package:** Designed to include all measures that meet a certain cost-effectiveness threshold (e.g., measures that cost less than $X per ccf of saved water.

The packages developed for Bend are described below.

- **Package #1 – Conservation Potential Assessment:** This package was designed to show the maximum water savings available, given certain assumptions such as participation rates. This package is intended to provide a "high end" of potential savings. This package was assembled by including all of the analyzed measures, except that certain mutually exclusive measures have been omitted.

- **Package #2 – Hardware Measures – Indoor and Outdoor:** This package was designed to show the maximum water savings from hardware measures that the City is most interested in. The City has less interest in behavioral measures since their savings are less certain. This package was assembled by starting with Package #1 and omitting the behavioral measures and a few hardware measures.

- **Package #3 – Hardware Measures – Outdoor Only:** This package was designed to show the maximum water savings from outdoor hardware measures that the City is most interested in. This package was assembled by starting with Package #2 and omitting all indoor measures, which results in a package that contains only ET Controllers.

- **Package #4 – Hardware Measures – Indoor Only:** This package was designed to show the maximum water savings from indoor hardware measures that the City is most interested in. This package was assembled by starting with Package #2 and omitting all outdoor measures.

3 Results and Conclusions

3.1 Initial Results for Individual Measures

The results of the initial analysis for each individual measure are provided in Table 6. (The table is located at the end of this Tech Memo since it is 11 x 17 in size.) The results represent the highest level of water savings (and associated costs) that can be expected from each analyzed measure, given certain assumptions such as participation rates. It should be noted that additional savings might be obtainable from measures not included in the model, such as supply-side measures (e.g., leak detection) or more aggressive demand-side measures, however that would require continued spending.

The savings and costs in Table 6 are not totaled since there is some overlap due to mutually exclusive measures. For example, the analysis includes 0.5, 1.0, and 1.5 gpm faucet aerator measures. Those measures were analyzed independently of each other. Bend would most likely choose to implement only one of those measures, therefore the savings and costs from the non-selected measures need to be disregarded. If Bend implemented all three measures, the

participation rates (and thus savings and costs) for all three measures would need to be reduced. (See Section 3.2 for a package that omits overlapping measures.)

There are four sets of mutually exclusive measures, as described below:

- **Mutually Exclusive Set #1 – Residential Bathroom Faucet Aerators:** Three versions of residential bathroom faucet aerators were analyzed: 0.5 gpm, 1.0 gpm, and 1.5 gpm. All three versions are more efficient than the plumbing code of 2.5 gpm.

- **Mutually Exclusive Set #2 - Showerheads:** Two versions of showerheads were analyzed: 1.5 gpm and 2.0 gpm. Both versions are more efficient than the plumbing code of 2.5 gpm.

- **Mutually Exclusive Set #3 – Toilets:** Two versions of toilets were analyzed: 1.28 gpf and 1.6 gpf. The 1.6 gpf version brings customers up to the plumbing code and the 1.28 gpf version goes beyond code.

- **Mutually Exclusive Set #4 - Urinals:** Three versions of urinals were analyzed: waterless, 0.5 gpf, and 1.0 gpf. The 1.0 gpf version brings customers up to the plumbing code, while the other two versions go beyond code.

Key definitions related to Table 6 (as well as the similar tables for packages) are provided below:

- **Participating Customers:** The number of customers with the applicable fixture or behavior that have not already implemented the measure and that participate in the program. For example, the number of single family households with showers that do not already have an efficient model that participate in the utility's showerhead program. Note that the number of "potential" customers is the number of single family households; multifamily households or accounts; or non-residential accounts (as applicable for each measure), which is provided in Table 4 Demographics.

- **Savings Generating Customers:** The number of customers that generate savings. For measures that only require one step to achieve savings (e.g., toilet rebates), this is the same as the number of participating customers. For measures that require two steps to achieve savings, this is the number of customers that perform both steps and therefore achieve the savings. For example, the number of single family households that take the utility's showerhead and follow through and install it.

- **Devices / Rebates / Audits:** The number of devices, rebates, or audits that will be distributed or performed. For example, the number of toilet rebates. This number can be higher than the number of participating customers since often there are multiple fixtures per customer and due to renewals.

- **Savings for All Customers at Full Implementation (gpd):** This is the gallons per day savings for all customers once the program has been fully implemented. This value is presented for both the average annual and peak season time periods.

- **Savings for All Customers Over Measure Life (ccf):** This is the total savings, in 100s of cubic feet, that are obtained by the measure over the measure lifespan (or multiple lifespans if the measure is renewed). This is the savings number that is used to calculate the cost-effectiveness of the measure.

- **Total Direct Cost Over Planning Period:** This is the total direct cost for a measure over the planning period including the impacts of renewals if applicable. This number is a key input to the measure cost effectiveness calculation.

- **Direct Cost per CCF Saved Over Measure Life:** This is the cost effectiveness of the measure. It is calculated by dividing the "Savings For All Customers Over Measure Life (ccf)" into the "Total Direct Cost Over Planning Period." This number can be used to compare measures to one another, or to compare conservation to other sources of supply.

3.2 Package #1 – Conservation Potential Assessment

As described previously, this package was designed to show the maximum water savings available, given certain assumptions such as participation rates. This package is intended to provide a bookend of the high end of potential savings. As described previously, this package omits certain mutually exclusive measures. This allows the results to be summed for all the remaining measures. The decisions for which measures within a mutually exclusive set were included are explained below:

- **Mutually Exclusive Set #1 – Residential Bathroom Faucet Aerators:** The 1.0 gpm versions were included since they are more cost effective and save a larger volume of water, compared to the 1.5 and 0.5 gpm versions.

- **Mutually Exclusive Set #2 - Showerheads:** The 1.5 gpm versions were included since they are more cost effective and save a larger volume of water, compared to the 2.0 gpm version.

- **Mutually Exclusive Set #3 – Toilets:** The 1.28 gpf versions were included since they are more cost effective, compared to the 1.6 gpf version.

- **Mutually Exclusive Set #4 - Urinals:** The 0.5 gpf versions were included since they are more cost effective and save a larger volume of water, compared to the 1.0 gpf version. The waterless versions were excluded since they are often less acceptable to customers.

The results for Package #1 are shown in Table 7. (The table is located at the end of this Tech Memo since it is 11 x 17 in size.) The analysis estimates the package would save approximately 740,000 gallons per day (gpd) on an annual average basis and 980,000 gpd on a peak season

basis. The annual average savings number represents 6.2% of Bend's 2004-2009 average day demand. (The 2004 to 2009 average day demand is 12 mgd per Exhibit 2-3 in Bend's draft *Water Management and Conservation Plan*). The total direct cost of achieving those savings is estimated at approximately $3 million over the course of the ten-year planning period. Those total costs average to approximately $300,000 a year. However, as discussed below, the estimated annual costs vary throughout the planning period with higher annual costs toward the beginning and lower annual costs toward the end.

Several pie charts are provided to convey more information regarding the nature of the savings from this package. Figure 4 shows that nearly two-thirds of the savings are from the single-family customer category, with the remaining savings attributed to the multifamily and non-residential customer categories. Figure 5 shows that approximately two-thirds of the savings are associated with measures focused only on the peak season and one-third of the savings is associated with measures with year-round savings. Figure 6 shows that approximately half of the savings are associated with hardware measures and half with behavioral measures.

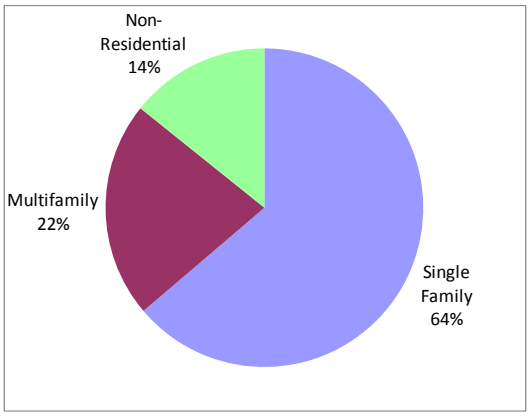


Figure 4 Savings by Customer Category (Package #1)

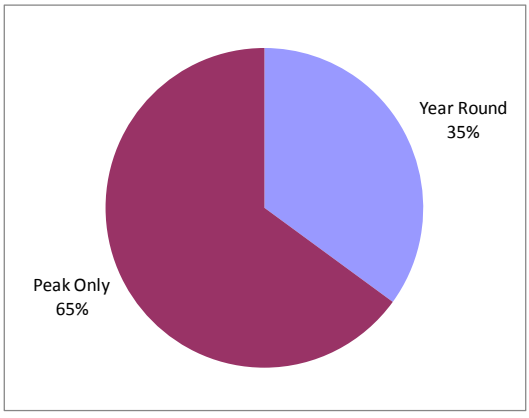


Figure 5 Savings by Seasonality (Package #1)

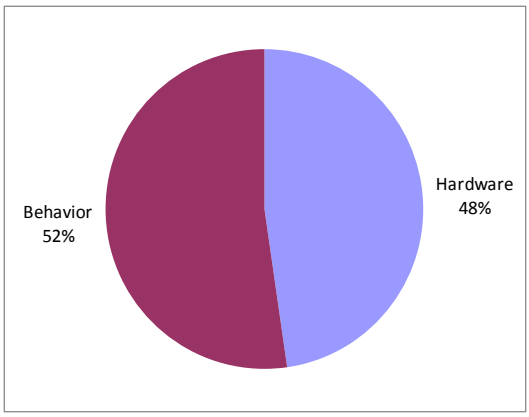


Figure 6 Savings by Hardware vs. Behavior (Package #1)

Figure 7 shows the gallons per day savings for each year. The figure shows how the gallons per day savings: 1) increase during the initial implementation period of 2011-2015, 2) reach their highest level by the last year of the initial implementation period, 3) stay at that level throughout the planning period until 2020, and 4) decline after the end of the planning period as the measures' lifespans expire and the measures are no longer renewed. Note that the savings could be preserved beyond the planning period, however that would require continued spending.

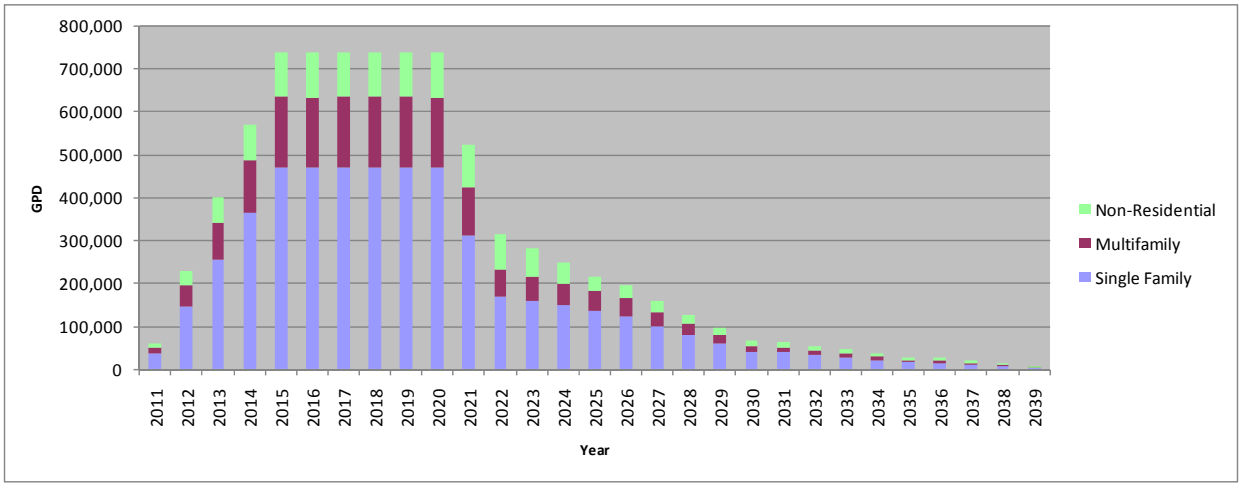


Figure 7 Total Savings Each Year (Package #1)

Figure 8 shows the total direct costs for each year during the planning period for each customer category. The figure shows how the costs: 1) are highest during the initial implementation period, 2) continue at a reduced level during the rest of the planning period due to measure renewal, and 3) end after the planning period. Note that the lower cost in the first year is due to the one-year "ramp-up" period, as described in Section 2.3 related to the implementation schedule.

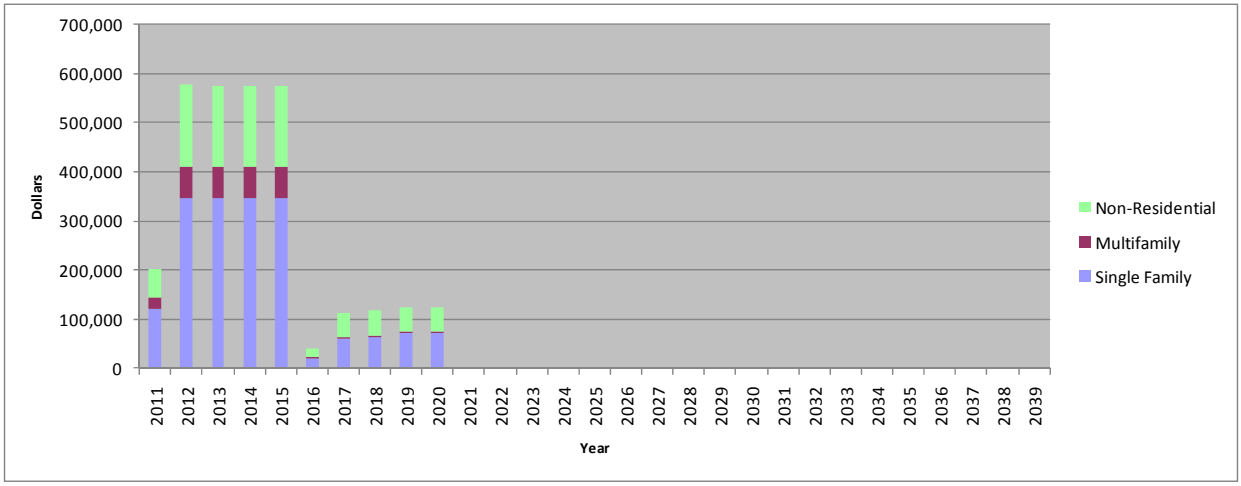


Figure 8 Total Direct Costs Each Year (Package #1)

3.3 Package #2 – Hardware Measures – Indoor and Outdoor

As discussed in Section 2.5, this package was designed to show the maximum water savings from hardware measures that are of most interest to the City. Note that this package includes toilet leak detection dye tablets which, as explained earlier, is considered a hardware measure by the City even though the HDR model technically classifies it as a behavioral measure

The results for Package #2 are shown in Table 8 (the table is located at the end of this Tech Memo since it is 11 x 17 in size). The analysis estimates the package would save approximately 296,000 gpd on an annual average basis and 337,000 gpd on a peak season basis. The total direct cost of achieving those savings is estimated at $1.9 million over the ten-year planning period.

Two pie charts convey information regarding the nature of the savings from this package. Figure 9 shows that the majority of the savings are from the single family category, with the remaining savings split between the multifamily and the non-residential sectors. Figure 10 shows the majority of savings are associated with measures with year-round savings, compared to measures with only peak season savings. By definition of the package, all of the savings are from hardware measures.

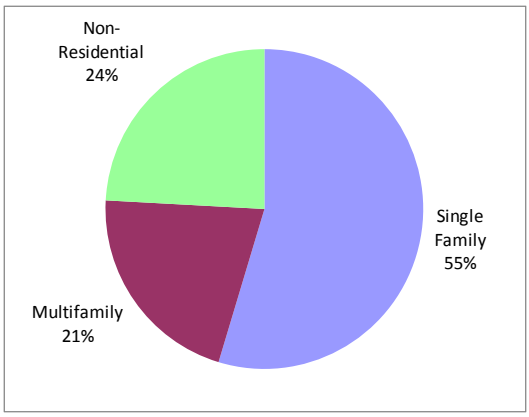


Figure 9 Savings by Customer Category (Package #2)

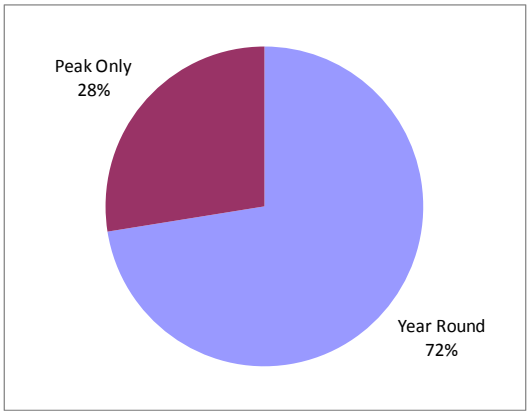


Figure 10 Savings by Seasonality (Package #2)

Figure 11 shows the gallons per day savings for each year, on an average annual basis. The pattern in the figure is similar to the pattern discussed under Package#1 - Conservation Potential Assessment.

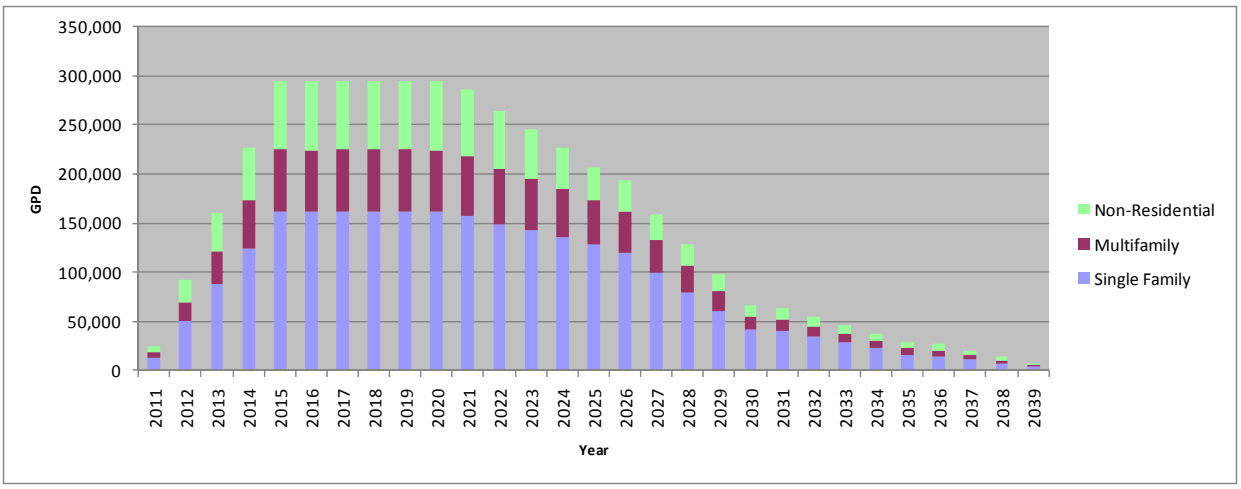


Figure 11 Total Savings Each Year (Package #2)

Figure 12 shows the direct costs for each year during the planning period for each customer category. Note that the lower cost in the first year is due to the one-year "ramp-up" period, as described in Section 2.3 related to the implementation schedule. Although it is not clearly shown in Figure 12, there are minor costs in years 2018 through 2020 due to measure renewal during the planning period.

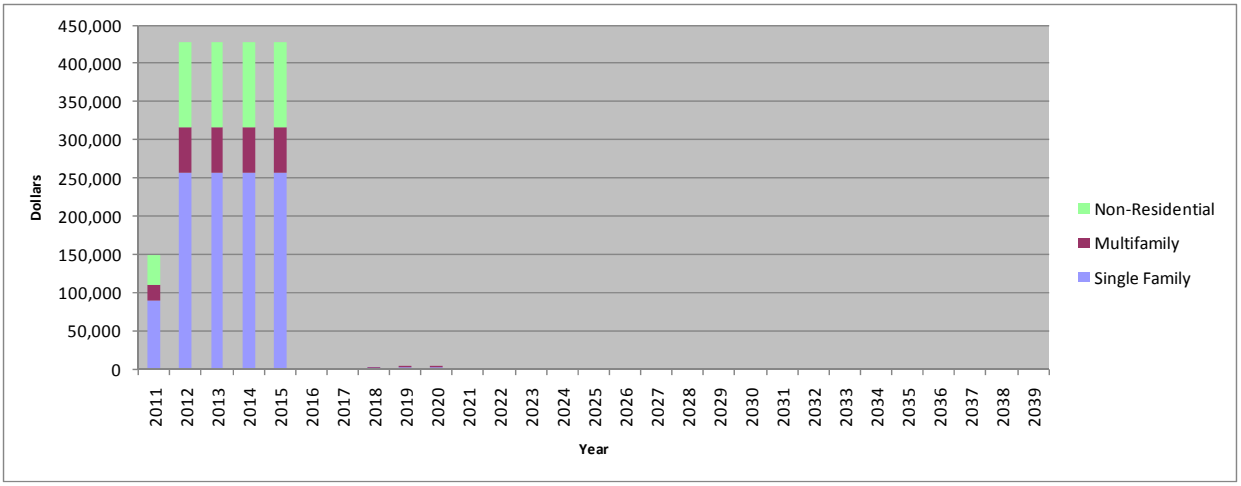


Figure 12 Total Direct Costs Each Year (Package #2)

3.4 Package #3 – Hardware Measures – Outdoor Only

This package was designed to show the maximum water savings from outdoor hardware measures that are of most interest to the City, which is limited to ET Controllers.

The results for Package #3 are shown in Table 9 (the table is located at the end of this Tech Memo since it is 11 x 17 in size). The analysis estimates the package would save approximately 81,000 gpd on an average annual basis and 122,000 gpd on a peak season basis. The total direct cost of achieving those savings is estimated at approximately $380,000 over the ten-year planning period.

Figure 13 shows that nearly half (46%) of the savings are attributed to the non-residential sector, while the single family sector accounts for 34% of the savings, and the remaining 20% of savings are attributed to the multifamily sector. By definition of the package, all of the savings are from hardware measures and are associated with measures focused only on the peak season.

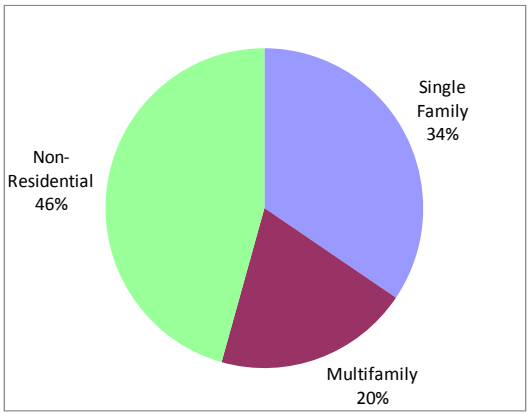


Figure 13 Savings by Customer Category (Package #3)

Figure 14 shows the gallons per day savings for each year, on an average annual basis. The pattern in the figure is similar to the pattern discussed under Package#1 - Conservation Potential Assessment. However, the savings decline more quickly after the end of the planning period since it was not necessary to renew measures during the planning period due to the interaction between the life span of ET controllers, the planning period, and the initial implementation period.

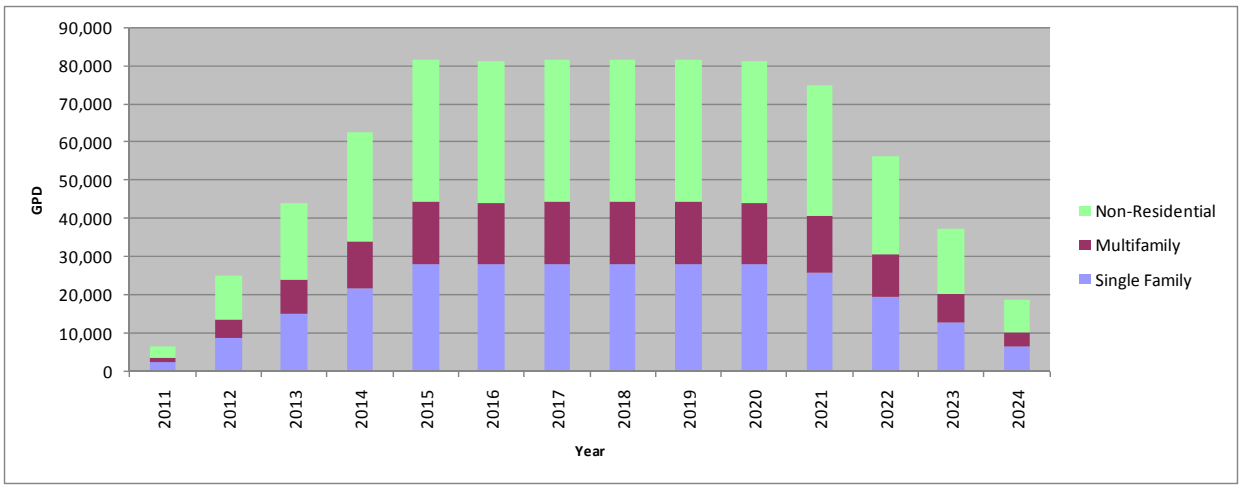


Figure 14 Total Savings Each Year (Package #3)

Figure 15 show the direct costs for each year during the planning period for each customer category. Note that the lower cost in the first year is due to the one-year "ramp-up" period, as described in Section 2.3 related to the implementation schedule.

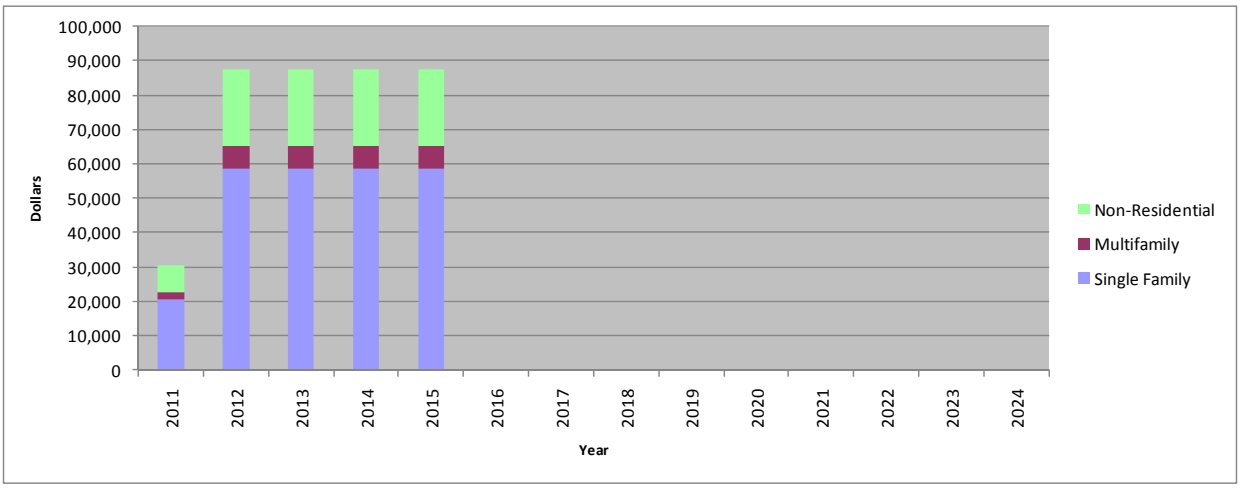


Figure 15 Total Direct Costs Each Year (Package #3)

3.5 Package #4 – Hardware Measures – Indoor Only

This package was designed to show maximum water savings for indoor hardware measures that are of most interest to the City.

The results for Package #4 are shown in Table 10 (the table is located at the end of this Tech Memo since it is 11 x 17 in size). The analysis estimates the package would save approximately 215,000 gpd on both an average annual and peak season basis. The saving are the same since the package only includes indoor measures. The total direct cost of achieving those savings is estimated at approximately $1.5 million over the ten-year planning period.

Figure 16 shows that 62% of the savings are from the single-family category, 22% from multifamily and the remaining 16% from the non-residential category. By definition of the package, all of the savings are from hardware measures and have year round savings.

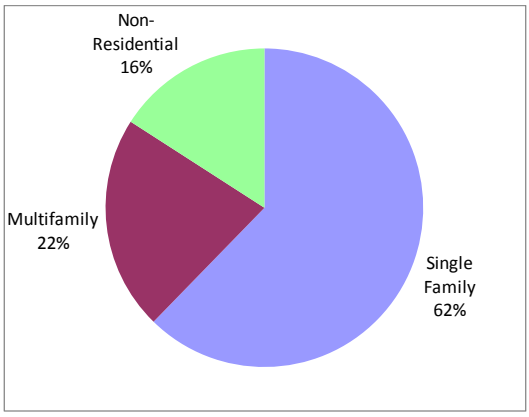


Figure 16 Savings by Customer Category (Package #4)

Figure 17 shows the gallons per day savings for each year, on an average annual basis. The pattern in the figure is similar to the pattern discussed under Package#1 - Conservation Potential Assessment.

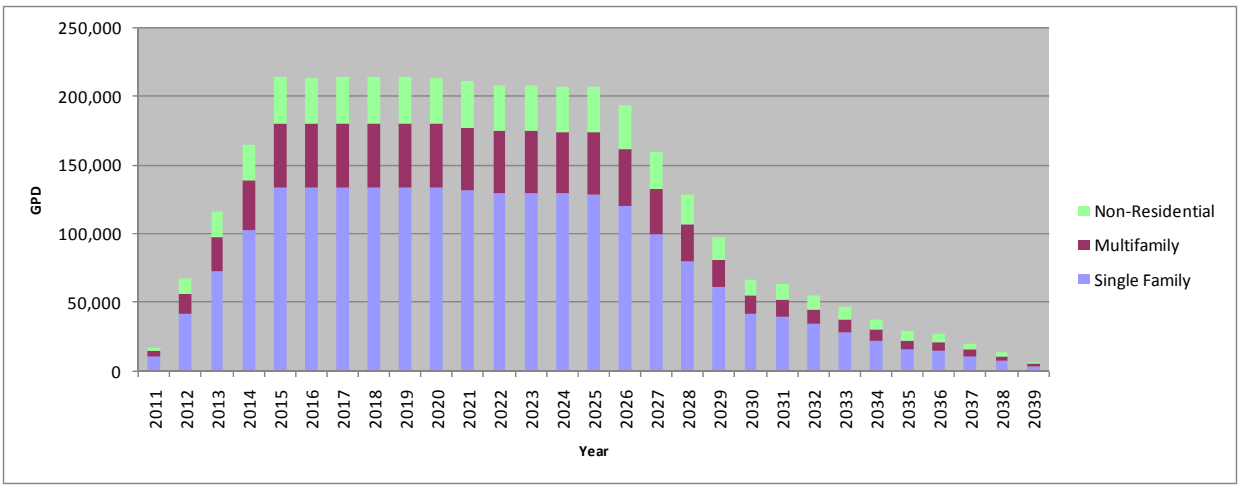


Figure 17 Total Savings Each Year (Package #4)

Figure 18 shows the direct costs for each year during the planning period for each customer category. Note that the lower cost in the first year is due to the one-year "ramp-up" period, as described in Section 2.3 related to the implementation schedule. Although it is not clearly shown in Figure 18, there are minor costs in years 2018 through 2020 due to measure renewal during the planning period.

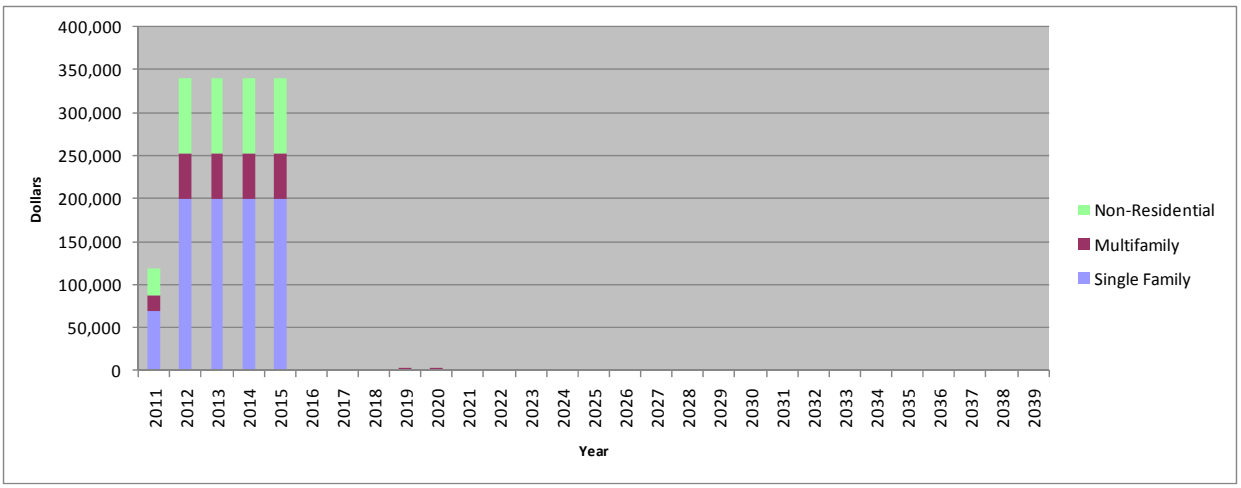


Figure 18 Total Direct Costs Each Year (Package #4)

3.6 Conclusions

A summary of the results from the conservation packages is provided in Table 11. A scatter plot of the average annual savings and the total direct cost over the planning period for each package is provided in Figure 19.

Table 11 Summary of Conservation Package Results

Package	Average Annual Savings		Peak Season Savings (gpd)	Total Direct Cost Over Planning Period	Direct Cost per CCF Saved Over Measure Life
	(gpd)	% of Average 2004-2009 Average Day Demand			
Package #1 - Conservation Potential Assessment	740,000	6.2%	980,000	$3,025,000	$0.80
Package #2 – Hardware Measures – Indoor and Outdoor	296,000	2.5%	337,000	$1,866,000	$0.93
Package #3 – Hardware Measures – Outdoor Only	81,000	0.7%	122,000	$381,000	$1.01
Package #4 – Hardware Measures – Indoor Only	215,000	1.8%	215,000	$1,485,000	$0.91

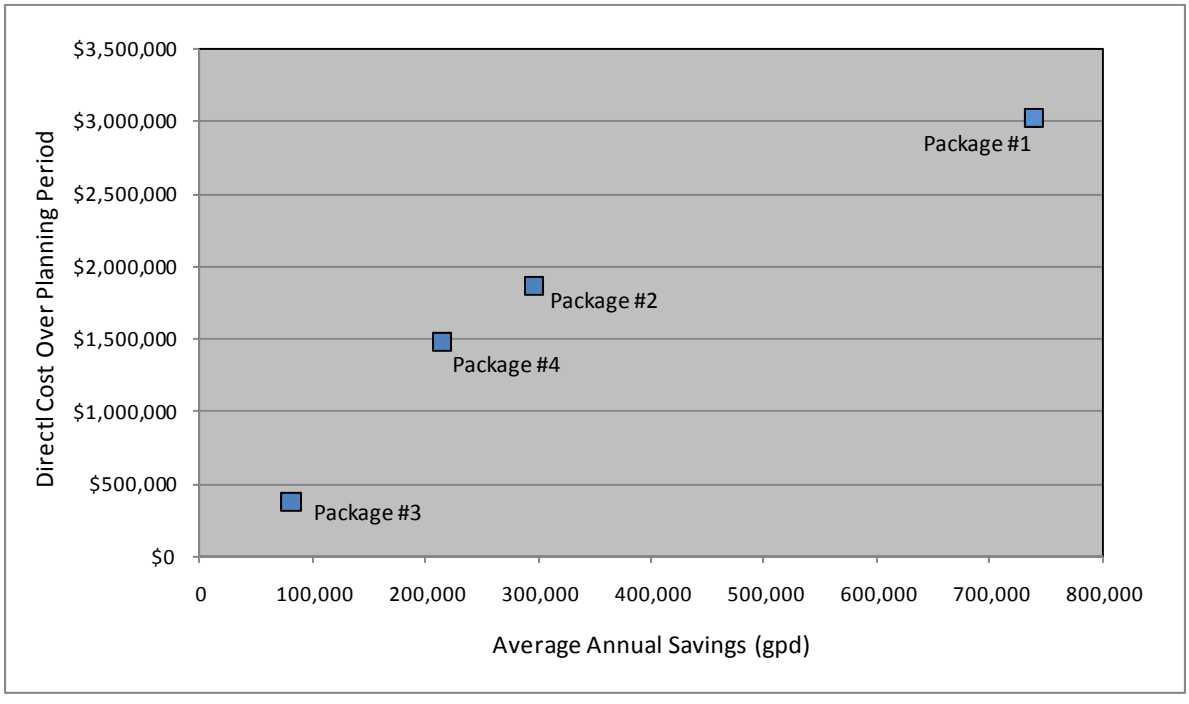


Figure 19 - Comparison of Savings and Costs

This information should be used in concert with Bend's conservation drivers, to determine which package, or subsets thereof, is the most appropriate to implement. Bend understands the environmental benefit of leaving water instream and in the aquifer and is interested in going beyond regulatory commitments to demonstrate strong stewardship of the resource. Bend is also interested in conservation as a mechanism to defer or avoid capital costs and to extend available supplies. As to the latter, the savings of each package should be compared to the volume of water needed to defer capital improvements or source development to determine if conservation can provide the volume of water needed. The direct costs and cost-effectiveness of each package should be compared to potential capital improvements and new sources to determine whether conservation is less expensive or more expensive than those more traditional solutions to water supply needs.

Even if conservation is not sufficient for Bend to avoid the need for capital improvements, the City will still want to implement conservation in order to meet State requirements and to be a good steward of the resource. In that case, each of the packages would be reasonable to implement from a cost effectiveness perspective since their cost effectiveness', which range from $0.80 to $1.01 per ccf of saved water, are all very reasonable. However, the total direct cost of every package is well beyond Bend's current conservation budget. Therefore, a desired conservation budget could be established and any of the packages could be scaled down to meet that budget by eliminating measures and/or decreasing the activity level of measures.

Table 6 Analysis Results – All Measures

Conservation Measure	Sector	Seasonality	Hardware vs Behavior	Customer Definition	PARTICIPATION[2]			SAVINGS			COSTS	
					All Customers			Savings For All Customers At Full Implementation (gpd)		Savings For All Customers Over Measure Life		
					Participating Customers	Savings Generating Customers	Devices / Rebates / Audits	Annual Average	Peak Season	CCF[1]	Total Direct Cost Over Planning Period	Cost per CCF Saved Over Measure Life
Clotheswashers - Efficient Res. Capacity (In Unit)	SF	Year Round	Hardware	SF Households	3,499	3,499	3,499	47,586	47,586	296,063	$349,900	$1.18
Clotheswashers - Efficient Res. Capacity (In Unit)	MF	Year Round	Hardware	MF Households	611	611	611	8,310	8,310	51,699	$61,100	$1.18
Clotheswashers - Efficient Res. Capacity (Common Area)	MF	Year Round	Hardware	MF Households	611	611	122	8,310	8,310	51,699	$12,220	$0.24
Clotheswashers - Efficient Comm. Capacity	NR	Year Round	Hardware	NR Accounts	7	7	84	9,408	9,408	58,533	$21,000	$0.36
Faucets - 0.5 gpm Bathroom Aerators	SF	Year Round	Hardware	SF Households	2,029	1,522	5,073	13,698	13,698	126,979	$5,070	$0.04
Faucets - 0.5 gpm Bathroom Aerators	MF	Year Round	Hardware	MF Households	789	592	1,184	3,434	3,434	31,821	$1,180	$0.04
Faucets - 1.0 gpm Bathroom Aerators	SF	Year Round	Hardware	SF Households	5,072	3,804	12,680	25,867	25,867	239,825	$12,680	$0.05
Faucets - 1.0 gpm Bathroom Aerators	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	6,512	6,512	60,365	$2,960	$0.05
Showerhead 2.0 gpm	SF	Year Round	Hardware	SF Households	5,072	3,804	10,144	18,259	18,259	126,966	$30,430	$0.24
Showerhead 2.0 gpm	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	7,104	7,104	49,390	$8,880	$0.18
Showerhead 2.0 gpm	NR	Year Round	Hardware	NR Accounts	43	32	430	6,400	6,400	44,850	$1,290	$0.03
Toilets - 1.28 gpf High Efficiency Toilets (HET)	SF	Year Round	Hardware	SF Households	2,029	2,029	4,667	16,232	16,232	188,117	$466,670	$2.48
Toilets - 1.28 gpf High Efficiency Toilets (HET)	MF	Year Round	Hardware	MF Households	789	789	1,420	6,312	6,312	73,151	$142,020	$1.94
Toilets - 1.28 gpf High Efficiency Toilets (HET)	NR	Year Round	Hardware	NR Accounts	344	344	1,455	6,777	6,777	78,543	$218,280	$2.78
Urinals - 0.5 gpf Models	NR	Year Round	Hardware	NR Accounts	689	689	1,457	4,893	4,893	45,363	$145,730	$3.21
Urinals - Waterless Models	NR	Year Round	Hardware	NR Accounts	138	138	292	1,946	1,946	18,042	$43,780	$2.43
Clotheswashers - Decrease Partial Loads	SF	Year Round	Behavior	SF Households	1,839	1,839	0	6,253	6,253	23,652	$0	$0.00
Clotheswashers - Decrease Partial Loads	MF	Year Round	Behavior	MF Households	642	642	0	2,183	2,183	8,257	$0	$0.00
Faucets - Decrease Use	SF	Year Round	Behavior	SF Households	2,029	2,029	0	6,899	6,899	26,096	$0	$0.00
Faucets - Decrease Use	MF	Year Round	Behavior	MF Households	789	789	0	1,736	1,736	6,566	$0	$0.00
Showerheads - Decrease Use	SF	Year Round	Behavior	SF Households	2,029	2,029	0	4,464	4,464	16,885	$0	$0.00
Showerheads - Decrease Use	MF	Year Round	Behavior	MF Households	789	789	0	1,736	1,736	6,566	$0	$0.00
Toilets - Decrease Flushes	SF	Year Round	Behavior	SF Households	2,029	2,029	0	4,870	4,870	18,420	$0	$0.00
Toilets - Decrease Flushes	MF	Year Round	Behavior	MF Households	789	789	0	1,894	1,894	7,163	$0	$0.00
Irrigation Controllers - ET Model	SF	Peak Only	Hardware	SF Households	1,020	1,020	1,020	28,066	42,100	130,107	$255,000	$1.96
Irrigation Controllers - ET Model	MF	Peak Only	Hardware	MF Accounts	57	57	57	16,202	24,304	75,110	$28,500	$0.38
Irrigation Controllers - ET Model	NR	Peak Only	Hardware	NR Accounts	195	195	195	37,191	55,787	172,407	$97,500	$0.57
Irrigation Controllers - Rain Sensors	SF	Peak Only	Hardware	SF Households	862	862	862	7,906	11,859	36,651	$86,200	$2.35
Irrigation Controllers - Rain Sensors	MF	Peak Only	Hardware	MF Accounts	48	48	48	4,548	6,822	21,083	$4,800	$0.23
Irrigation Controllers - Rain Sensors	NR	Peak Only	Hardware	NR Accounts	164	164	164	10,426	15,639	48,333	$16,400	$0.34
Outdoor Irrigation Kits	SF	Peak Only	Hardware	SF Households	2,847	2,135	4,384	19,584	29,376	97,878	$65,773	$0.67
Outdoor Audit	SF	Peak Only	Behavior	SF Households	1,034	259	2,068	7,127	10,690	32,973	$517,000	$15.68
Outdoor Audit	MF	Peak Only	Behavior	MF Accounts	57	14	114	3,980	5,969	18,777	$28,500	$1.52
Outdoor Audit	NR	Peak Only	Behavior	NR Accounts	196	49	392	9,345	14,018	43,323	$392,000	$9.05
Lawn Dormant	SF	Peak Only	Behavior	SF Households	1,725	1,725	0	253,180	379,770	957,710	$0	$0.00
Lawn Dormant	MF	Peak Only	Behavior	MF Accounts	55	55	0	83,309	124,964	315,136	$0	$0.00
Faucets - 0.5 gpm Bathroom Aerators	NR	Year Round	Hardware	NR Accounts	78	59	165	997	997	724	$160	$0.22
Toilets - 1.6 gpf Ultra Low Flow Toilets (ULFT)	SF	Year Round	Hardware	SF Households	977	977	2,247	22,961	22,961	33,612	$168,530	$5.01
Toilets - 1.6 gpf Ultra Low Flow Toilets (ULFT)	MF	Year Round	Hardware	MF Households	380	380	684	8,931	8,931	13,073	$51,300	$3.92
Toilets - 1.6 gpf Ultra Low Flow Toilets (ULFT)	NR	Year Round	Hardware	NR Accounts	166	166	702	9,827	9,827	14,386	$52,670	$3.66
Urinals - 1.0 gpf Models	NR	Year Round	Hardware	NR Accounts	62	62	131	440	440	322	$13,110	$40.68
Toilets - Leak Detection	SF	Year Round	Hardware	SF Households	981	491	71,866	9,034	9,034	45,101	$9,379	$0.21
Toilets - Leak Detection	MF	Year Round	Hardware	MF Households	382	191	14,203	3,514	3,514	17,562	$2,433	$0.14
Faucets - 1.5 gpm Bathroom Aerators	SF	Year Round	Hardware	SF Households	5,072	3,804	12,680	17,498	17,498	162,234	$12,680	$0.08
Faucets - 1.5 gpm Bathroom Aerators	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	4,294	4,294	39,805	$2,960	$0.07
Showerhead 1.5 gpm	SF	Year Round	Hardware	SF Households	5,072	3,804	10,144	34,997	34,997	243,352	$30,430	$0.13
Showerhead 1.5 gpm	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	13,616	13,616	94,663	$8,880	$0.09
Showerhead 1.5 gpm	NR	Year Round	Hardware	NR Accounts	43	32	430	12,160	12,160	85,216	$1,290	$0.02
Spray Valves - 1.25 gpm Pre-Rinse Spray Valve	NR	Year Round	Hardware	NR Accounts	123	123	369	14,539	14,539	67,397	$47,980	$0.71

SF – Single Family, MF – Multifamily, NR – Non-Residential

1. Savings from free riders have been omitted from this column, since this number is used in the cost-effectiveness calculation.
2. For the number of potential customers, look at the number of SF households, MF households, MF accounts, or NR accounts (as applicable) in Table 4 Demographics.

Table 7 Analysis Results – Package #1 Conservation Potential Assessment

Conservation Measure	Sector	Seasonality	Hardware vs Behavior	Customer Definition	PARTICIPATION[2]			SAVINGS			COSTS	
					All Customers			Savings For All Customers At Full Implementation (gpd)		Savings For All Customers Over Measure Life		
					Participating Customers	Savings Generating Customers	Devices / Rebates / Audits	Annual Average	Peak Season	CCF[1]	Total Direct Cost Over Planning Period	Cost per CCF Saved Over Measure Life
Clotheswashers - Efficient Res. Capacity (In Unit)	SF	Year Round	Hardware	SF Households	3,499	3,499	3,499	47,586	47,586	296,063	$349,900	$1.18
Clotheswashers - Efficient Res. Capacity (In Unit)	MF	Year Round	Hardware	MF Households	611	611	611	8,310	8,310	51,699	$61,100	$1.18
Clotheswashers - Efficient Res. Capacity (Common Area)	MF	Year Round	Hardware	MF Households	611	611	122	8,310	8,310	51,699	$12,220	$0.24
Clotheswashers - Efficient Comm. Capacity	NR	Year Round	Hardware	NR Accounts	7	7	84	9,408	9,408	58,533	$21,000	$0.36
Faucets - 1.0 gpm Bathroom Aerators	SF	Year Round	Hardware	SF Households	5,072	3,804	12,680	25,867	25,867	239,825	$12,680	$0.05
Faucets - 1.0 gpm Bathroom Aerators	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	6,512	6,512	60,365	$2,960	$0.05
Toilets - 1.28 gpf High Efficiency Toilets (HET)	SF	Year Round	Hardware	SF Households	2,029	2,029	4,667	16,232	16,232	188,117	$466,670	$2.48
Toilets - 1.28 gpf High Efficiency Toilets (HET)	MF	Year Round	Hardware	MF Households	789	789	1,420	6,312	6,312	73,151	$142,020	$1.94
Toilets - 1.28 gpf High Efficiency Toilets (HET)	NR	Year Round	Hardware	NR Accounts	344	344	1,455	6,777	6,777	78,543	$218,280	$2.78
Urinals - 0.5 gpf Models	NR	Year Round	Hardware	NR Accounts	689	689	1,457	4,893	4,893	45,363	$145,730	$3.21
Clotheswashers - Decrease Partial Loads	SF	Year Round	Behavior	SF Households	1,839	1,839	0	6,253	6,253	23,652	$0	$0.00
Clotheswashers - Decrease Partial Loads	MF	Year Round	Behavior	MF Households	642	642	0	2,183	2,183	8,257	$0	$0.00
Faucets - Decrease Use	SF	Year Round	Behavior	SF Households	2,029	2,029	0	6,899	6,899	26,096	$0	$0.00
Faucets - Decrease Use	MF	Year Round	Behavior	MF Households	789	789	0	1,736	1,736	6,566	$0	$0.00
Showerheads - Decrease Use	SF	Year Round	Behavior	SF Households	2,029	2,029	0	4,464	4,464	16,885	$0	$0.00
Showerheads - Decrease Use	MF	Year Round	Behavior	MF Households	789	789	0	1,736	1,736	6,566	$0	$0.00
Toilets - Decrease Flushes	SF	Year Round	Behavior	SF Households	2,029	2,029	0	4,870	4,870	18,420	$0	$0.00
Toilets - Decrease Flushes	MF	Year Round	Behavior	MF Households	789	789	0	1,894	1,894	7,163	$0	$0.00
Irrigation Controllers - ET Model	SF	Peak Only	Hardware	SF Households	1,020	1,020	1,020	28,066	42,100	130,107	$255,000	$1.96
Irrigation Controllers - ET Model	MF	Peak Only	Hardware	MF Accounts	57	57	57	16,202	24,304	75,110	$28,500	$0.38
Irrigation Controllers - ET Model	NR	Peak Only	Hardware	NR Accounts	195	195	195	37,191	55,787	172,407	$97,500	$0.57
Irrigation Controllers - Rain Sensors	SF	Peak Only	Hardware	SF Households	862	862	862	7,906	11,859	36,651	$86,200	$2.35
Irrigation Controllers - Rain Sensors	MF	Peak Only	Hardware	MF Accounts	48	48	48	4,548	6,822	21,083	$4,800	$0.23
Irrigation Controllers - Rain Sensors	NR	Peak Only	Hardware	NR Accounts	164	164	164	10,426	15,639	48,333	$16,400	$0.34
Outdoor Irrigation Kits	SF	Peak Only	Hardware	SF Households	2,847	2,135	4,384	19,584	29,376	97,878	$65,773	$0.67
Outdoor Audit	SF	Peak Only	Behavior	SF Households	1,034	259	2,068	7,127	10,690	32,973	$517,000	$15.68
Outdoor Audit	MF	Peak Only	Behavior	MF Accounts	57	14	114	3,980	5,969	18,777	$28,500	$1.52
Outdoor Audit	NR	Peak Only	Behavior	NR Accounts	196	49	392	9,345	14,018	43,323	$392,000	$9.05
Lawn Dormant	SF	Peak Only	Behavior	SF Households	1,725	1,725	0	253,180	379,770	957,710	$0	$0.00
Lawn Dormant	MF	Peak Only	Behavior	MF Accounts	55	55	0	83,309	124,964	315,136	$0	$0.00
Faucets - 0.5 gpm Bathroom Aerators	NR	Year Round	Hardware	NR Accounts	78	59	165	997	997	724	$160	$0.22
Toilets - Leak Detection	SF	Year Round	Hardware	SF Households	981	491	71,866	9,034	9,034	45,101	$9,379	$0.21
Toilets - Leak Detection	MF	Year Round	Hardware	MF Households	382	191	14,203	3,514	3,514	17,562	$2,433	$0.14
Showerhead 1.5 gpm	SF	Year Round	Hardware	SF Households	5,072	3,804	10,144	34,997	34,997	243,352	$30,430	$0.13
Showerhead 1.5 gpm	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	13,616	13,616	94,663	$8,880	$0.09
Showerhead 1.5 gpm	NR	Year Round	Hardware	NR Accounts	43	32	430	12,160	12,160	85,216	$1,290	$0.02
Spray Valves - 1.25 gpm Pre-Rinse Spray Valve	NR	Year Round	Hardware	NR Accounts	123	123	369	14,539	14,539	67,397	$47,980	$0.71
Total					N/A	N/A	N/A	739,962	980,395	3,760,467	$3,024,785	$0.80

SF – Single Family, MF – Multifamily, NR – Non-Residential

1. Savings from free riders have been omitted from this column, since this number is used in the cost-effectiveness calculation.
2. For the number of potential customers, look at the number of SF households, MF households, MF accounts, or NR accounts (as applicable) in Table 4 Demographics.

Table 8 Analysis Results – Package #2 Hardware Measures: Indoor and Outdoor

Conservation Measure	Sector	Seasonality	Hardware vs Behavior	Customer Definition	PARTICIPATION[2]			SAVINGS			COSTS	
					All Customers			Savings For All Customers At Full Implementation (gpd)		Savings For All Customers Over Measure Life		
					Participating Customers	Savings Generating Customers	Devices / Rebates / Audits	Annual Average	Peak Season	CCF[1]	Total Direct Cost Over Planning Period	Cost per CCF Saved Over Measure Life
Clotheswashers - Efficient Res. Capacity (In Unit)	SF	Year Round	Hardware	SF Households	3,499	3,499	3,499	47,586	47,586	296,063	$349,900	$1.18
Clotheswashers - Efficient Res. Capacity (In Unit)	MF	Year Round	Hardware	MF Households	611	611	611	8,310	8,310	51,699	$61,100	$1.18
Clotheswashers - Efficient Res. Capacity (Common Area)	MF	Year Round	Hardware	MF Households	611	611	122	8,310	8,310	51,699	$12,220	$0.24
Clotheswashers - Efficient Comm. Capacity	NR	Year Round	Hardware	NR Accounts	7	7	84	9,408	9,408	58,533	$21,000	$0.36
Faucets - 1.0 gpm Bathroom Aerators	SF	Year Round	Hardware	SF Households	5,072	3,804	12,680	25,867	25,867	239,825	$12,680	$0.05
Faucets - 1.0 gpm Bathroom Aerators	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	6,512	6,512	60,365	$2,960	$0.05
Toilets - 1.28 gpf High Efficiency Toilets (HET)	SF	Year Round	Hardware	SF Households	2,029	2,029	4,667	16,232	16,232	188,117	$466,670	$2.48
Toilets - 1.28 gpf High Efficiency Toilets (HET)	MF	Year Round	Hardware	MF Households	789	789	1,420	6,312	6,312	73,151	$142,020	$1.94
Toilets - 1.28 gpf High Efficiency Toilets (HET)	NR	Year Round	Hardware	NR Accounts	344	344	1,455	6,777	6,777	78,543	$218,280	$2.78
Urinals - 0.5 gpf Models	NR	Year Round	Hardware	NR Accounts	689	689	1,457	4,893	4,893	45,363	$145,730	$3.21
Irrigation Controllers - ET Model	SF	Peak Only	Hardware	SF Households	1,020	1,020	1,020	28,066	42,100	130,107	$255,000	$1.96
Irrigation Controllers - ET Model	MF	Peak Only	Hardware	MF Accounts	57	57	57	16,202	24,304	75,110	$28,500	$0.38
Irrigation Controllers - ET Model	NR	Peak Only	Hardware	NR Accounts	195	195	195	37,191	55,787	172,407	$97,500	$0.57
Faucets - 0.5 gpm Bathroom Aerators	NR	Year Round	Hardware	NR Accounts	78	59	165	997	997	724	$160	$0.22
Toilets - Leak Detection	SF	Year Round	Hardware	SF Households	981	491	71,866	9,034	9,034	45,101	$9,379	$0.21
Toilets - Leak Detection	MF	Year Round	Hardware	MF Households	382	191	14,203	3,514	3,514	17,562	$2,433	$0.14
Showerhead 1.5 gpm	SF	Year Round	Hardware	SF Households	5,072	3,804	10,144	34,997	34,997	243,352	$30,430	$0.13
Showerhead 1.5 gpm	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	13,616	13,616	94,663	$8,880	$0.09
Showerhead 1.5 gpm	NR	Year Round	Hardware	NR Accounts	43	32	430	12,160	12,160	85,216	$1,290	$0.02
Total					N/A	N/A	N/A	295,986	336,716	2,007,601	$1,866,132	$0.93

SF – Single Family, MF – Multifamily, NR – Non-Residential

1. Savings from free riders have been omitted from this column, since this number is used in the cost-effectiveness calculation.
2. For the number of potential customers, look at the number of SF households, MF households, MF accounts, or NR accounts (as applicable) in Table 4 Demographics.

Table 9 Analysis Results –Package 3 Hardware Measures: Outdoor Only

Conservation Measure	Sector	Seasonality	Hardware vs Behavior	Customer Definition	PARTICIPATION[2]			SAVINGS			COSTS	
					All Customers			Savings For All Customers At Full Implementation (gpd)		Savings For All Customers Over Measure Life		
					Participating Customers	Savings Generating Customers	Devices / Rebates / Audits	Annual Average	Peak Season	CCF[1]	Total Direct Cost Over Planning Period	Cost per CCF Saved Over Measure Life
Irrigation Controllers - ET Model	SF	Peak Only	Hardware	SF Households	1,020	1,020	1,020	28,066	42,100	130,107	$255,000	$1.96
Irrigation Controllers - ET Model	MF	Peak Only	Hardware	MF Accounts	57	57	57	16,202	24,304	75,110	$28,500	$0.38
Irrigation Controllers - ET Model	NR	Peak Only	Hardware	NR Accounts	195	195	195	37,191	55,787	172,407	$97,500	$0.57
Total					N/A	N/A	N/A	81,460	122,190	377,624	$381,000	$1.01

SF – Single Family, MF – Multifamily, NR – Non-Residential

1. Savings from free riders have been omitted from this column, since this number is used in the cost-effectiveness calculation.
2. For the number of potential customers, look at the number of SF households, MF households, MF accounts, or NR accounts (as applicable) in Table 4 Demographics.

Table 10 Analysis Results – Package #4 Hardware Measures: Indoor Only

Conservation Measure	Sector	Seasonality	Hardware vs Behavior	Customer Definition	PARTICIPATION[2]			SAVINGS			COSTS	
					All Customers			Savings For All Customers At Full Implementation (gpd)		Savings For All Customers Over Measure Life		
					Participating Customers	Savings Generating Customers	Devices / Rebates / Audits	Annual Average	Peak Season	CCF[1]	Total Direct Cost Over Planning Period	Cost per CCF Saved Over Measure Life
Clotheswashers - Efficient Res. Capacity (In Unit)	SF	Year Round	Hardware	SF Households	3,499	3,499	3,499	47,586	47,586	296,063	$349,900	$1.18
Clotheswashers - Efficient Res. Capacity (In Unit)	MF	Year Round	Hardware	MF Households	611	611	611	8,310	8,310	51,699	$61,100	$1.18
Clotheswashers - Efficient Res. Capacity (Common Area)	MF	Year Round	Hardware	MF Households	611	611	122	8,310	8,310	51,699	$12,220	$0.24
Clotheswashers - Efficient Comm. Capacity	NR	Year Round	Hardware	NR Accounts	7	7	84	9,408	9,408	58,533	$21,000	$0.36
Faucets - 1.0 gpm Bathroom Aerators	SF	Year Round	Hardware	SF Households	5,072	3,804	12,680	25,867	25,867	239,825	$12,680	$0.05
Faucets - 1.0 gpm Bathroom Aerators	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	6,512	6,512	60,365	$2,960	$0.05
Toilets - 1.28 gpf High Efficiency Toilets (HET)	SF	Year Round	Hardware	SF Households	2,029	2,029	4,667	16,232	16,232	188,117	$466,670	$2.48
Toilets - 1.28 gpf High Efficiency Toilets (HET)	MF	Year Round	Hardware	MF Households	789	789	1,420	6,312	6,312	73,151	$142,020	$1.94
Toilets - 1.28 gpf High Efficiency Toilets (HET)	NR	Year Round	Hardware	NR Accounts	344	344	1,455	6,777	6,777	78,543	$218,280	$2.78
Urinals - 0.5 gpf Models	NR	Year Round	Hardware	NR Accounts	689	689	1,457	4,893	4,893	45,363	$145,730	$3.21
Faucets - 0.5 gpm Bathroom Aerators	NR	Year Round	Hardware	NR Accounts	78	59	165	997	997	724	$160	$0.22
Toilets - Leak Detection	SF	Year Round	Hardware	SF Households	981	491	71,866	9,034	9,034	45,101	$9,379	$0.21
Toilets - Leak Detection	MF	Year Round	Hardware	MF Households	382	191	14,203	3,514	3,514	17,562	$2,433	$0.14
Showerhead 1.5 gpm	SF	Year Round	Hardware	SF Households	5,072	3,804	10,144	34,997	34,997	243,352	$30,430	$0.13
Showerhead 1.5 gpm	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	13,616	13,616	94,663	$8,880	$0.09
Showerhead 1.5 gpm	NR	Year Round	Hardware	NR Accounts	43	32	430	12,160	12,160	85,216	$1,290	$0.02
Total					N/A	N/A	N/A	214,526	214,526	1,629,977	$1,485,132	$0.91

SF – Single Family, MF – Multifamily, NR – Non-Residential

1. Savings from free riders have been omitted from this column, since this number is used in the cost-effectiveness calculation.
2. For the number of potential customers, look at the number of SF households, MF households, MF accounts, or NR accounts (as applicable) in Table 4 Demographics.