Water Management and Conservation Plan

September 2021

CITY OF BEND

GSI Water Solutions, Inc.

Exhibit 25
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Cover Photos (clockwise from top-left): WaterWise landscaping (City of Bend); aerial view of Bend looking West (City of Bend); Prowell Springs, Bend Municipal Watershed (Patrick Griffiths).

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Abbreviations and Acronyms

ADD	average day demand
MDD	maximum day demand
MMD	maximum monthly demand
NRW	non-revenue water
BMW	Bend Municipal Watershed
USFS	U.S. Forest Service
TID	Tumalo Irrigation District
OAR	Oregon Administrative Rule
ORS	Oregon Revised Statute
City	City of Bend
Avion	Avion Water Company, Inc.
Roats	Roats Water System, Inc.
UGB	Urban Growth Boundary
IWSMP	Integrated Water System Master Plan
WMCP	Water Management and Conservation Plan
WQA	winter-quarter average
cfs	cubic foot per second
SWIP	Surface Water Improvement Project
AMI	advanced metering infrastructure
SCADA	supervisory control and data acquisition
DSS	decision support system
SUP	special use permit
WARS	water availability reporting system
gpm	gallons per minute
gpcpd	gallons per capita per day
WFF	Water Filtration Facility

1. Municipal Water Supplier Plan Elements

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

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

1.1 Introduction

The City of Bend (City) is located along the Deschutes River in the eastern foothills of the scenic Cascade Range. Vibrant economic growth and extensive outdoor recreation opportunities continue to draw new residents and businesses, increasing the demand for water within the City. The City operates a public drinking water system that supplies water to its customers using surface water from the Bend Municipal Watershed (BMW), and groundwater from the Deschutes Regional Aquifer to meet seasonal demand. The City recognizes the value of these dual water sources and actively seeks opportunities to protect and conserve its water supply for the benefit of its customers and the entire Deschutes River Basin. 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.

Two private water utilities, Avion Water Company, Inc. (Avion) and Roats Water System, Inc. (Roats) serve areas within the City limits and Urban Growth Boundary (UGB) under franchise agreements with the City. As a result, the City's water service population is estimated to be 67,187, approximately 75% of the population of the City of Bend UGB population. The City's water service population is likely higher due to the daily influx of commuters and visitors for recreation and tourism. Irrigation needs also increase summer water demand.

In 2002, the Oregon Water Resources Commission adopted administrative rules requiring mitigation for the impacts of pumping under new groundwater permits (OAR 690-507). Two of the City's permits for groundwater use (G-18123 and G-18124) require the City to provide mitigation as part of the Deschutes Basin Groundwater Mitigation Program, and the City has an approved incremental mitigation plan for each permit. The City continues to develop water use under these permits.

This Water Management and Conservation Plan has been developed in conjunction with the City of Bend's Integrated Water System Master Plan (IWSMP).

1.2 Plan Requirement

This Water Management and Conservation Plan (WMCP or Plan) fulfills the requirements of Oregon Administrative Rules (OAR) Chapter 690, Division 86, effective as of December 2018.

The City completed its first WMCP in August 1998. The City has submitted two updated WMCPs to the Oregon Water Resources Department (OWRD) since that time. The most recent update was submitted on January 3, 2011. OWRD issued a final order approving the City's current WMCP on June 30, 2011. Consistent with that order, the City also submitted a WMCP Progress Report in June 2016 describing the City's water use and progress on water conservation measures. The 2011 final order required the

City to submit an updated WMCP within 10 years of approval of the WMCP and no later than December 29, 2020.

1.3 Plan Organization

The Plan is organized into the following five sections, each addressing specific requirements 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 provides the foundation for the sections that follow. Sections 3 through 5 describe how the City can improve its water conservation and water supply planning efforts. The Plan also includes appendices with supporting information.

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

1.4 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 entities listed above along with a request for comments related to consistency with the local government's comprehensive land use plan. The letter requesting comments and any comments received are included in **Appendix A**.

1.5 Plan Update Schedule

OAR 690-086-1025(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.

1.6 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 water supplier'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 water supplier's customers and their water use, the water system, interconnections with other water suppliers, and quantification of water loss.

2.1 Terminology

The following terminology is used in this WMCP.

Demand refers to the quantity of water delivered to a distribution system from a water treatment plant, wholesale supplier, or groundwater well. By definition, production equals system demand. Demand includes metered consumption (for example, residential, commercial, industrial, public, and irrigation customers), unmetered public uses (firefighting, hydrant flushing, other), and water lost to leakage and other factors. The City uses the American Water Works Association's (AWWA) M36 methodology for evaluating water system efficiency. The term demand, as used in this document, is equivalent to the AWWA's "water supplied." See **Exhibit 2-1** for a matrix showing the water balance table with terms and components used to describe water production, consumption, and loss in a water system, through the standards of AWWA's M36 methodology.

Authorized consumption is equal to metered water use and unmetered, authorized water use (e.g., system flushing), both billed and unbilled. Note that exhibits and descriptions of monthly or seasonal consumption only consider metered water use, as certain unmetered water uses are only estimated on an annual basis. Due to the low volume of unmetered water uses, metered water use is sufficiently similar to authorized consumption to make monthly and seasonal comparisons across years.

Demand minus authorized consumption equals **water loss.** Water loss is equal to the sum of apparent and real losses. **Apparent losses** include unauthorized consumption and meter inaccuracies, among other loss types; **real losses** include leakage on transmission and distribution mains up to the point of customer metering.

Non-revenue water (NRW) is the volume of water supplied that is unbilled and does not produce revenue, equal to real and apparent losses plus unbilled authorized consumption.

Generally, demand and consumption in municipal systems are expressed in units of million gallons per day (mgd), but also may be expressed in cubic feet per second (cfs) or gallons per minute (gpm). One mgd is equivalent to approximately 1.55 cfs or 694 gpm. For annual or monthly values, a quantity of water is typically reported in million gallons (MG). Water use per person (per capita use) is expressed in gallons per capita per day (gpcd).

The following terms are used to describe specific values of system demand:

- **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 one-day MDD or peak-day demand.
- **Monthly demand** equals the total volume of water produced in a month.
- **Maximum monthly demand (MMD)** equals the highest demand that occurs over a single month of a calendar year.
- **Maximum operational demand** equals the four-hour rolling average maximum demand during the year.
- **Peaking factors** are the ratios of one demand value to another. The most common and important peaking factor is the ratio of the MDD to the ADD.

Exhibit 2-1. AWWA M36 Water Audit Matrix

<table>
<tr><td rowspan="8">Volume from Own Sources (Adjusted for known errors)</td><td rowspan="11">System Input Volume</td><td>Water Exported</td><td colspan="3">Billed Water Exported</td><td>Revenue Water</td></tr>
<tr><td rowspan="10">Water Supplied</td><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption (water exported is removed)</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="8">Non-Revenue Water (NRW)</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="6">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Systematic Data Handling Errors</td></tr>
<tr><td rowspan="3">Water Imported</td><td rowspan="3">Real Losses</td><td>Leakage on Transmission and/or Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections</td></tr>
</table>

2.2 Water Sources

OAR 690-086-0140(1)

The City's primary water sources are surface water from the BMW and groundwater from the Deschutes Regional Aquifer.

2.2.1 Surface Water

The City's surface water intake is approximately 11.5 miles west of the city limits; on Bridge Creek, just above its confluence with Tumalo Creek. A 1926 agreement between the U. S. Forest Service (USFS) and the City created the BMW, and subsequent USFS plans recognize and designate municipal use as the highest and best use of the watershed. The BMW lies within the Deschutes National Forest, which is managed by the USFS. In addition, the USFS has issued several special use permits to the City that require significant environmental analysis and provide clear communication channels between signatories, control human activity, and protect water quality through regulations, restrictions, and ongoing monitoring.

The City's surface water system was developed in the 1920s and expanded in the 1950s as an unfiltered, gravity-flow system. Surface water provides approximately half of the City's annual water supply; groundwater provides the other half. The surface water supply is diverted at the Heidi Lansdowne Intake Facility located on Bridge Creek, which contains the combined flows from Bridge Creek and natural springs in the BMW from the Middle Fork of Tumalo Creek that are conveyed into Bridge Creek. Surface water is diverted from Bridge Creek and then conveyed approximately ten miles to the City's Outback Facility, where it is treated using membrane filtration. In 2016, the City upgraded the surface water intake and replaced the original transmission mains with a single pipe. The City's diversion is currently limited to a maximum of 18.2 cfs by Special Use Permit (SUP) BEN1178 issued by the USFS.

2.2.2 Groundwater

The City appropriates groundwater from the Deschutes Regional Aquifer using 20 active wells and associated water rights. The City's records show that groundwater levels in the City's wells are stable. Water levels in the Deschutes Regional Aquifer fluctuate in response to climate cycles, but there is no long-term trend.

2.3 Interconnections with Other Systems

OAR 690-086-0140(7)

The City's drinking water system has an emergency interconnection with Avion. The interconnection with Avion, constructed in 2003, is at the intersection of 27th Street and Bear Creek Roads. The City has yet to convey water through this interconnection except for flow-testing purposes and does not intend to rely on Avion to supply water to the City's customers.

The City previously maintained interconnections with Roats that allowed Roats to serve water to the Juniper Utility service area. In 2018, the City completed a sale of the Juniper Utility service area and associated infrastructure to Avion and Roats.

2.4 Water Supply Contracts

The City has a wholesale water supply contract to purchase water from Avion. Under this contract, Avion provides wholesale water service to the Bend Municipal Airport *only*. The airport is a small, isolated water system that is not connected to the main City system. The City has a well available for redundancy and fire protection, but normal demand is met with water supplied by Avion.

The City also has agreements to provide water to Tetherow, a resort adjacent to the Bend UGB, and to The Tree Farm, a rural residential development approved by Deschutes County adjacent to the City of Bend UGB to the West.

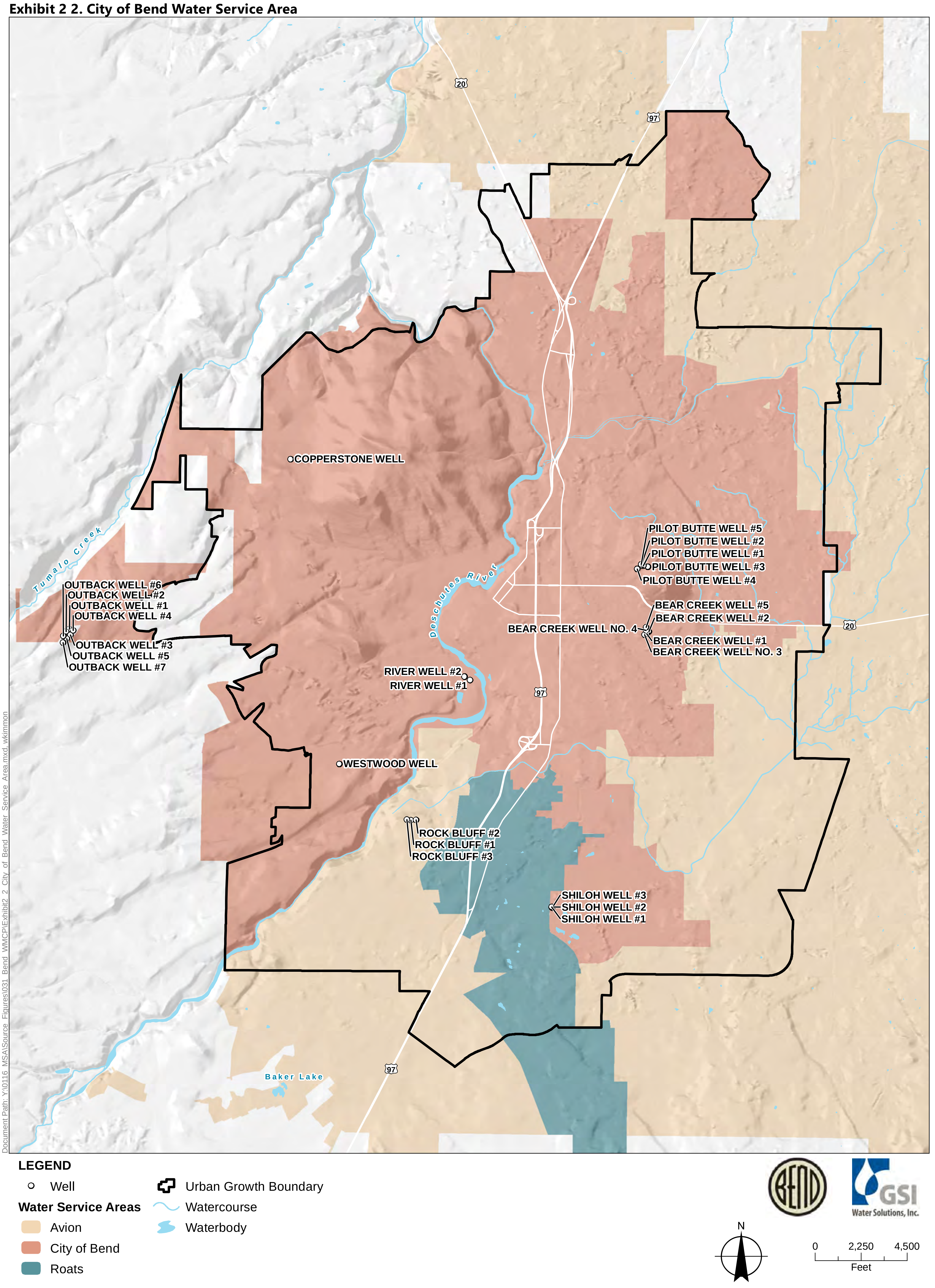
2.5 Intergovernmental Agreements

The City does not have any intergovernmental cooperation agreements regarding the provision of water to the City. The City and Tumalo Irrigation District (TID) have entered into an intergovernmental agreement to improve communication and cooperation and to set forth the structure of an approach and potential future projects that will enhance streamflows in Tumalo Creek.

2.6 Current Service Area Description and Population

The City’s current service area appears in **Exhibit 2-2**. 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 most of the area within the City’s current UGB, as well as the Tetherow and Tree Farm developments on the City’s west side. The two private water utilities, Avion and Roats, serve water both outside and within the UGB in areas not served by the City’s water system, primarily on the City’s south and east sides. According to 2019 billing data, the City’s water system had an average of approximately 25,826 meters billed each month (i.e., meters in active use), serving residential and non-residential customers. The City’s 2019 estimated service area population is 68,379, based on the Portland State Population Research Center estimated population of 91,385, less 23,615 service population for Avion and Roats combined within the City of Bend, plus 609 service population in Tetherow (91,385- 23,615+ 609), which equates to approximately 75 percent of the UGB population. This number likely does not accurately capture increases in service population caused by an influx of temporary residents, which include both daily commuters and a year-round tourist population. The City estimates that the daytime influx of employees and tourists combined is approximately 50,000 per day, with some seasonal variation.

Exhibit 2 2. City of Bend Water Service Area



Date: November 16, 2020
Data Sources: City of Bend, OSIP

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2.7 Demand

OAR 690-086-0140(4)

The City's demand consists of the volume of water pumped from the City's groundwater wells and the volume of surface water treated and placed into the distribution system.

2.7.1 Historical Water Demand

Exhibit 2-3 presents the volumes produced annually from 2014 through 2019, broken down by groundwater and surface water sources. The dip in surface water production that occurs from 2015 through 2016—and associated increase in groundwater demand—is due to planned reductions of surface water use during construction activities for the City's Surface Water Improvement Project (SWIP). During this time, the City replaced the main transmission pipelines that conveyed water 10 miles from the Heidi Lansdowne Intake Facility to the City's Outback Facility, where the City also constructed a new state-of-the-art membrane Water Filtration Facility (WFF) to meet new drinking water regulations. The City also rebuilt the intake structure with new features to control and measure the rate of flow into the Bridge Creek intake along with state-of-the-art monitoring and fish screening. The original transmission lines from the intake ran at full capacity (as they were not designed to hold pressure when off). When turbidity was above limits or when water was not needed to meet customer demand, unused water was returned to Tumalo Creek near the Outback Facility. This practice ended with completion of the SWIP in 2016.

Exhibit 2-3. Historical Water Demand, 2014 through 2019

Year	Surface Water (MG)	Groundwater (MG)	Total (MG)	ADD (mgd)	MMD (MG)	MDD (mgd)	MDD Date	Peaking Factor (MDD:ADD)	June – Sept Reference ET Less Precipitation (inches)
2014	2024	2207	4231	11.6	686.5	24.4	7/16/2014	2.10	21.08
2015	953	3575	4528	12.4	723.5	26.5	7/3/2015	2.13	20.42
2016	1818	2704	4522	12.4	719.1	25.8	8/19/2016	2.09	19.78
2017	2988	1736	4723	12.9	788.1	28.0	8/3/2017	2.17	23.44
2018	2566	2230	4796	13.1	794.0	28.2	8/9/2018	2.14	22.35
2019	2721	1599	4320	11.8	686.8	26.1	8/7/2019	2.20	18.95
Average	2068	2490	4559	12.5	742.2	26.6	7/26	2.13	21.00

Notes

ET = evapotranspiration
MG = million gallons
mgd = million gallons a day
ADD = average daily demand
MDD = maximum daily demand

Exhibit 2-4 displays the City's ADD and MDD trends from 2014 through 2019. From 2014 through 2018, the ADD increased from 11.6 mgd to 13.1 mgd, with an average of 12.5 mgd. For the same period, the MDD increased from 24.4 mgd to 28.2 mgd, with an average of 26.6 mgd. Both ADD and MDD declined slightly in 2019. Compared with data reported in the previous WMCP, the ADD has increased slightly and MDD has decreased slightly. During periods of hot and dry weather, there tends to be an increase in water use for irrigation, resulting in higher MDD values. Similarly, during wet and cool periods, the MDD tends to decrease. Economic conditions also play a role. The City's MDD decreased from 29.2 to 21.3 between 2008 and 2012, a period that coincided with both economic recession and cooler, wetter weather. In contrast, 2013 through 2018 coincided with warmer, drier weather and increased growth. The influence of these factors is also complicated by the City's long-term investments in advanced metering infrastructure (AMI) and supervisory control and data acquisition (SCADA) that have helped the City to more carefully and precisely manage the use of water; and by changes in the water service population, including the sale of the Juniper Utility service area to Avion and Roats. As a result, short-term influences on authorized consumption may mask longer trends toward reduced per capita consumption.

Exhibit 2-4. Average Day and Maximum Day Demand, 2014 through 2019

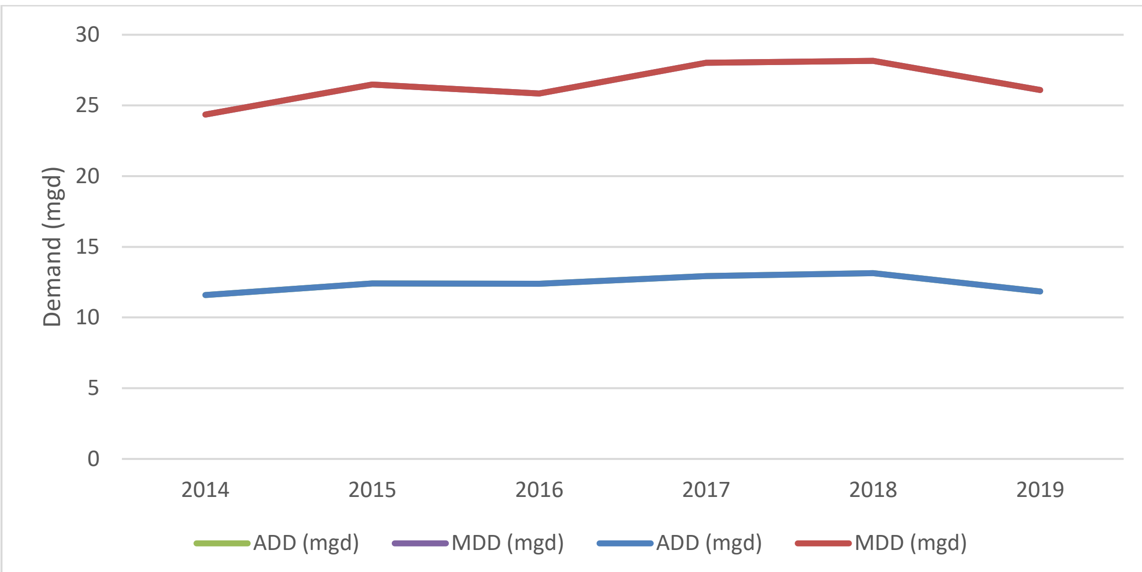


Exhibit 2-5 graphically represents the ratio of the MDD to ADD, which are the peaking factors presented in Exhibit 2-3, for the years 2014 through 2019. The peaking factor ranged from 2.09 to 2.20, with an average of 2.14. This is slightly lower than the most recently reported average peaking factors in the WMCPs for the Cities of Prineville and Redmond, which are 2.3 (2007 through 2015) and 2.5 (2006 through 2011), respectively. For use in projecting future demand in Section 5 of this WMCP, a peaking factor of 2.14 was used, following the City's 2020 IWSMP. In general, the City's peaking factor showed little variation from 2014 through 2019.

Exhibit 2-5. Maximum Day to Average Day Peaking Factor, 2014 through 2019

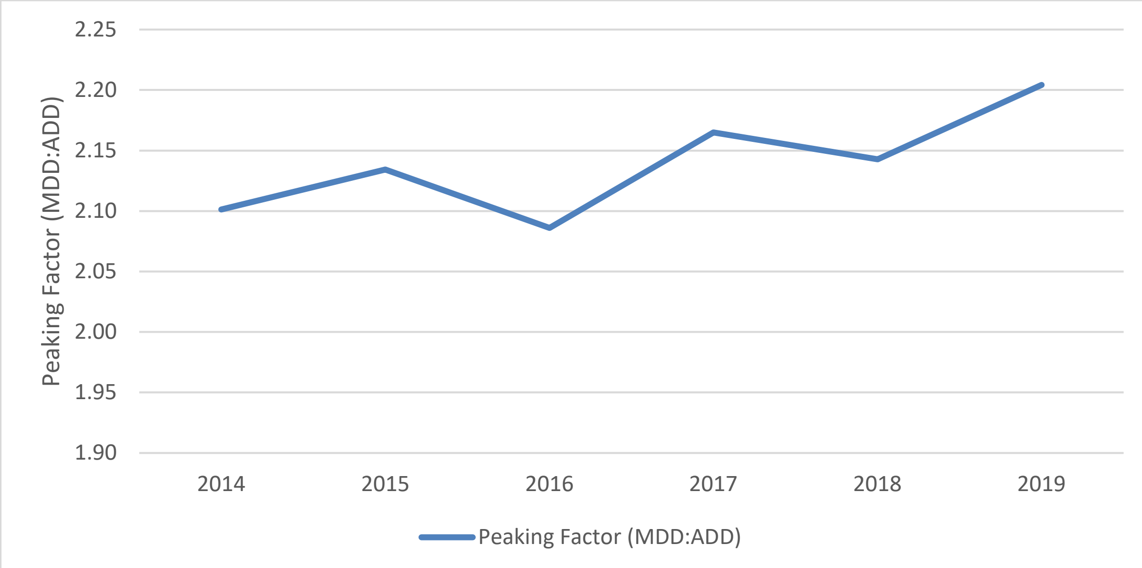
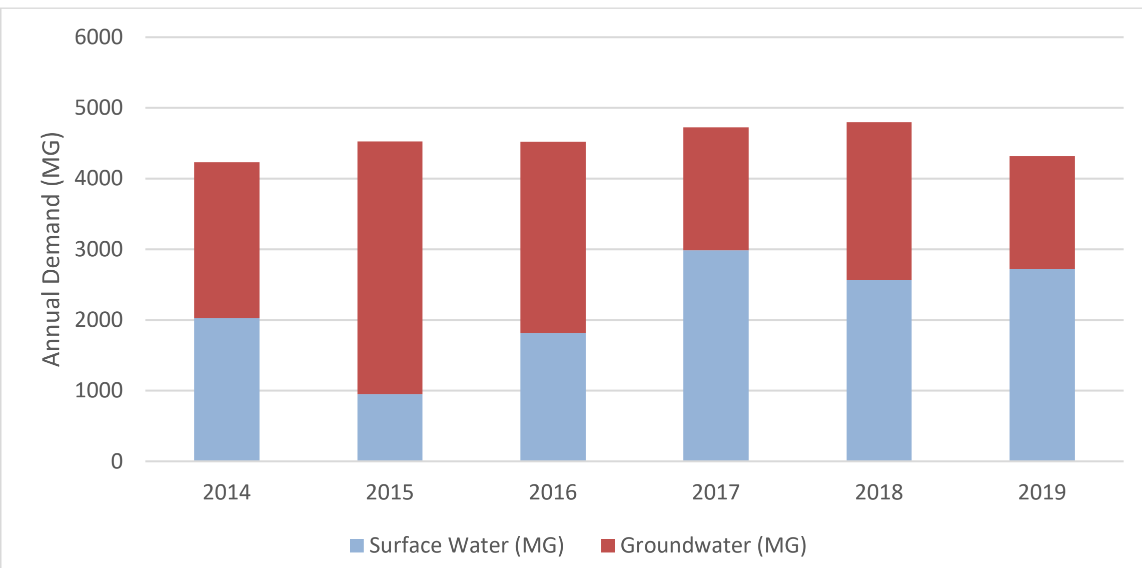


Exhibit 2-6 illustrates the annual demand for surface water and groundwater. On average from 2014 through 2019, the City's demand was made up of 55 percent groundwater and 45 percent surface water. However, this number was skewed by planned temporary reductions in surface water usage during replacement of raw water pipelines and addition of the WFF as part of the SWIP. The data from 2017 through 2019, when the City diverted a little more than half of its water supply from surface water, are likely more representative of anticipated groundwater and surface water usage.

Exhibit 2-6. Annual Demand of Surface Water and Groundwater, 2014 through 2019



Surface water is used year-round to meet the City's base water demand, and groundwater is used when surface water supplies are insufficient to meet demand. **Exhibit 2-7** illustrates the monthly demand volumes from 2014 through 2019. After completion of the SWIP, surface water provided nearly all of the water supply during the winter months, while groundwater generally augmented supply during the peak seasons. However, due to work on the SWIP, the City temporarily relied more heavily on groundwater from 2015 through 2016. The data also show the shutdown of the City's WFF from April through early June 2018 for emergency maintenance of the City's chlorine contact basin reservoir.

Exhibit 2-7. Monthly Surface Water and Groundwater Demand, 2014 through 2019

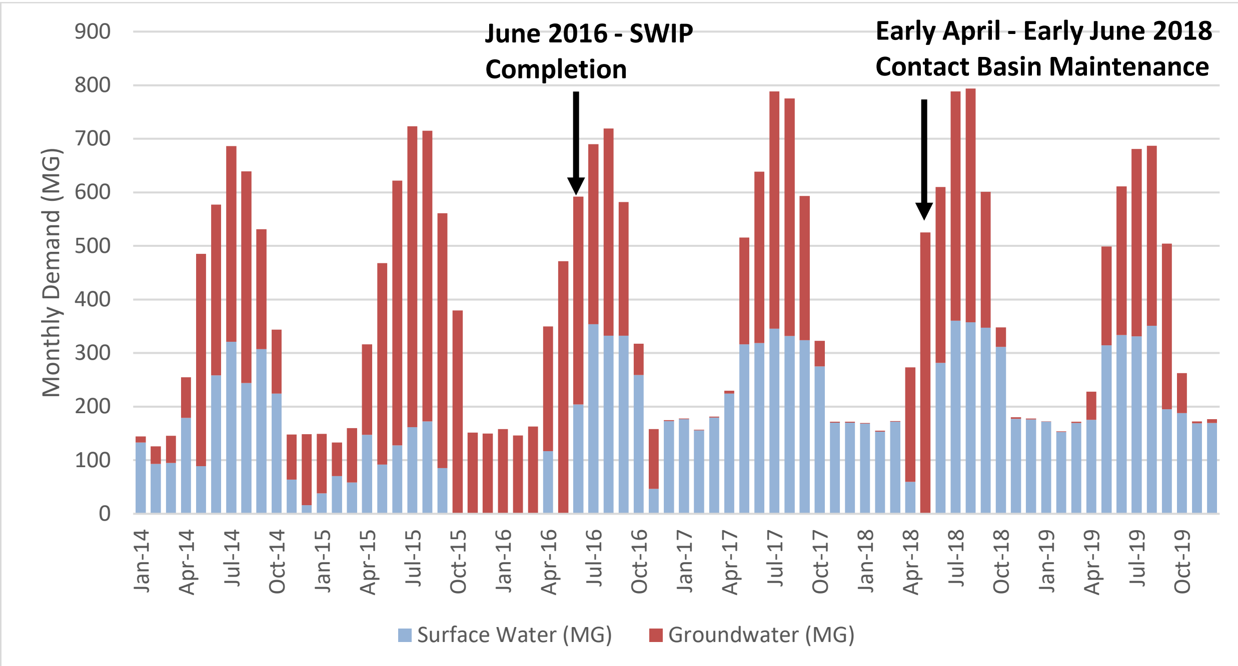
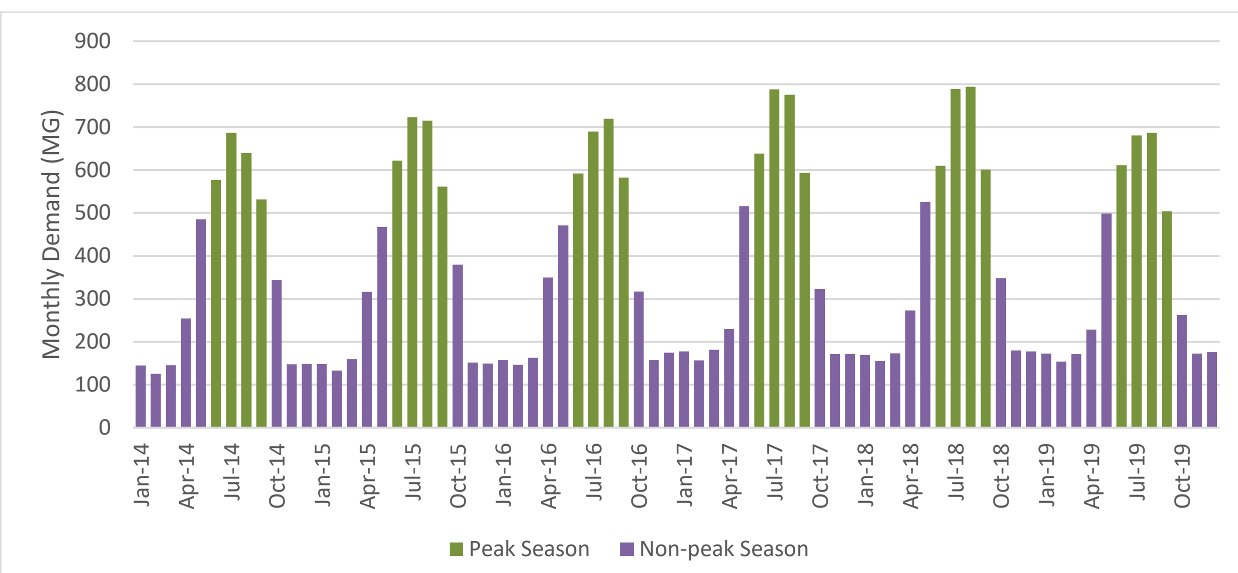


Exhibit 2-8 shows total monthly demand, with the peak season of June through September in green and the non-peak season in purple. The average monthly demand was 654.6 MG during the peak season and 237.7 MG during the non-peak season. The MMD averaged 733.0 MG and these peaks occurred in July (2014, 2015, 2017) and August (2016, 2018, 2019).

Exhibit 2-8. Monthly and Seasonal Demand, 2014 through 2019



2.7.2 Per Capita Demand

Exhibit 2-9 shows the estimated per capita demand within the City's water service area. The average and maximum day per capita demand represent use by all customer categories. Because the per capita demand includes all water use from both residential and non-residential uses, the calculated per capita demand values exceed the amounts of water actually used by a typical individual. Therefore, although per capita demand may show year-to-year trends, the evaluation of per capita demands benefits from additional context, including consideration of customer mix, climate, rainfall, economic conditions, and fluctuations in hotel or hospital occupancy or in large commercial and industrial uses. For example:

- The Bend Economic Development Department estimates that the average daily population increase from tourism and job commuters is approximately 50,000 people.
- Bend hosts a regional medical center with 250 beds.
- There are more than 25 breweries and distilleries in Bend.
- Evapotranspiration data presented in Exhibits 2-3 and 2-9, along with information presented in Section 2.8, provide additional context, as the largest use of water remains seasonal use for outdoor irrigation.

While this allows for consideration of year-to-year trends within the City, per capita demand is generally not a suitable metric to compare water demand across communities.

Exhibit 2-9. Average and Maximum Day per Capita Demand, 2014 through 2019

Year	Service Population	ADD (mgd)	MDD (mgd)	Per capita ADD (gpcd)	Per capita MDD (gpcd)	June – Sept Reference ET Less Precipitation (inches)
2014	59,744	11.6	24.4	194	408	21.08
2015	60,673	12.4	26.5	204	436	20.42
2016	62,901	12.4	25.8	197	411	19.78
2017	64,905	12.9	28.0	199	432	23.44
2018	67,187	13.1	28.2	196	419	22.35
2019	68,379	11.8	26.1	173	382	18.95
Average	63,965	12	26	194	415	21.00

Notes

ADD = average daily demand
ET = evapotranspiration
gpcpd = gallons per capita per day
MDD = maximum daily demand
MG = million gallons
mgd = million gallons a day

2.8 Customer Characteristics and Use Patterns

Authorized consumption is equal to the metered and certain unmetered water uses within the system. All customers are metered; however, authorized water use for activities such as fighting fires and system maintenance are not always metered by the City. Maintenance use and water used for water quality purposes, such as system flushing, are tracked informally by City operations staff. To obtain a more accurate determination of water loss, the City has developed a Water Loss Control Program to calculate and track unbilled authorized consumption as part of its AWWA M36 Water Audit Program, as further described in Section 3.

The City currently has five key customer categories: single-family, multi-family, commercial, irrigation-only, and hydrant meters. In 2019, 90 percent of meters were single-family or multi-family, and the remaining 10 percent were commercial or irrigation-only. Hydrant meters made up 0.6 percent of meters. Residential customers include single-family and multi-family accounts, and non-residential customers include commercial and irrigation-only account categories.

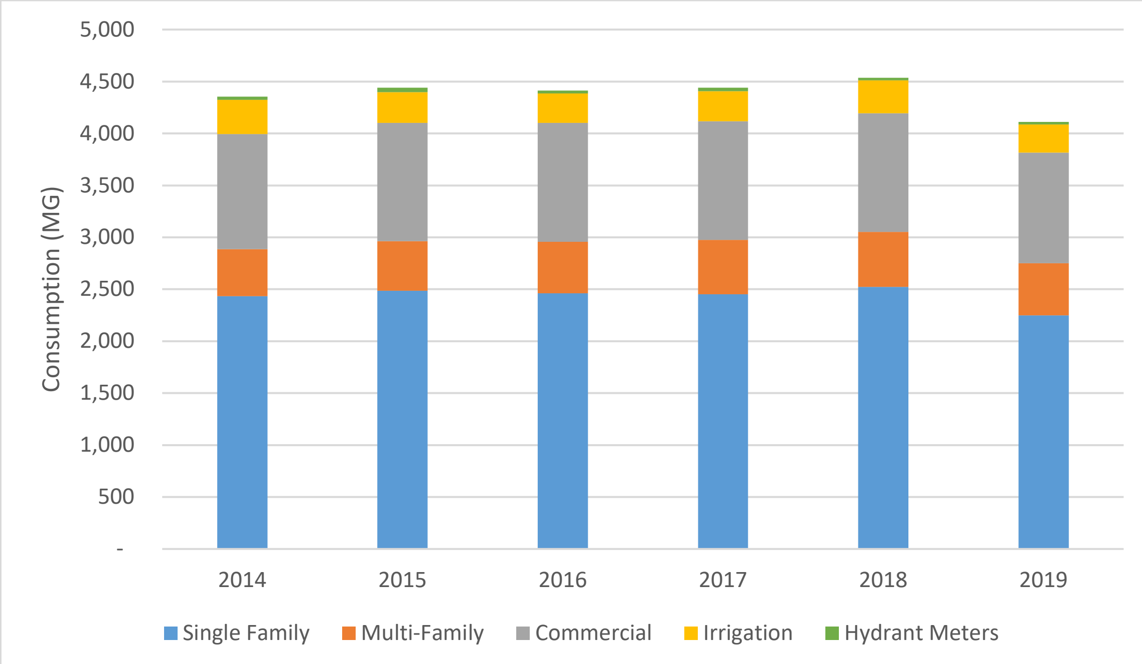
Understanding the characteristics of customers within the system is important when analyzing water use and forecasting future demand and consumption patterns. **Exhibit 2-10** shows the number of meters by customer category from 2016 through 2019. The numbers do not include meters from the Juniper Utility service area, which was sold to Roats and Avion in 2018. The City's irrigation-only account category includes meters providing water for seasonal outdoor irrigation only to locations such as parks and school fields as well as irrigated landscapes owned by the City and larger home owners' associations. Prior to the completion of the previous WMCP in 2011, the City created a Hydrant Meter Program, which requires temporary meters when using hydrants for non-emergency purposes. Hydrant meters measure and charge for water use for temporary uses, including construction and dust abatement. A single hydrant meter box can be used at multiple job sites for different purposes over a season. Although the number of meters and authorized consumption are reported in the same way as other customer categories, the hydrant meter category is not readily comparable to other categories for this reason.

Exhibit 2-10. Number of Meters by Customer Category, 2016 through 2019

Year	Single Family	Multi-Family	Commercial	Irrigation-Only	Hydrant Meters	Total
2016	20,649	1,569	2,124	359	61	24,762
2017	20,658	1,597	2,141	359	56	24,811
2018	21,017	1,631	2,169	371	57	25,245
2019	21,540	1,671	2,184	374	57	25,826

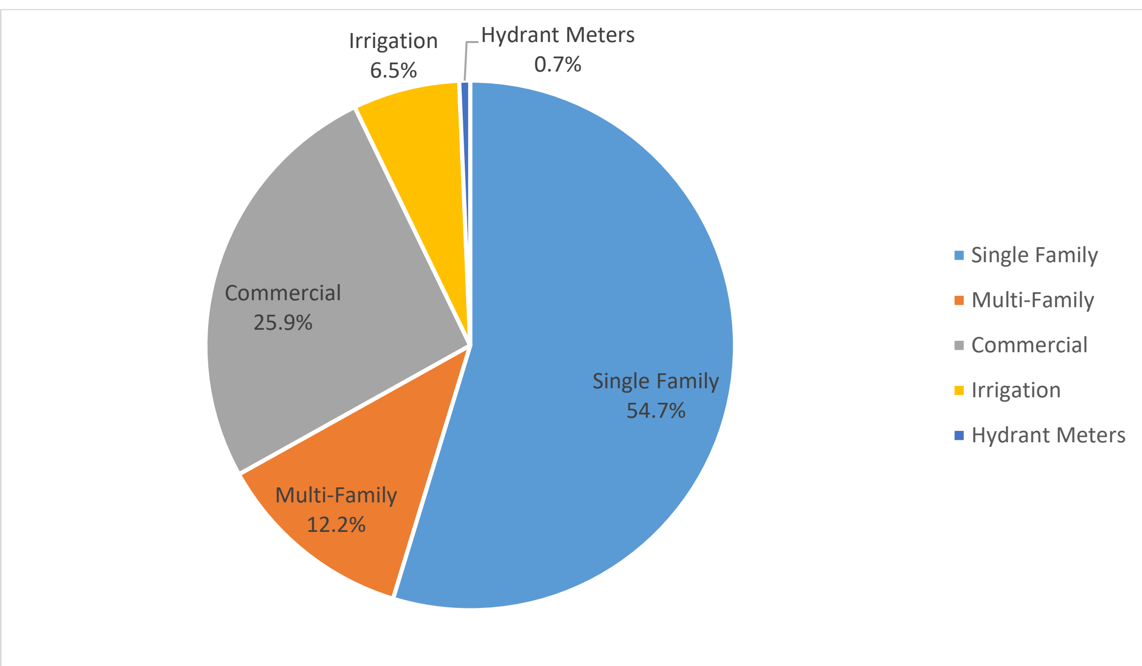
The annual metered consumption by customer category from 2014 through 2019 is shown in **Exhibit 2-11**.

Exhibit 2-11. Annual Consumption by Customer Category, 2014 through 2019



The percent of total water used by each customer category in 2019 is illustrated in the pie chart in **Exhibit 2-12**. Residential use comprised 67.3 percent of consumption; non-residential comprised 32.7 percent of use.

Exhibit 2-12. Percent Annual Consumption by Customer Category, 2019



The monthly consumption by customer category from 2014 through 2019 is shown in **Exhibit 2-13**. Consumption during the peak season is typically higher than during the non-peak season. For single and multi-family residential meters, and especially irrigation-only meters, seasonal water use will mostly reflect outdoor water use for irrigation of landscaping. For commercial and hydrant meters, differences in seasonal water use may not reflect indoor and outdoor (irrigation) water use, but rather other seasonally correlated activities. For example, water use for industrial cooling or use of hydrants for dust suppression activities during construction season would also likely increase during the summer and decrease during the winter. However, seasonal fluctuations in the City's water use will also reflect differences in service population during the summer and winter seasons.

2019 peak season water use was 4.7 times higher than non-peak-season water use for single family residential connections (due to outdoor landscape watering associated primarily with large residential lots), 2.1 times higher for multi-family connections (most which have combined indoor and outdoor uses on the meter and typically smaller areas for landscape), and 2.7 times higher for commercial connections.

These ratios suggest that conservation efforts focused on reducing outdoor use by single-family homes and certain commercial customers with large landscape water use, may help to address peak-season demand (See **Exhibit 2-13**).

Exhibit 2-13. Monthly Consumption by Customer Category, 2014 through 2019

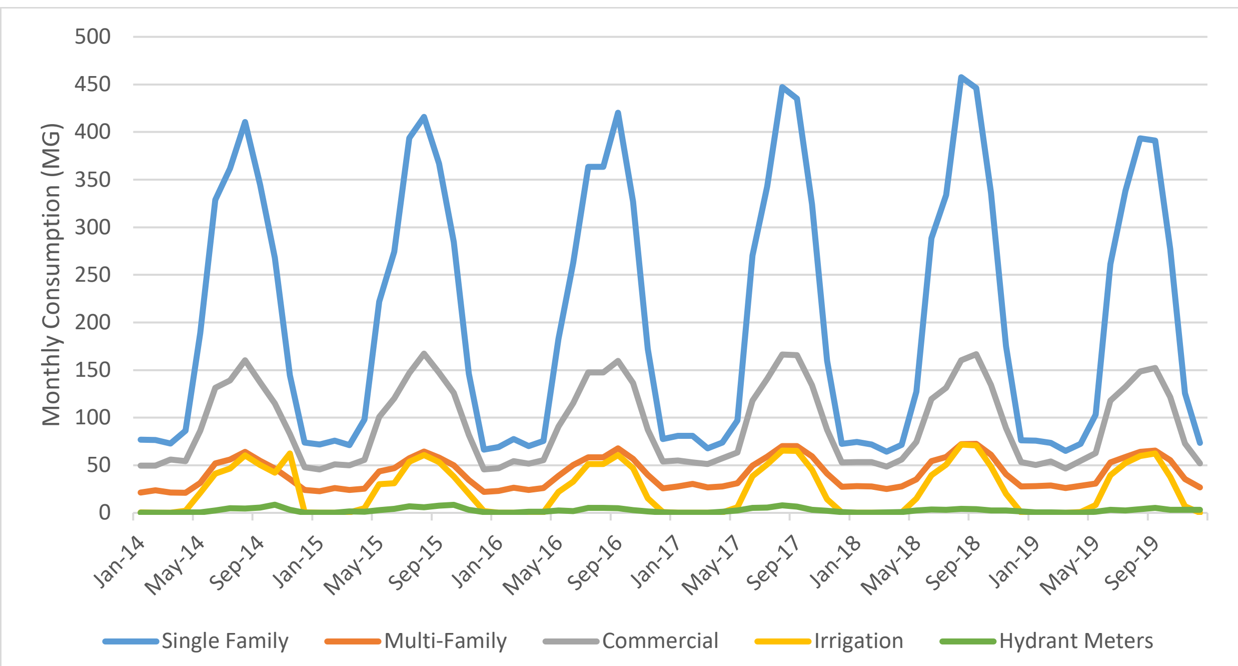


Exhibit 2-14 shows the City's annual water consumption by customer category. **Exhibit 2-15** compares the City's annual consumption to that of 2009 in the previous WMCP. The City's customer categories have changed, therefore only the residential and non-residential categories are compared. Due to the change in the categorization of residential and non-residential accounts—some commercial accounts from 2009 were reclassified as multi-family when that category was created in 2013—and the sale of the Juniper Utility service area to Avion and Roats, it is difficult to compare data from 2009 and 2019. The first full year that customer categories existed as they do now was 2014.

Exhibit 2-14. Water Consumption by Customer Category (MG), 2014 through 2019

Year	Single Family	Multi-Family	Commercial	Irrigation-Only	Hydrant Meters	Total
2014	2,433	452	1,110	328	31	4,354
2015	2,487	475	1,139	295	43	4,439
2016	2,461	495	1,146	283	28	4,413
2017	2,453	521	1,145	287	35	4,441
2018	2,523	531	1,140	318	26	4,537
2019	2,250	502	1,065	268	27	4,113

Exhibit 2-15. Comparison of Water Consumption by Customer Category (MG), 2009 and 2019

	Accounts			Consumption (MG)		
Year	Residential	Non-Residential	Total	Residential	Non-Residential	Total
2009	19,033	3,211	22,244	2,551	1,639	4,190
2019	23,211	2,614	25,826	2,752	1,361	4,113
% Change	18%	-23%	14%	7%	-20%	-2%

Note
MG = million gallons

2.9 Water Loss

OAR 690-086-0140(9)

For the purposes of this WMCP, water loss is equal to the difference between annual demand ("water supplied," according to M36 methodology) and authorized consumption, excluding unmetered consumption, and represents the sum of unmetered consumption (e.g., hydrant flushing and distribution system flushing), system leakage, and inaccuracies of measurement at production (i.e., demand) meters and customer meters. When this difference is divided by the demand value, water loss is expressed as a percentage of total demand. The OWRD administrative rules for WMCPs set a water loss goal of 10 percent or less (OAR 690-086-0150(4)(e).

Exhibit 2-16 presents the annual water loss for 2014 through 2019. Water loss has remained below 10 percent since 2008 and averaged 4.7 percent from 2014 through 2019.

Beginning in 2013, the City began using the AWWA M36 Water Audit Methodology to conduct annual water audits. This comprehensive methodology has been adopted as an industry-wide best practice and provides the most up-to-date analysis of the City's water distribution system efficiency and accuracy. In addition to real losses (system leakage, overflows), the M36 Water Audit Methodology estimates apparent losses, which include unauthorized consumption, customer metering inaccuracies, and systematic data handling errors. The reporting worksheets for 2014 through 2019 and performance indicators for 2019 are presented in **Appendix B**, and provide additional information about the source of water loss and estimates of avoidable loss.

The annual demand totals shown in **Exhibit 2-18** differ from those shown in Exhibit 2-2 and used for other calculations involving demand. The numbers used in the City's water audits, summarized in **Exhibit 2-17**, include pumping from the Hole Ten wells, which were sold to Roats in 2016 along with the Juniper Utility service area. Production from Hole Ten ceased to be accounted for as part of the City's system in January 2017. The numbers used in Exhibit 2-2 and elsewhere include pumping from the City's current water sources only.

Exhibit 2-16. City of Bend Estimated Water Loss, 2014 through 2019

Year	Annual Demand/ Water Supplied (MG)	Authorized Consumption (MG)	Water Loss (MG)	Water Loss (%)	Apparent Losses (MG)	Real Losses (MG)
2014	4,461	4,371	90	2.0%	44	46
2015	4,746	4,455	291	6.1%	45	246
2016	4,727	4,449	278	5.9%	45	232
2017	4,746	4,453	294	6.2%	45	248
2018	4,793	4,549	244	5.1%	46	198
2019	4,370	4,119	251	5.7%	42	209
Average	**4,640**	**4,399**	**241**	**5.2%**	**45**	**197**

Notes

[1] Third-party verification to the M36 audit process in 2015 improved the utility department's systematic data handling and reporting practices, which may be responsible for the difference between 2014 and other years.

MG = million gallons

2.10 Water Rights

OAR 690-086-0140(5)

2.10.1 Summary of Water Rights

The City holds six surface water rights that authorize a total use of up to 36.123 cfs (23.3 mgd) from Tumalo Creek and Bridge Creek for municipal purposes: four certificates, one transfer and one permit. **Exhibit 2-17** summarizes the City's surface water rights. In addition, the City holds 12 groundwater rights that authorize the use of groundwater at a rate of up to 68.2 cfs (44.1 mgd). Six certificates and three permits authorize the use of water for municipal purposes, Certificate 85526 authorizes the use of water for Domestic and Municipal use, and Certificates 94101 and 85411 authorize the use of water for Quasi-municipal use. In total, the City holds nine certificates and three permits. **Exhibit 2-18** summarizes the City's groundwater rights. The exhibit includes the source, priority date, completion date (if applicable), and maximum instantaneous rate of water diverted to date for each water right.

Exhibit 2-17. City of Bend Surface Water Rights

Application	Permit	Certificate or Transfer Number	Source(s)	Priority	Completion Date	Authorized Rate (cfs)	Authorized Volume (AF)	Maximum Diverted to Date (cfs)	Notes	Average Annual Demand (MG)					Average Monthly Demand (MG)					Average Daily Demand (MG)				
										2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Tumalo Creek Decree		85526	Tumalo Creek or its Tributaries	Senior to all other rights on Tumalo Creek	N/A	6	N/A	18.2	4/15 through 9/15 only.	953	1,818	2,988	2,566	2,721	79.4	151.5	249.0	213.9	226.7	2.61	4.97	8.19	7.03	7.45
Tumalo Creek Decree		31411	Tumalo Creek	8/5/1900 9/1900 6/1/1907	N/A	2 4.5 0.02	821.7																	
Tumalo Creek Decree		31665	Tumalo Creek	9/1900 4/28/1905 6/1/1907	N/A	1.314 0.186 1.103	328.14																	
Tumalo Creek Decree		B-112	Tumalo Creek, Crater and Little Crater Creek, Three Spring Branches	9/1900 6/1/1907 10/29/1913	10/1/2038	1.62 0.39 Varies (2.43 - 5.99)	1923.5		4/1 through 10/31 only. Total diversion under this right is limited to 2.43 cfs in April and October; 3.23 cfs from 5/1 through 5/15 and 9/16 to 9/30; and 5.99 cfs from 5/16 through 9/15.															
S-67983	S-49823	85713	Bridge Creek	12/12/1983	N/A	12.2		12.2	Authorized source is Bridge Creek, "with any deficiency in the available supply from Bridge Creek to be made up by appropriation from an unnamed tributary to Middle Fork of Tumalo Creek and Tumalo Creek." Extension pending for undeveloped portion.															
S-67983	S-49823		Bridge Creek	12/12/1983	10/1/1999	2.8		0																

* Demand data measured at Bridge Creek intake

Exhibit 2-18. City of Bend Groundwater Rights

Application	Permit	Certificate or Transfer Number	Priority	Completion Date	Source(s)	Authorized Rate (cfs)	Authorized Volume (AF)	Maximum Diverted to Date	Notes	Average Annual Demand (MG)					Average Monthly Demand (MG)					Average Daily Demand (MG)				
										2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
G-4677	G-4435	94100	11/8/1968	N/A	Outback Well 3 Outback Well 4 Bear Creek Well 2 Pilot Butte Well 4 Outback Well 5 Outback Well 6 Shiloh Well	7.75		7.75		3,249	2,273	1,173	1,712	1,100	270.8	189.4	97.7	142.7	91.7	8.90	6.21	3.21	4.69	3.01
G-8695	G-8565	94101	12/22/1978	N/A	Westwood Well Pilot Butte Well 4 Shiloh Well	0.94		0.94																
G-8695	G-8565	85411	12/22/1978	N/A	Westwood Well	1.51		1.51																
G-5644	G-4946	85412	10/13/1971	N/A	River Well 1 River Well 2 Pilot Butte Well 2 Copperstone Well	7.57		7.57																
G-5644	G-4946	85413	10/13/1971	N/A	River Well 1 River Well 2 Pilot Butte Well 1 Bear Creek Well 1 Bear Creek Well 2	4.87		4.87																
G-12226	G-11380	85414	9/7/1990	N/A	Outback Well 1 Outback Well 2 Outback Well 3 Outback Well 4 Bear Creek Well 1 Airport Well 2*	10		10																
G-5644	G-4946	85415	10/13/1971	N/A	River Well 1 River Well 2	2.7		2.7																
G-5644	G-4946	68702	10/13/1971	N/A	River Well 1 River Well 2	0.9		0.9																
G-11942	G-11379	85559	6/30/1989	N/A	Rock Bluff Well 1 Rock Bluff Well 2 Rock Bluff Well 3	4.16		4.16		110	204	194	114	270	9.1	17.0	16.2	9.5	22.5	0.30	0.56	0.53	0.31	0.74
G-11942	G-11379		6/30/1989	10/1/1998	Rock Bluff Well 1 Rock Bluff Well 2 Rock Bluff Well 3 Pilot Butte Well 3	3.84		2.35	Extension of time pending.2.35 cfs utilized prior to 2005.															
G-13097	G-18123		8/27/1992	4/26/2027	Bear Creek Well 3 Bear Creek Well 4 Bear Creek Well 5 Shiloh Well Outback Well 7	12	3,223	3.01	209.5 mitigation credits assigned (maximum annual volume of 419 AF)	216	227	369	404	229	18.0	18.9	30.7	33.6	19.1	0.59	0.62	1.01	1.11	0.63
G-13098	G-18124		8/27/1992	4/26/2027	Pilot Butte Well 3 Pilot Butte Well 4 Pilot Butte Well 5 Shiloh Well Outback Well 7	12	3,223	3.01	608.95 mitigation credits assigned (maximum annual volume of 1,217.9 AF)															

* Although Airport Well 2 is included in Certificate 85414 and in this exhibit, it is now used exclusively for fire-flow events only as a backup to the water supplied by Avion. The well does not provide water to the City's municipal water system.

**Demand data are measured at well head; however, several wells are on multiple water rights so the data are consolidated.

AF = acre-feet MG = million gallons N/A = not applicable or available

2.10.2 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 Tumalo Creek watershed. While the maximum rate of the City's combined surface water rights is 36.1 cfs, due to seasonal limitations, sharing of priority dates with other water users on Tumalo Creek, and seasonal low flows, the reliable rate of the City's water rights is significantly lower than 36.1 cfs. Furthermore, under the terms of the City's SUP (BEN1178) authorizing operation of the surface water system on USFS lands, the City's diversion is currently limited to 18.2 cfs (11.8 mgd). The current SUP expires in 2037.

The City's surface water rights are evidenced by four certificates, one permit, and one transfer.

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. 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.[1]

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. The City acquired the lands to which the rights were appurtenant and transferred the water rights to municipal purposes. As a result, these certificates each have multiple priority dates and a different maximum authorized rate associated with each date, corresponding to the priority dates of TID's decreed water rights. 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 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. A permit extension is pending for Permit S-49823.

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 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 August 7, 2019, OWRD approved an extension of time allowing the City to complete this transfer by October 1, 2038.

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[1] *City of Bend vs. Deschutes County Municipal Improvement District,* August 11, 1926. Circuit Court of the State of Oregon for Deschutes County. Judge D.R. Parker. Oregon Water Resourced Department Order Volumes 1M-153.

The City's water right Transfer B-112 includes Crater Creek and Little Crater Creek as sources. Crater Creek was constructed between 1913 and 1914 to augment Tumalo Creek flows via the Crater Creek ditch, which drains the southern slope of Broken Top. The water is conveyed to the headwaters of Middle Fork Tumalo Creek. The diversion is operated by the TID.

2.10.3 Groundwater

Discussion of the City's groundwater rights benefits from a brief summary of groundwater regulations in the Upper Deschutes Basin over the past three decades. In 1993, the U.S. Geological Survey and OWRD initiated a study on the groundwater in the Deschutes Basin upgradient from Lake Billy Chinook. One of the conclusions of the study is that there is a direct hydraulic connection between groundwater and surface water within the study area.[2] As a result of this conclusion, OWRD determined that groundwater appropriations in the study area would interfere with existing surface water rights (including instream water rights) and would measurably reduce flows needed for scenic waterways in the Deschutes Basin. Under the Scenic Waterway Act (ORS 390.835) OWRD could only approve new groundwater permits if qualifying mitigation were provided.

In 2002, the Deschutes Basin Groundwater Mitigation Program was established to create a mechanism for water users to provide mitigation for impacts to scenic waterway flows and senior water rights, while allowing additional appropriations of groundwater in the Deschutes Ground Water Study Area. The Mitigation Program is authorized by Oregon Revised Statute (ORS) 537.746 and is established in OWRD's administrative rules (OAR Chapter 690, Divisions 505, 521, and 522).

All nine of the City's groundwater right certificates and one permit, and the undeveloped portion of G-11379, predate the establishment of the Deschutes Basin Groundwater Mitigation Program. The City refers to these as "Tier 1" groundwater rights. These more senior groundwater rights do not require mitigation under OWRD's Mitigation Program. The City's two most junior groundwater right permits, G-18123 and G-18124, were issued after the establishment of OWRD's mitigation program and are referred to as "Tier 2" groundwater rights.

The City has a total of 44.2 cfs of Tier 1 groundwater rights, of which 40.4 cfs have been certificated. One Tier 1 water right, G-11379, remains in the permit development phase, with 3.84 cfs remaining undeveloped after a partial perfection in 2009. The City submitted an extension application for the remaining undeveloped 3.84 cfs in 2003 and an addendum in 2018. In the 2018 addendum, the City identified that a total of 6.51 cfs was developed prior to June 29, 2005; therefore there is a 1.49 cfs undeveloped portion of the permit (8 cfs permit – 6.51 cfs developed prior to 6/29/2005 = 1.49 cfs undeveloped portion of the permit). This 1.49 cfs undeveloped portion of the permit is subject to fish persistence conditions that will be recommended by Oregon Department of Fish and Wildlife (ODFW).

Permits G-18123 and G-18124 each have a priority date of August 27, 1992, and each authorizes water use at a rate of up to 12.0 cfs and an annual volume of up to 3,223 acre-feet. OWRD determined that each permit has a total mitigation obligation of 1,611.5 mitigation credits based on an estimated consumptive use coefficient of 50 percent. To date, the City has assigned 209.5 and 608.95 mitigation

[2] Gannett, M. W. (2001). Ground-water hydrology of the upper Deschutes Basin, Oregon (No. 4162). US Department of the Interior, US Geological Survey.

credits to permits G-18123 and G-18124, respectively, allowing pumping of up to a total of 1,636.9 acre-feet per year.

2.10.4 Aquatic Resource Concerns

OAR 690-86-140(5)(i) requires identification of any streamflow-dependent species listed by a state or federal agency as sensitive, threatened, or endangered that are present in the source, and listing of the source as water quality limited and the water quality parameters for which the source was listed, and any designation of the source as being in a critical groundwater area.

The City's water supply comes 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 in the BMW are within the Tumalo Creek watershed. **Exhibit 2-19** shows the listed fish species that occur in Bridge Creek and Tumalo Creek. Bridge Creek is within the Upper Tumalo Creek Watershed Unit (WU). The Upper Tumalo Creek WU is listed on Oregon Department of Environmental Quality's (DEQ) 303(d) list of impaired water bodies for water temperature. The Lower Tumalo Creek WU is listed on DEQ's 303(d) list of impaired water bodies for temperature and flow modification. Crater Creek and Little Crater Creek are not 303(d) listed and do not provide habitat for listed fish.

Exhibit 2-19. Listed Native Fish Species Occurring in Bridge and Tumalo Creeks[1]

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

Notes

[1] Native fish species occurring in Bridge and Tumalo Creeks listed as Sensitive, Threatened, or Endangered under the Oregon or Federal Endangered Species Acts.

2.10.5 Assessment of Water 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 Regional Aquifer, and the City's surface water supply from the BMW is currently limited to 18.2 cfs (11.8 mgd) based on the City's SUP. The City's existing water right capacity is sufficient to meet its current peak water demand. The City's surface water supply may be further limited by stream flow, the requirement to share water supply with water users of similar priority date, surface water quality events, and system capacity.

1. Surface Water

Flows in Tumalo Creek are influenced by snow melt. Flows typically peak during May and June and are lowest during September. According to OWRD's Water Availability Reporting System (WARS), the 80 percent exceedance of the natural stream flow in Tumalo Creek is 51.8 cfs in September. In recent dry years, the calculated 7-day rolling average flow has occasionally dropped below 50 cfs.

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. **Exhibit 2-20** shows the maximum rate of Tumalo Creek water rights by priority date for the Tumalo Creek water right holders (which share several priority dates) during the month of July.

Exhibit 2-20. Maximum Rate of Tumalo Creek Natural Flow Water Rights (cfs)

Priority Date	City of Bend	Tumalo Irrigation District (TID)	State of Oregon Instream Water Right (measured at gage USGS 14073520)
Unrestricted	6.00		
8/5/1900	2.00	5.02	0.81
9/1900	7.43	35.19	11.47
4/28/1905	0.19	3.71	0.60
5/27/1907		0.52	0.08
6/1/1907	1.51	12.22	1.96
10/29/1913[1]	5.99	136.00	
12/8/1961		Tumalo Reservoir Storage	7.80
12/12/1983	15.00		
10/11/1990[2]			32.00
Maximum Diversion[3]	36.11	183.42	32.00

Notes

[1] The maximum authorized rate under the City's 1913 water right is limited to no more than 5.99 cfs in combination with the 1900 and 1907 water rights included in Transfer B-112. TID's 1913 water right, together with the amount secured under other water rights for the same lands, is limited to no more than 1/32.4 cfs per acre at the point of diversion. Exhibit 2-20 shows the maximum rate allowed under each priority, regardless of joint limitation.

[2] Instream water rights with priorities senior to 1990 are designated to replace a portion of the 1990 instream water right created pursuant to ORS 537.341.

[3] The maximum rate for each entity takes into account all joint limitations on each users' water rights.

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 continue to have a seasonal limitation and an annual volume limitation. 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. During the irrigation season, several of the City's water rights share priority dates with other irrigation water rights held by TID and instream water rights held by the State of Oregon created through Allocations of Conserved Water from TID's canal piping efforts. In practice, the required instream water right downstream of TID's Tumalo Feed Canal diversion—which varies depending on the total flow of Tumalo Creek—is met or exceeded throughout the irrigation season. Over the course of the 214-day irrigation season in 2019, with approximately 5 cfs of TID instream leases, the instream flow at USGS gage 14073520 below TID's diversion did not drop below 18.4 cfs, which is well in excess of the flow required by the leases and instream water rights. As a result, there was no need to "distribute water" in 2019 to ensure the instream water right was being satisfied.

The City's previous WMCP included a discussion of the vulnerability of the City's surface water supply to high-turbidity events during periods of high runoff or forest fires. The City's WFF, completed in 2016, employs membrane filtration, removing silt and other particles that cause turbidity from water diverted at the Bridge Creek intake, limiting supply interruptions during periods of high turbidity. The City is also evaluating the potential for a pre-sedimentation basin to further reduce the impact of high-turbidity events on the WFF.

In summary, the City's surface water rights have been reliable up to the maximum rate of 18.2 cfs authorized by the USFS SUP (BEN 1158) in recent years. There has been no need for water distribution among the water right holders on Tumalo Creek; the established instream water rights below TID's Tumalo Feed Canal have consistently been met or exceeded. Despite this recent streamflow reliability, in 2018 and 2019, the WFF was temporarily unavailable, due to planned and unplanned maintenance and lightning strikes. As the City continues to learn more about potential risks to the uninterrupted operation of the WFF, it will be possible to identify and mitigate events that compromise the reliability of the surface water system. For the purposes of this WMCP and the City's IWSMP, the City assumed a conservative firm yield of 6,600 gpm (14.7 cfs) from the surface water system, which is the yield that is achievable with one of the WFF's current filter racks offline.

2. Groundwater

As described above, the City holds nine water right certificates and three permits for the use of groundwater.

The City's wells develop the Deschutes Regional Aquifer, located in the Deschutes Formation. The permeable geology underlying the Deschutes Basin, combined with the large annual precipitation in the Cascade Range, results in a large aquifer system that is highly productive. The Deschutes Formation consists of a variety of highly permeable volcanic and sedimentary deposits that are between 4 million years old to 7.5 million years old. The Deschutes Formation is up to 2,000 feet thick in places. Groundwater flows from the recharge areas in the Cascade Range and Newberry Volcano towards the discharge area near the confluence of the Deschutes, Crooked, and Metolius Rivers. The aquifer is highly transmissive and supports most of the region's water supply wells, with some that can produce more than 2,000 gpm. The aquifer developed by the City's wells appears to be a reliable and sustainable source of supply.

Certificates 85414 and 85559 and Permit G-11379 have static water level conditions that may reduce the water available under the water rights if a well listed on the right displays a total static water level decline of 25 feet or more over any period of years. At the basin scale, fluctuations in the groundwater levels generally follow climate cycles, with periods of high groundwater levels generally corresponding to high precipitation and lower water levels corresponding to low precipitation. This effect dampens going eastward and away from the recharge area. Additionally, it is possible that any extension of time for the 1.49 cfs portion of Permit G-11379 not developed prior to 2005 will include fish persistence conditions that limit the City's access to water under the extended permit.

The City's groundwater permits, G-18123 and G-18124, require mitigation under the Deschutes Basin Groundwater Mitigation Program. The need to mitigate for the use of water under these permits limits their reliability to some extent. The administrative rules implementing the Mitigation Program are scheduled to expire on January 2, 2029, but may be extended.[3] The City will be able to maintain the mitigation established before that date, but it is unclear how, or if, mitigation can be established if the administrative rules are not extended beyond 2029. Permits G-18123 and G-18124 both have development deadlines of April 26, 2027. Regardless of the timeline for the City to develop the full rate of Permits G-18123 and G-18124, the City can only make proof on (certificate) the water rights with a volume equal to the volume for which mitigation credits have been provided, which may require the City to seek extensions of time to complete development of the permits. The availability of mitigation credits is also a limiting factor in the reliability of water supply under Permits G-18123 and G-18124. In general, the mitigation credits assigned to Permits G-18123 and G-18124 were created through instream transfer of existing surface water rights in the name of irrigation districts. It is unclear to what extent mitigation credits will continue to be made available from this source. However, as detailed in Section 5 of this WMCP the City's demand projections indicate that the City may need to apply for a new groundwater right within the next 10 years.

2.11 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 2-25** provides a schematic of the City's existing distribution system. **Exhibit 2-26** provides a map 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 11.5 miles west of the City at the Heidi Lansdowne 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 Intake Facility and raw water is conveyed approximately 10 miles via a pipeline to the City's Outback Facility. After treatment at the WFF and disinfection at the Outback Facility with the addition of chlorine, the water flows through the chlorine contact basin and Outback Reservoir 1 and Reservoir 2. Two finished water transmission pipes transmit water from the Outback Facility to the City's distribution system. The groundwater supply originates from 20 active wells associated with water rights.

The City's distribution system comprises nearly 450 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 six primary pressure zones serving customers ranging in elevation from approximately 3,530 feet to 4,170 feet above mean sea level. Summary information for the wells, reservoirs, pipelines, and pump stations is presented in **Exhibits 2-21, 2-22, 2-23,** and **2-24**, respectively.

[3] ORS 537.746 directs the Water Resources Commission to repeal the rules for the Deschutes Basin ground water study area effective September 27, 2002, on January 2, 2029.

Exhibit 2-21. Summary of Pipeline Sizes

Diameter (inches)	Miles
1 to 6	63.8
8	208.8
10 to 14	118.6
16 to 18	38.5
24 to 36	9.7
Total	**439.3**

Exhibit 2-22. Summary of Reservoirs

Reservoir	Volume (MG)	Material
Awbrey Reservoir	5.00	Concrete
College Reservoir #1 (South)	0.5	Steel
College Reservoir #2 (North)	1.0	Steel
Contact Basin Reservoir (Outback Facility)	1.5	Steel
Outback Reservoir #1	2.0	Steel
Outback Reservoir #2	3.0	Steel
Outback Reservoir #3	3.6	Steel
Overturf Reservoir East	1.5	Steel
Overturf Reservoir West	1.5	Steel
Pilot Butte Reservoir #1	1.5	Steel
Pilot Butte Reservoir #2	1.0	Steel
Pilot Butte Reservoir #3	5.0	Concrete
Rock Bluff Reservoir #1	1.5	Steel
Tower Rock Reservoir	1.0	Steel
Westwood Reservoir	0.5	Steel

Exhibit 2-23. Summary of Existing Wells Associated with Water Rights for Bend's Municipal System

Well	Flow
Bear Creek Well 1	1050
Bear Creek Well 2	1100
Bear Creek Well 3	Not Yet Constructed
Bear Creek Well 4	Not Yet Constructed
Bear Creek Well 5	Not Yet Constructed
Copperstone Well	950
Outback Well 1	800
Outback Well 2	950
Outback Well 3	1050
Outback Well 4	1150
Outback Well 5	1050
Outback Well 6	1100
Outback Well 7	1300
Pilot Butte Well 1	750
Pilot Butte Well 2	Not Operational
Pilot Butte Well 3	900
Pilot Butte Well 4	1150
Pilot Butte Well 5	Not Yet Constructed
River Well 1	1800
River Well 2	1900
Rock Bluff Well 1	750
Rock Bluff Well 2	800
Rock Bluff Well 3	800
Shiloh Well 3	1200
Westwood Well	700
Airport Well 2*	240

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

Exhibit 2-24. Summary of Existing Pump Stations

Pump Station	Flow[1] (gpm)	Total Capacity	Firm Capacity[2]
Awbrey Pump 1	1,200	3,600	2,400
Awbrey Pump 2	1,200		
Awbrey Pump 3	1,200		
College Pump 1	1,100	2,200	1,100
College Pump 2	1,100		
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	1,000	3,000	2,000
Scott Street Booster Pump 2	1,000		
Scott Street Booster Pump 3	1,000		
Tetherow Pump 1	120	3,220	2,520
Tetherow Pump 2	300		
Tetherow Pump 3	700		
Tetherow Pump 4	700		
Tetherow Pump 5	700		
Tetherow Pump 6	700		
Westwood Pump 1	275	2,275	1,375
Westwood Pump 2	550		
Westwood Pump 3	900		
Westwood Pump 4	550		

Notes

[1] Flow rates indicate typical flow rates based on available SCADA data and model results if available; otherwise they are based on pump curves which may or may not be accurate.

[2] Firm capacity is defined as the total installed capacity remaining with the largest pump at a facility out of service.

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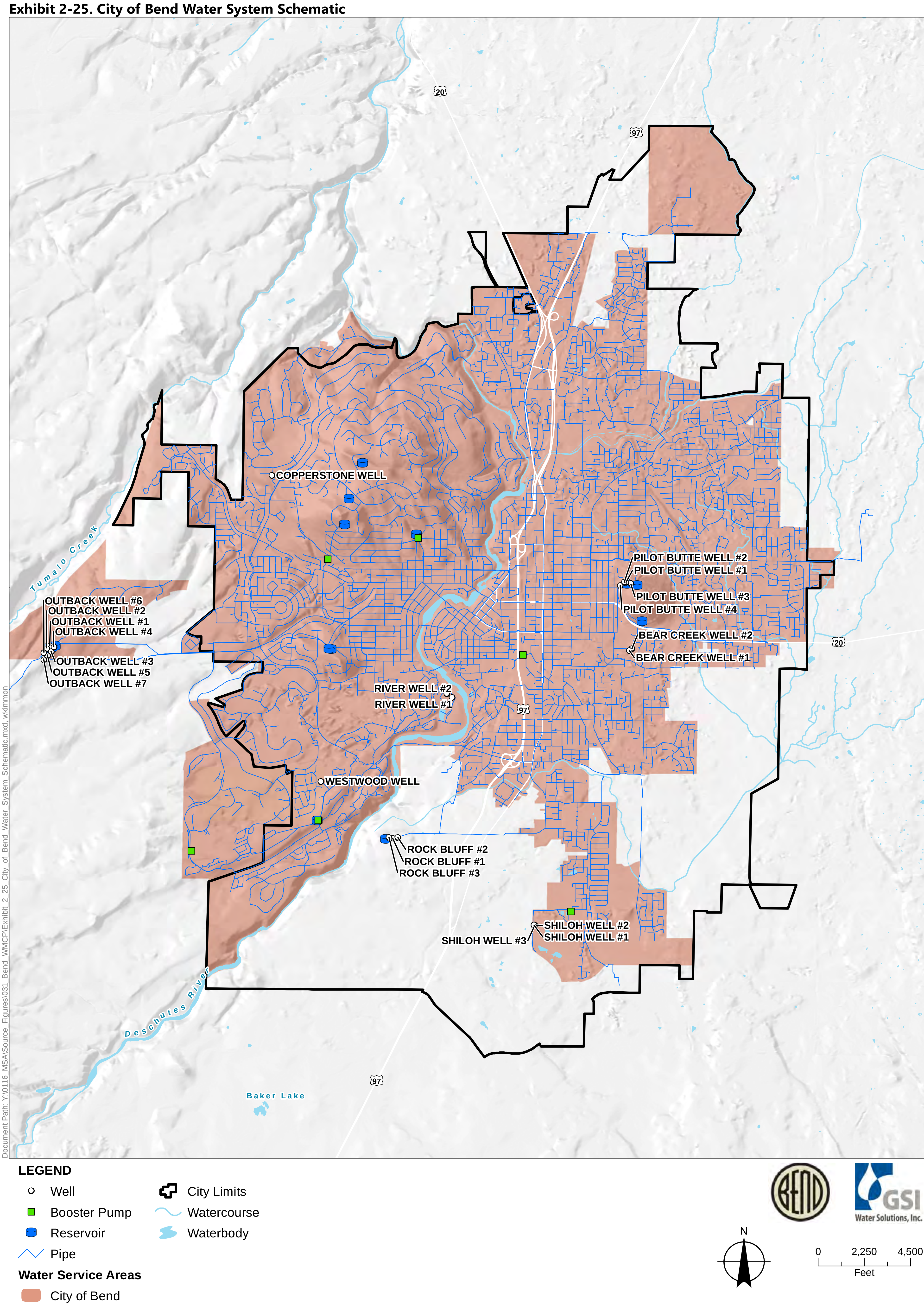
Exhibit 2-25. City of Bend Water System Schematic



Document Path: Y:\0116_MSA\Source_Figures\031_Bend_WMCP\Exhibit_2_25_City_of_Bend_Water_System_Schematic.mxd, wkimmon

Date: November 16, 2020
Data Sources: City of Bend, OSIP

Exhibit 2-26. Bend Municipal Watershed and Bridge Creek Intake

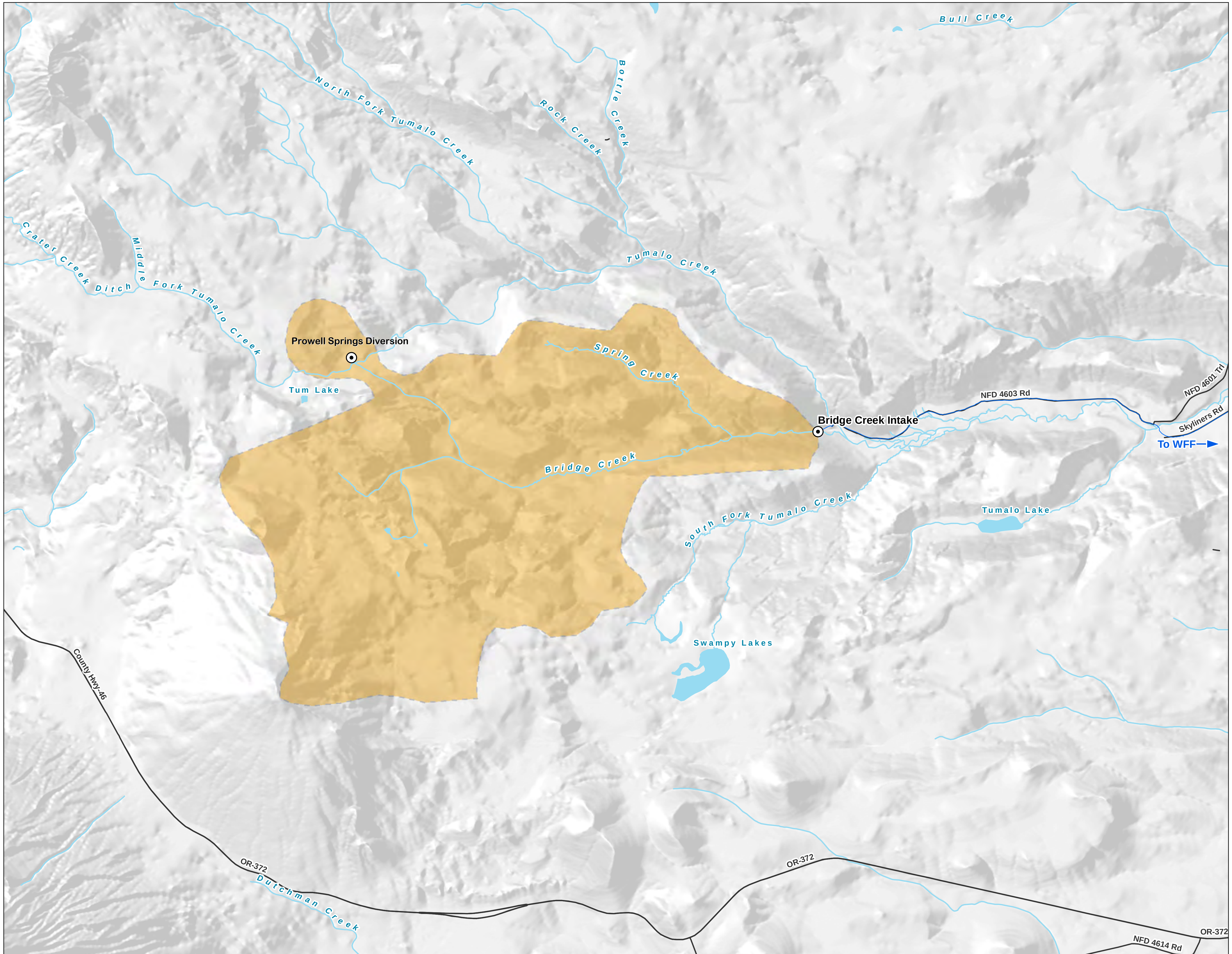


EXHIBIT 2-26
City of Bend
Bend Municipal Watershed

2021 Water Management and Conservation Plan

LEGEND

- POD
- City of Bend Municipal Watershed
- Pipe
- Major Road
- Watercourse
- Waterbody

Note: Land ownership is not shown, but nearly all lands shown within the extent of the map are within the Deschutes National Forest.

N

0 2,000 4,000
Feet

Date: October 28, 2020
Data Sources: City of Bend, OSIP

Document Path: Y:\0116_MSA\Source_Figures\031_Bend_WMCP\Exhibit_2_24_City_of_Bend_Surface_Water_Schematic_Landscape.mxd, wkimmon

3. Water Conservation Element

This section addresses the requirements of OAR 690-086-0150(1) – (6). This rule requires a description of specific required conservation measures and benchmarks, and additional conservation measures implemented by the City.

3.1 Progress Report

OAR 690-086-0150(1)

OAR 690-086-0150(1) requires the water conservation element of a municipal WMCP to include a progress report on the conservation measures that were scheduled for implementation in the prior WMCP. The City previously submitted WMCPs to OWRD in 1998, 2004, and 2011, with the most recent WMCP approved by OWRD in a final order dated June 30, 2011. In addition, the City submitted a required WMCP Five-Year Progress Report to OWRD in June 2016, and OWRD issued a letter on August 12, 2016 stating that its review found no deficiencies. **Exhibit 3-1** shows (1) the required and additional conservation measures required by OAR 690-086-0150(4)-(5) that were included in the approved 2011 WMCP,[4] (2) the City's five-year water conservation benchmarks established for each conservation measure in the approved 2011 WMCP, and (3) the City's current status of each water conservation benchmark. Please note that benchmarks marked as "IMPLEMENTED" may also be associated with continuing programs that have been successfully implemented, but are continuing.

[4] OWRD updated some rules in December 2018, which are reflected in the exhibit.

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Exhibit 3-1. Conservation Measures and Benchmarks

Sub-section Requirement	2011 Benchmark	2020 Progress Summary
OAR 690-086-150 (4) A description of the specific activities, along with a schedule that establishes five-year benchmarks, for implementation of each of the following conservation measures that are required of all municipal water suppliers:		
(a) An annual water audit that includes a systematic and documented methodology for estimating any un-metered authorized and unauthorized uses	Develop and implement an annual Water Audit Program within the next 5 years; as part of this effort, 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.	**IMPLEMENTED[1].** The City successfully developed and implemented an annual Water Audit Program in 2013. Since then, annual water audits utilizing the AWWA M36 reporting methodology have been conducted. In 2015, the City hired an external water loss control expert to perform a third-party validation of the 2015 M36 Water Audit results consistent with Water Research Foundation parameters for third-party reviews. The City formed a Water Loss Control Team in 2016 to review, evaluate, and implement recommendations from annual M36 Water Audits. Authorized unbilled water use for flushing, water quality testing, and reservoir cleaning and draining are tracked. The City's water loss in 2019 was 5.7 percent and averaged 4.7 percent from 2014 through 2019 according to the M36 Water Audit.
	Reorganize and update customer classes and service codes, as well as work towards equipping all water meters with automated metering infrastructure (AMI) meters.	**IMPLEMENTED.** AMI technology was completely implemented by 2013. Staff continue to manage the City's AMI infrastructure and customer water use data. Customer classes and service codes were last updated in 2015 through the latest rate modernization effort and included the addition of a multi-family customer class (MF).
(b) If the system is not fully metered, a program to install meters on all un-metered water service connections.	Continue to install meters at all new service connections.	**IMPLEMENTED.** All new water services are equipped with water meters and fully AMI.
(c) A Meter Testing and Maintenance Program	Continue to replace all existing meters with the new AMI standard within the next 5 years.	**IMPLEMENTED.** AMI implementation completed in 2013. All new water service meters are fully AMI.
	Use improved technology when upgrading or replacing existing source meters during the next 5 years.	**IMPLEMENTED.** All new production water meters are mag meter type with the highest metering accuracy rate available. Five older model production meters were replaced in 2015.
(d) A rate structure under which customers' bills are based, at least in part, on the quantity of water metered at the service connections	Continue to bill customers based, in part, on the quantity of water metered.	**IMPLEMENTED.** All customers are billed based on quantity of water consumed.
	Reduce the base quantity allowance from 4 CCF to zero CCF within the next 5 years.	**IMPLEMENTED.** The City eliminated the base quantity allowance (4 ccf) in 2015 with its rate modernization effort.
(e) If the annual water audit indicates that system leakage exceeds 10 percent, a regularly scheduled and systematic program to detect leaks in the transmission and distribution system using methods and technology appropriate to the size and capabilities of the municipal water supplier;	Continue to conduct leak detection surveys to monitor changes in pipe integrity over time.	**IMPLEMENTED.** Leak detection is not required of the City since leakage is well below the 10 percent threshold. However, staff conduct supply side leak detection annually as part of its commitment to reducing non-revenue water and system leakage.
	Continue to monitor customer consumption records for evidence of leaks and to work cooperatively with customers when leaks are discovered.	**IMPLEMENTED.** Customer water use is monitored by utility and billing staff. Notifications of constant consumption are made to the customer. Beginning in 2017, The City's customer engagement software was implemented as a new means of constant consumption notification and customer communication.
	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.	**IMPLEMENTED.** AMI implementation completed in 2013.

Sub-section Requirement	2011 Benchmark	2020 Progress Summary
(f) A public education program to encourage efficient water use and the use of low water use landscaping that includes regular communication of the supplier's water conservation activities and schedule to customers	Continue to provide water efficiency and conservation outreach information to the public using print materials, radio, and video.	**IMPLEMENTED.** The City continues to offer customers a wide variety of educational information through such means as a conservation website (waterwisetips.org), a three-part series of WaterWise Guides, public workshops on low-water landscape methods, and regular news/media releases emphasizing the importance of reducing water waste and using water efficiently.
	Continue to update the website and outreach materials as needed.	**IMPLEMENTED.** Regular updates to the City's Utility Department and water conservation websites are made by Utility Department staff. The City's website underwent a complete redesign in 2016 to update graphics and improve navigation.
	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.	**IMPLEMENTED.** The Utility Program Compliance Specialist job description was created in 2015 to address dual program needs for enforcing stormwater and water use regulations, and that position was filled soon thereafter. In 2017, the City added a 0.5 FTE Utility Program Compliance Specialist to the Water Conservation Program.
OAR 690-086-150 (5) If the Municipal Water Supplier serves a population greater than 1,000 and proposes to expand or initiate diversion of water under an Extended Permit for which resource issues have been identified under OAR 690-086-0140(5)(i), or if the Municipal Water Supplier serves a population greater than 7,500, a description of the specific activities, along with a schedule that establishes five-year Benchmarks, for implementation of each of the following measures; or documentation showing that implementation of the measures is neither feasible nor appropriate for ensuring the efficient use of water and the prevention of waste		
(a) A system-wide leak repair or line replacement program to reduce system leakage to 15 percent and if the reduction of system leakage to 15 percent is found to be feasible and appropriate, to reduce system leakage to 10 percent	As stated in Leak Detection and Repair under OAR 690-086-0150(4), continue to conduct leak detection surveys to monitor changes in pipe integrity over time.	**IMPLEMENTED.** System leakage is below 15 percent (water loss was 5.7 percent in 2019). However, City staff continue to conduct leak detection surveys.
	Continue to monitor customer consumption records for evidence of leaks.	**IMPLEMENTED.** System leakage is below 15 percent (Water loss was 5.7 percent in 2019). However, City staff continue to monitor customer consumption records for evidence of leaks using AMI.
(b) Technical and financial assistance programs to encourage and aid residential, commercial, and industrial customers in implementation of conservation measures;	Continue efforts to develop and maintain WaterWise partnerships with large use customers during the next 5 years.	**IMPLEMENTED.** The Large Landscape Program pairs water conservation staff with owners of large landscapes to manage irrigation efficiently. The science-based program is data driven and utilizes a combination of AgriMet weather data, GIS spatial data, hourly AMI water use data, and the latest water budget calculation best management practices. Under the Large Landscape Program, the City has partnered with such entities as: Bend Metro Parks and Recreation District, Bend-La Pine Schools, Housing Works, Shevlin Center Owners Association, and Oregon State Parks: Pilot Butte State Park.
	Continue to distribute toilet tank leak detection dye tablets, shower timers, and related items to customers during the next 5 years.	**IMPLEMENTED.** These are available year round at various City events, the WaterWise Kiosk in City Hall, and at Utility Department offices. Staff also distribute approximately 300 indoor water conservation kits annually.
	Conduct cost analysis aimed at the creation of cost-effective rebate programs within the next 5 years.	**IMPLEMENTED.** Staff utilized the Alliance for Water Efficiency (AWE) Tracking Tool to evaluate the cost-effectiveness of various conservation measures until recently. In 2019 through 2020, the City conducted a Water Conservation Program Water Savings and Cost-effectiveness Analysis, which analyzed several rebate programs. This effort is detailed in Sections 3.3 and 3.5.2.
	Develop a pilot program for creation of water budgets for targeted customer groups, based on evapotranspiration data.	**IMPLEMENTED.** Water budgets continue to be a key landscape water efficiency performance indicator. Water budgets are now calculated for all customers participating in the Sprinkler Inspection Program (described in Section 3.5.1) and the Large Landscape Program to identify the greatest conservation potential.

Sub-section Requirement	2011 Benchmark	2020 Progress Summary
	Continue to fund and promote the use by all customers of the AgriMet weather station and its website, including a pilot project to place real time evapotranspiration data on the City website for use in creation of outdoor water use budgets.	**IMPLEMENTED.** The AgriMet Bend weather station continues to be funded in part by the City of Bend. Due to software incompatibilities, the City was unable to auto-populate its water conservation website with ET data from AgriMet. However, the website link is not necessary given that the AgriMet weather station is still able to supply real-time weather data to signal-based irrigation controllers.
(c) Supplier financed retrofitting or replacement of existing inefficient water using fixtures, including distribution of residential conservation kits and rebates for customer investments in water conservation;	Continue to pursue greater irrigation efficiency of its existing City-owned landscapes and all new landscapes so they will meet the latest Engineering Standards and Specifications, which includes the use of smart irrigation controller technology, xeriscaping principles, and other sustainable landscape practices.	**IMPLEMENTED.** The City's Engineering Standards and Specifications were revised to improve irrigation efficiency in City-owned landscape projects going forward. This standard promotes an increased level of water efficiency in the landscape based on national standards for using smart irrigation technology and drip irrigation where possible and limiting the use of lawn and overhead irrigation to functional areas. Site improvements were also made to over 15 Utility Department facilities including new landscaping, new irrigation systems, and new irrigation controllers with remote access capabilities.
	Study the cost effectiveness of implementing a toilet rebate replacement or incentive program based on the new voluntary federal HET standard.	**IMPLEMENTED.** Within the past 10 years, staff evaluated a High-Efficiency Toilet (HET) rebate program with the AWE Water Conservation Tracking Tool. Initial findings showed that the rebate was not a cost-effective conservation measure based on the Tracking Tool inputs. However, the City's 2020 Water Conservation Program Water Savings and Cost-effectiveness Analysis (detailed in Section 3.3) indicated that a toilet rebate was cost-effective.
	Become an EPA WaterSense Program partner and make related information available through its web links, bill stuffers, and other methods.	**IMPLEMENTED.** The City is now an EPA WaterSense Partner, member of Alliance for Water Efficiency, Irrigation Association, and Oregon Landscape Contractors Association.
	Provide a list of qualifying toilets that meet the various flush standards along with the creation of a toilet efficiency fact sheet.	**IMPLEMENTED.** A link to EPA WaterSense approved devices is located on the City's water conservation website.
(d) Adoption of rate structures, billing schedules, and other associated programs that support and encourage water conservation;	As stated in Unit-based Billing Program under OAR 690-086-0150(4), continue to bill customers based, in part, on the quantity of water metered.	**IMPLEMENTED.** A new rate structure went into effect on July 1, 2015. This eliminated the remaining 4 ccf monthly allowance and based sewer charges on winter quarter average water use.
	Reduce the base quantity allowance from 4 CCF to zero CCF within the next 5 years.	**IMPLEMENTED.** A new rate structure went into effect on July 1, 2015. This eliminated the remaining 4 ccf monthly allowance and based sewer charges on winter quarter average water use.
	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 website.	**IMPLEMENTED.** A variety of public education and communication tools are utilized by water conservation staff including monthly utility bill newsletters, social media, City website, press releases, attending public events, and more.
(e) Water reuse, recycling, and non-potable water opportunities; and	During the next 5 years, continue to look for opportunities to increase the use of recycled water.	**IMPLEMENTED.** The City currently sends approximately one-half of its recycled water to an area golf course. The other one-half is placed in recharge ponds that help recharge the Deschutes Basin Aquifer.
(f) Any other conservation measures identified by the water supplier that would improve water use efficiency.	Within the next 5 years, evaluate adoption of modified irrigation restrictions based on time of day (hours that promote efficient water use).	**IMPLEMENTED.** Approved irrigation hours and days have been incorporated into the Bend Code. These may be revised based on information resulting from the City's IWSMP, which is currently under development.

Sub-section Requirement	2011 Benchmark	2020 Progress Summary
	Continue to implement current landscape standards through related approval processes during the next 5 years.	**IMPLEMENTED.** New City-owned and public landscapes will follow the Engineering Standards and Specifications. This document outlines standards that contractors and City staff must follow regarding landscape and irrigation work. Private development projects follow Bend Development Code, which is currently under review.
	Continue to seek appropriate partnership opportunities based on current project priorities, budget, and staff time.	**IMPLEMENTED.** Staff continue to seek new partnerships to advance water conservation efforts in the community. This includes partnership with large customers such as the local school district, local parks district, state parks, churches, and homeowners' associations. Staff also seek public education partnerships with Oregon State University Extension Service, Central Oregon Community College, Central Oregon Builders Association, and more.
	Continue to look for coordination opportunities to more efficiently communicate and implement related programs.	**IMPLEMENTED.** The Water Conservation Program manager oversees the coordination of water efficiency efforts throughout the City. Staff regularly seek input on how to best deliver services in the most cost-effective manner.
	Continue to implement the Hydrant Meter Program and related fill station.	**IMPLEMENTED.** The Hydrant Meter Program continues to be instrumental in reducing non-revenue water. A total inventory of 94 AMI hydrant meters was recorded as of 2018. Each includes an AMI transmitting unit to ensure all hydrant water usage is tracked for billing and water auditing purposes.
	During the next 5 years, 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.	**IMPLEMENTED.** Within the past 10 years, staff evaluated the cost-effectiveness of water conservation measures with the AWE Water Conservation Tracking Tool. However, the City recently analyzed water conservation measures in greater detail through its 2020 Water Conservation Program Water Savings and Cost-effectiveness Analysis (detailed in Section 3.3) as part of its IWSMP process to identify cost-effective water conservation measures to fund and implement over the next 20 years.

Notes

[1] Please note that benchmarks marked as "IMPLEMENTED" may also be associated with continuing programs that have been successfully implemented, but are continuing.
AMI = advanced metering infrastructure
AWWA = American Water Works Association
ccf = 100 cubic feet
ET = evapotranspiration
EPA = U.S. Environmental Protection Agency
FTE = full-time equivalent
GIS = geographic information system
HET = high-efficiency toilet
OAR = Oregon Administrative Rule

3.2 Use and Reporting Program

OAR 690-086-0150(2)

The City's Water Measurement and Reporting Program complies with the measurement and reporting standards in OAR Chapter 690, Division 85.

The City currently measures surface water entering the distribution system at the Heidi Lansdowne Intake Facility using a mag meter. The City's AMI infrastructure enables the City to record surface water diversion hourly. The City measures groundwater entering the distribution system wellheads using mag meters with AMI and the SCADA system and records groundwater use continuously.

Each year, the City submits monthly water use measurements to OWRD for the previous water year (October 1 to September 30). The City's water use records can be found here: https://apps.wrd.state.or.us/apps/wr/wateruse_query/

3.3 Other Current Water Conservation Measures

OAR 690-086-0150(3)

The City implements numerous water conservation measures, which are described in the progress report in Section 3.1 as well as in Sections 3.4 through 3.6. The following section provides detail on individual conservation measures evaluated as part of the Water Savings and Cost-effectiveness Analysis, described in greater detail in a report in **Appendix C.**

- Sprinkler Inspection Program for single family customers
- Water Waste Prevention Program
- Large Landscape Program
- Meter Testing and Maintenance Program now utilizes AMI
- Customer Leak Detection Program
- Utility bill newsletters
- Educator resources about water conservation
- Water Conservation Program Water Savings and Cost-effectiveness Analysis in 2020 (see below)

2020 Water Conservation Program Water Savings and Cost-effectiveness Analysis

As part of the effort to update the City's IWSMP and WMCP, in 2020 the City conducted a Water Conservation Program Water Savings and Cost-effectiveness Analysis using the Maddaus Water Management, Inc., Decision Support System (DSS) Model. The City used the DSS model to evaluate different water conservation programs consisting of conservation measures that can be pursued over the next 20 years; dependent upon City Council concurrence and funding in future City budgets.

The DSS Model output and additional post-model analysis shows that the program preferred by City staff (Program C), consisting of a combination of indoor and outdoor conservation measures, could reduce MDD by 5.1 mgd (7.89 cfs) by 2040. The City conducted this analysis in coordination with development of an updated IWSMP and this WMCP update. The measures comprising the program consist of two existing measures (outdoor water surveys provided through the Sprinkler Inspection Program and indoor water conservation kits), new outdoor water conservation incentives, new indoor and outdoor water conservation ordinances, and the Water-efficient Toilet Rebate Program. The annual and maximum-day water savings, estimated cost of implementation, and estimated avoided infrastructure costs based on these water savings are summarized in **Exhibit 3-2.** The avoided infrastructure cost of approximately $21,000,000 is equal to the cost of constructing three new wells and one 4-MG reservoir (which would not need to be constructed if 5.1 mgd in water savings in a MDD scenario is realized). The impact of the estimated water savings is discussed in greater detail in Section 5.

Exhibit 3-2. Summary of Water Conservation Program Water Savings, Costs, and Avoided Infrastructure Costs

Maximum Day Water Savings in 2040 (mgd)	5.1
Total Water Savings (2020–2040) (MG)	7,939
Estimated Cost of Implementation through 2040	$ 11,071,052
Avoided Infrastructure Cost	$ 21,000,000

Notes
MG = million gallons
mgd = million gallons per day

Conservation measures in Program C are summarized in **Exhibit 3-3. Appendix C** includes the documentation for the City's analysis, including additional tables describing the Water Conservation Program, descriptions of approach, methods and assumptions, and estimated water savings and costs of implementing that program.

Exhibit 3-3. Water Savings and Cost-effectiveness Analysis Measures

Water Savings and Cost-effectiveness Analysis Measures Included	Water Savings and Cost-effectiveness Analysis Measure Summary Description
Retrofit on Resale	Require installation of WaterSense-approved fixtures in conjunction with any construction that requires a permit or in the course of resale of the property: lavatory faucets that flow at no more than 1.0 gpm (public restrooms are 0.5 gpm), kitchen faucets no more than 1.8 gpm, showerheads no more than 1.5 gpm, urinals no more than 0.125 gpf, and toilets no more than 1.28 gpf. Work with the real estate industry to require a certificate of compliance be submitted to the City that verifies that a qualified inspector has inspected the property and efficient fixtures were either already there or were installed before close of escrow.
High Efficiency Toilet Rebate	Provide customers a rebate for replacing a toilet that uses 1.6 gpf or more with an EPA WaterSense-approved Ultra-High Efficiency Toilet (UHET) that uses 1.28 gpf or less. For single family, multi-family, and commercial customers.
Free Faucet Aerators and Showerheads	Provide free water-efficient showerheads (1.5 gpm) and faucet aerators (1.5 gpm for bathrooms and kitchens) to single family, multi-family, and commercial customers by mail upon customer request or as a prize for signing up for WaterSmart. (This is an existing water conservation measure; these fixtures are distributed in the indoor water conservation kits.) ***This is currently a WMCP measure with an associated benchmark.***
Indoor Plumbing Fixture Ordinance	Require developers to install the following WaterSense approved in new developments: lavatory faucets that flow at no more than 1.0 gpm (public restrooms are 0.5 gpm), kitchen faucets no more than 1.8 gpm, showerheads no more than 1.5 gpm, urinals no more than 0.125 gpf, and toilets no more than 1.28 gpf. Work with the real estate industry to require a certificate of compliance be submitted to the City that verifies that the property has been inspected and water-efficient fixtures were installed before close of escrow.
Landscape and Irrigation Ordinance	Develop and enforce Water Efficient Landscape Design Standards. Standards specify that new development projects and renovations of existing units subject to design review be landscaped according to water-efficient best management practices including, appropriate plant selection and placement, efficient irrigation systems, and smart irrigation controllers. The ordinance could require certification of landscape professionals.

Water Savings and Cost-effectiveness Analysis Measures Included	Water Savings and Cost-effectiveness Analysis Measure Summary Description
Outdoor Water Surveys	Provide free landscape water surveys to existing single family and multi-family residential customers upon request and to high water use single family and multi-family customers identified by the City. The City provides a customized report (a water budget generated using WaterSmart Software) to the customer on how to save water. Water budgets will be updated annually based on lots square footage and weather. No devices will be given away as part of this program. (This is an existing water conservation measure; these surveys are provided under the Sprinkler Inspection Program and the Large Landscape Program.) ***This is currently a WMCP measure with an associated benchmark.***
Weather-based Irrigation Controller Rebate	Provide a rebate of $100 for the purchase of a WaterSense approved weather-based irrigation controller. These controllers have on-site weather sensors or rely on a signal from a central weather station that modifies irrigation times at least weekly.
Pressure Regulation Rebate	Provide a $100 rebate for the installation of an in line pressure regulator. This device is meant to regulate the incoming service pressure to the entire property affecting indoor and outdoor end uses, such as faucets, showers, clothes washers, and irrigation.
Drip Irrigation Kits	Offer free drip irrigation kits to single family residential customers.
Rotating Sprinkler Nozzles Rebate	Provide rebates to replace standard spray sprinkler nozzles with high-efficiency nozzles. Rebates will be $4 per nozzle up to a maximum purchase of 20 nozzles.
Pressure Regulating Sprinkler Bodies Rebate	Rebate customers $3 per pressure regulating sprinkler body Rainbird PRS/Hunter PR40 or similar to regulate pressure at the sprinkler head on individual irrigation zones.

Notes

EPA = U.S. Environmental Protection Agency
gpf = gallons per flush
gpm = gallons per minute
UHET = ultra-high-efficiency toilet

3.4 Required Conservation Measures

OAR 690-086-0150(4)(a-f)

3.4.1 Annual Water Audit

In 2013, the City began using the AWWA M36 Water Audit and Loss Control Program methodology to conduct annual water audits and has been refining its processes each year to improve its score, which reflects strengths of the water auditing accounting system. In 2015 and 2019, the City hired an external water loss control expert to perform a third-party validation of the M36 Water Audit results consistent with Water Research Foundation parameters for third-party reviews. The AWWA M36 Water Audit methodology provides the most up-to-date analysis of the City's water distribution system efficiency and accuracy. In addition to unmetered uses and real losses (e.g., system leakage, overflows, evaporation), the M36 Water Audit Methodology includes in its estimate of non-revenue water such factors as customer metering inaccuracies and systematic data handling errors.

Since 2016, the City has had in place a Water Loss Control Team that conducts annual water audits to review, evaluate, and implement recommendations from annual M36 Water Audits. The reporting worksheets and performance indicators for these water audits (from 2015 through 2019) are presented in **Appendix B**, and provide additional information about the source of water loss and estimates of avoidable loss. The City's water loss in 2019 was 5.7 percent and averaged 4.7 percent from 2014 through 2019 according to the M36 Water Audit, as shown in **Exhibit 2-16**. The M36 audit recommendations included addressing real losses from system leakage and improving some meter accuracy, so the City implemented a Supply Meter Testing Plan for Water Operations staff to implement into routine operations.

Five-Year Benchmarks

- The City will continue to conduct annual water audits utilizing the AWWA M36 Water Audit methodology.
- The City will consult with an external water loss control expert to perform a third-party validation of the M36 Water Audit results at least once in the next 5 years.
- The City will assess annual audit results as part of an evaluation of potential system and operational improvements.

3.4.2 System-wide Metering

The City's water system is fully metered and fully converted to AMI. The City completed conversion of its water system to AMI in 2013 and all new water service connections have AMI meters. The City's previous investments in AMI have allowed the City to leverage water use data.

The benefits the City has realized from AMI include the following:

- The collection of hourly water use data has enhanced the City's supply-side and customer-side leak-detection capabilities.
- Access to detailed customer water use data has improved the City's ability to target

conservation measures for individual customers and groups of customers.

- An improved understanding of customer water use patterns across different customer categories has enhanced the City's ability to project future water demands.

Five-Year Benchmarks

- The City will continue to install AMI meters on all new water connections.
- The City will investigate the feasibility of adding AMI meters to detects on fire flow connections, related fire systems, and bypass vaults.

3.4.3 Meter Testing and Maintenance

Production meters for the City's surface water and groundwater sources are nearly all mag meters accurate to within 0.5 percent. The production meters are connected to the City's SCADA system and are tested annually. Source meters are verified through draw down and fill exercises on reservoirs and validated by third-party consultants. Each year, the City tests production meters and all customer meters 3 inches and larger following AWWA's M36 Water Audit and Loss Control guidelines. The City is developing a program to expand annual meter testing to the City's 1.5- to 2-inch customer meters.

The City samples a percentage of customer meters 1 inch and smaller for annual testing. The City typically replaces small customer meters when they reach a metered volume of 300,000 cubic feet or 2,200,000 gallons, roughly corresponding to a 20-year lifespan. Recently, the City has begun installing electromagnetic meters on customer connections of 1 inch and smaller. The accuracy of electromagnetic meters is maintained through the 20-year guaranteed lifespan of the meter eliminating decline in meter accuracy over time. In 2019, the City contracted with a third party to verify the meter accuracy data recorded by City staff.

Five-Year Benchmarks

- The City will continue to develop a standardized production Meter Verification Program.
- The City will continue to test all customer meters 3 inches and larger annually.
- The City will develop a formal annual testing and Meter Replacement Program for 1.5-inch to 2-inch customer meters.
- The City will complete development of a Small Meter Testing and Replacement Program (3/4-inch and 1-inch meters) aligning with AWWA's M36 Water Audits and Loss Control Program standards. The program will allow gradual transition to use of new electromagnetic meters as adopted in City of Bend Standards and Specifications.[5]

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[5] https://www.bendoregon.gov/government/departments/community-development/private-development-engineering-division/standards-and-specifications

3.4.4 Water Rate Structure

The City's rate structure is based, in part, on the quantity of water metered at each service connection. The City has a base rate, which is contingent on meter size. It also has a volumetric rate based on the volume of water consumed, which currently applies uniformly to all customer classes. This current rate structure has been in place since July 2015, replacing a 4 ccf (1 ccf = 100 cubic feet) monthly allowance that provided little financial incentive to conserve water. The new rate structure also was changed to calculate sewer charges based on the volume of potable water used indoors (and assumed to go to the sewer system). The proxy for determining indoor water use uses the summed average of all metered water use during December, January, and February, which is referred to as winter-quarter-average (WQA). The new sewer rate methodology provides an additional financial incentive to increase indoor water use efficiency. In addition, sewer rate calculations for multi-family customers changed to per-dwelling unit-based charges instead of the flat sewer rate that was previously in place, resulting in greater incentive to conserve water indoors for these facilities.

In late 2020, the City will complete an update to a new utility billing software that will make it more feasible for the City to implement a new rate structures in the future, if desired. In the coming years, the City plans to explore implementation of a new rate structure, such as tiered rates, water budget-based rates, or another approach aimed at reducing peak-season demand. The City reads customers' meters and bills customers monthly.

Exhibit 3-4 presents the City's current residential and non-residential water rates for customers inside and outside of city limits.

Exhibit 3-4. City of Bend Water Rates for Residential and Non-Residential Customers, as of July 1, 2020

	Inside City		Outside City	
Meter Size (inches)	Base Rate	Usage Rate	Base Rate	Usage Rate
3/4	$23.60	$1.96 / 100 cu ft	$35.41	$2.94 / 100 cu ft
1	$27.15		$40.72	
1 1/2	$35.93		$53.89	
2	$46.50		$69.75	
3	$74.74		$112.12	
4	$106.46		$159.71	
6	$194.57		$291.85	
8	$300.32		$450.49	
10	$423.75		$635.63	
12	$568.27		$852.41	

Note
cu ft = cubic foot

Five-Year Benchmarks

- The City will continue to bill customers based on the existing uniform rate structure, which charges customers based on the volume of water they consume.
- The City will complete implementation of an updated utility billing system, which will provide the administrative feasibility to change rate structures in the future.
- The City will continue to review existing customer categories and rate classes as part of the City's annual rate review process to promote efficiency and equity.

3.4.5 Water Loss Analysis

The City's water loss in 2019 was 5.7 percent and averaged 4.7 percent from 2014 through 2019, according to the AWWA M36 Water Audit. As described under Annual Water Audit in Section 3.4.1 above, the City conducts annual AWWA M36 Water Audits, which consist of the most up-to-date best management practices for conducting water audits.

OWRD requires the development and implementation of a Leak Detection Program when system water losses exceed 10 percent. The City's water losses are less than 10 percent, but the City has maintained its Distribution System Leak Detection Program since 2004. In 2018, the City surveyed more than 25 miles of water mains for hidden leaks and surveyed all water mains in streets scheduled to be paved in 2018 and 2019. The survey identified and then repaired 16 water main leaks that were estimated to be losing a total of 42 gpm. In 2017, a distribution system leak detection contractor surveyed approximately 25 miles of water mains and located three leaks that were estimated to be losing a total of 2.25 gpm. In 2016, a leak detection contractor surveyed approximately 19 miles of water mains and located 17 leaks that were estimated to be losing a total of 33 gpm.

Although customer leaks (leaks that occur on the downstream, customer side of the meter) are considered metered demand, ongoing customer leak detection is possible with the City's AMI metering infrastructure software to identify and notify customers of potential leaks downstream of the water meter. More than 13,000 leak alerts were sent to customers in 2019. This is known as the Customer Leak Notification Program.

The City has also correlated pipeline replacement with street maintenance activities to minimize redundant construction costs and loss of service. A majority of the City's delivery mains are ductile iron pipe. Replacements and new lines will continue to use ductile iron pipe, which has a greater lifespan and lower leak potential than galvanized steel pipe. In 2018 and 2019, City Staff surveyed 38 miles of water main. A total of 13 leaks were repaired in the distribution system, which accounted for an estimated 36 MG annually.

Five-Year Benchmarks

- The City will continue its efforts to minimize water loss by continuing the Distribution System Leak Detection Program and completing an annual Leak Detection Report as part of the City's M36 Water Audit Program.
- The City will evaluate the feasibility of developing a more formal pipe replacement program to identify and replace aging and failing pipe segments on an annual basis as outlined in the City's Capital Improvement Plans, to be adopted in late 2020 or early 2021.

3.4.6 Public Education

The City implements a comprehensive Public Education Program that promotes water conservation, which includes the following:

- **Website Content:** The City has web pages promoting indoor and outdoor water conservation at WaterWisetips.org. The site provides a comprehensive list of resources for customers on water use efficiency and current with seasonal events and program offerings. In addition, customers can report water waste, request free indoor conservation kits, and evaluate their water use through the City's customer engagement software.

- **WaterWise Guides:** The City created three WaterWise publications. The WaterWise Guides (Landscape, Irrigation, Streetscape) contain water efficiency, horticultural, and maintenance information specific to the Central Oregon landscape. The WaterWise Landscape Guide provides photos and information on how to plan, design, install, and maintain a beautiful Bend WaterWise landscape. The WaterWise Irrigation Guide covers irrigation design basics as well as technical tips for landscape professionals. The WaterWise Streetscape Guide focuses exclusively on street-side landscaping, offering example landscape plans, plant lists, and step-by-step instructions aimed to keep irrigation water from running off onto pavement. Guides are available at nearly 20 local garden centers, nurseries, libraries, at City facilities, and online on the City's WaterWise Program webpage.[6]

- **Annual Outdoor Water Conservation Campaign:** The City conducts an outdoor water conservation media campaign annually from April through October to coincide with peak seasonal water demands. The City plans to formalize the public outreach of seasonal water conservation messages under a Seasonal Advisory Alert messaging. Seasonal Advisory Alert messages are intended to heighten awareness regarding seasonal outdoor landscape and irrigation water use efficiency and to inform water customers of the potential for higher-than-normal water demands and/or the need to pay close attention to their irrigation consumption to help manage peak season water use. The WaterWise Program will issue Seasonal Advisory Alerts and may request that all water users strive for increased efficiency and or voluntary reductions in outdoor water use. The request may include a summary of the current water supply situation and the reasons for the requested reductions, including programmatic goals or incentives that may be available.

  In declaring a Seasonal Advisory Alert, the City may do the following:

  - Contact local media outlets and request that the public be informed about the need to use water efficiently during the peak season of April through October.
  - Create and post prepared public service announcements, including conservation tips, on the City's web page and social media outlets.
  - Provide customer notifications on water bills, through utility bill inserts, or through the

[6] https://www.bendoregon.gov/government/departments/utilities/conservation/waterwise-guides

City's customer engagement portal, potentially including reference to AMI data.

- **Conservation Connection Newsletter:** The WaterWise Program sends a quarterly newsletter to more than 150 local green industry contractors, irrigators, architects, and designers. The newsletter keeps the industry informed on local issues that affect the green industry with a focus on reducing outdoor water use.

Workshops and Events

- **WaterWise Garden at Hollinshead Park:** The City's WaterWise Program partnered with Oregon State University Extension Service, Central Oregon Master Gardeners Association, and Bend Parks and Recreation to develop a water conservation demonstration garden at Hollinshead Park. This historic park has served as an excellent location for multiple WaterWise workshops addressing topics such as drip irrigation and low-water landscape transformation.
- **WaterWise Workshops Professional Series:** The City proactively engages green industry contractors to provide continuing education opportunities and to support the State's landscape and irrigation contractor certification programs administered through the Oregon Landscape Contractors Board.
- **WaterWise Water Waste Prevention Program:** The City provides technical assistance to customers to help them reduce water waste, provides a one-page Water Use Analysis that identifies water and financial savings potential of reducing waste outdoors, and encourages customers to use its WaterSmart Software to track daily water use and receive water use notifications. The City also enables community members to report water waste through a "Report Waste" online form on the City's Water Waste Prevention Program web page.
- **Educator Resources:** The City offers educational materials for middle school students, classroom presentations accompanied by field trips to water facilities, and a lending library with free resources for educators. The City's website describes these resources, provides flyers and guides, and includes videos about the City's water facilities and the importance of working together to care for local water resources.
- **Additional Activities:** The City promotes water conservation through utility bill newsletters, press releases, social media, and public events.

Five-Year Benchmarks

- The City will continue to update its educational resources for customers and the landscape industry through the City's WaterWise website, workshops, and related educational outreach activities.
- Formalize seasonal public outreach efforts under the Seasonal Advisory Alert Program.

3.5 Additional Conservation Measures

OAR 690-086-0150(5)

OAR 690-086-0150(6) requires municipal water suppliers (1) that serve a population greater than 1,000 and propose to expand or initiate the diversion of water under an *extended permit* for which resource issues have been identified, or (2) if the population served is greater than 7,500, to provide a description of the specific activities, along with a five-year schedule to implement several additional conservation measures. The City serves a population of greater than 7,500.

3.5.1 Technical and Financial Assistance

The City provides technical and financial assistance to customers through a variety of means, including the following:

- **Indoor Water Conservation Kits:** The City offers indoor water conservation kits, which include a showerhead with the U.S. Environmental Protection Agency's (EPA's) WaterSense label, two bathroom faucet aerators, a shower timer, a dual-spray kitchen faucet aerator, toilet leak detection dye tabs, plumber's tape, and installation instructions. Multi-family and apartment complex owners are eligible for a more customized combination of indoor water conservation items. Since the City began offering the kits in 2016, it has distributed approximately 300 kits annually, with an estimated 85 percent going to single family residential customers and 15 percent going to multi-family residential customers.

- **Sprinkler Inspection Program:** The City has a Sprinkler Inspection Program that offers free outdoor water surveys for single family residential customers. Sprinkler inspections include a visual check to pinpoint any problems with the irrigation system, tests to measure how much water the irrigation system delivers, tests for irrigation system pressure, and soil sampling to determine root depth and soil type. Program participants receive a customized inspection report with a water budget and recommended watering schedule, as well as recommendations and tips to make their irrigation system more efficient. Customers are either recruited into the Sprinkler Inspection Program (i.e., targeted) by the City based on high outdoor water use when compared to lot size, or they can request sprinkler inspections. **Exhibit 3-5** presents the number of sprinkler inspections the City has provided since the program began in 2015.

Exhibit 3-5. Inspections Provided by the Sprinkler Inspection Program, 2015-2019

Year	Total Inspections	Targeted	Requested
2015	64	N/A	64
2016	189	65	124
2017	211	78	133
2018	165	89	76
2019	165	98	67
Total	794	330	464

- **Large Landscape Program:** The City has a Large Landscape Program that offers free outdoor water audits to customers with large landscapes (of approximately 1 acre or more). Typical program participants include multi-family residences, commercial establishments, City-owned landscapes, schools, parks, homeowners' associations, and churches. City conservation staff meet with landscape owners to inspect irrigation systems, develop detailed irrigation water budgets, track actual water use to compare with the water budget, and identify cost-effective improvements to increase landscape water efficiency. The Large Landscape Program is data driven and utilizes a combination of AgriMet weather data, GIS spatial data, hourly AMI water use data, and a customized water budget to guide water management throughout the season. The program also introduces customers to the City's customer engagement software, which provides water use data to aid customers' water management decisions.

- **Home Water Use Report:** In 2020 the City entered a pilot project to evaluate the extent to which providing customers with a Home Water Use Report, a tool available through the City's customer service software, would result in reductions in water use. The Home Water Use Report delivers a summary of the customer's monthly water use alongside a comparison to the water use of customers of comparable homes. The City's pilot project provides the Home Water Use Reports to a group of high water users and a control group of average water users to evaluate the effectiveness of the reports on various types of water users.

- **WaterWise Demonstration Garden:** In 2017, the City established a WaterWise demonstration garden at Hollinshead Park, which was a collaborative effort with Oregon State University Extension, the Master Gardeners Association, and Bend Parks and Recreation Department. The WaterWise demonstration garden includes low-to-moderate water use landscape plants and examples of water-efficient irrigation techniques that work well in Central Oregon. The City's water conservation staff designed and installed the four-station irrigation system. The four different irrigation techniques featured are inline drip irrigation, point source irrigation with drip emitters, pressure regulating tree bubblers, and an overhead application showcasing high-efficiency sprinkler nozzles. The WaterWise demonstration garden is open to the public to enable water customers to learn about ways to make their landscape and irrigation system more water efficient, and it serves as an excellent location for water conservation workshops.

Five-Year Benchmarks

- The City will continue the Large Landscape Program.
- The City will continue to offer the Sprinkler Inspection Program to its residential customers during the irrigation season.
- The City will continue to evaluate the feasibility and effectiveness of the use of Home Water Use Reports as a customer outreach and awareness tool.

3.5.2 Supplier Financed Retrofit or Replacement of Inefficient Fixtures

As described under 3.5.1, the City offers free indoor water conservation kits that include technical assistance items and the following water efficient fixtures to replace existing inefficient fixtures: an EPA WaterSense-labeled showerhead, two bathroom faucet aerators, and a dual-spray kitchen faucet aerator.

In 2019, the City financed irrigation efficiency improvements for more than 15 existing City Utility Department landscapes, which included installing new irrigation systems, new irrigation controllers with remote access capabilities, and landscaping that is more water efficient. In addition, the City will continue to upgrade all new City-owned landscapes to meet the low-water specifications detailed in the City's Engineering Standards and Specifications document, which the City updated and City Council adopted in 2017. The Engineering Standards and Specifications document applies to all City-owned and public landscapes, and promotes an increased level of water efficiency in the landscape. The City will continue to upgrade City-owned landscapes as additional changes are made to the Engineering Standards and Specifications document.

As described in Section 3.3, the City used a Water Savings and Cost-effectiveness Analysis to help identify a potential water conservation program that includes measures that could be pursued over the next 20 years, dependent upon City Council concurrence and funding in future City budgets. The potential water conservation program identified a number of potential new supplier-financed measures to replace inefficient fixtures, such as a high-efficiency toilet rebate, weather-based irrigation controller rebate, pressure reducing valve rebate, rotating sprinkler nozzles rebate, pressure-regulating sprinkler bodies rebate, and free drip irrigation kits.

Five-Year Benchmarks

- The City will continue to offer free indoor water conservation kits that include water-efficient faucet aerators and a showerhead.
- The City will implement new supplier-financed measures to replace inefficient fixtures identified in the Water Savings and Cost-effectiveness Analysis to the extent the measures are approved by City Council and funded in future City budgets.

3.5.3 Rate Structure and Billing Practices that Encourage Conservation

As described under Section 3.4.4, the City's rate structure is based, in part, on the quantity of water metered at each service connection. The City has a base rate based on meter size and a usage rate based on the volume of water consumed, applicable to all customer classes. This current rate structure has been in place since July 2015. In late 2020, the City will complete conversion of its utility billing software to a system with more robust capabilities, which will make it feasible for the City to implement a new rate structure, if desired. In the coming years, the City plans to explore implementation of a new rate structure, such as tiered rates, water budget-based rates, or another approach aimed at reducing peak-season demand.

Five-Year Benchmarks

- The City will continue to bill customers monthly based, in part, on the volume of water consumed.
- The City will investigate the feasibility of increasing tiered water rates based on water budgets to promote water conservation and to provide consistent revenue to meet operational, financial, and rate objectives set by the City Council.

3.5.4 Water Reuse, Recycling, and Non-potable Opportunities

The City's wastewater treatment facility is located over 8 miles northeast and downhill from Bend. It is finalizing the capability to produce high quality reclaimed water suitable for reuse for irrigation. The City previously delivered a small portion of its reclaimed water to Pronghorn Resort located downhill from the Reclamation Facility. At this time, the WPCF permits on file with DEQ for operation of the water reclamation facility require the City's treated wastewater, to be discharged to seepage ponds for return to the Deschutes Basin Aquifer.

Five-Year Benchmark

- The City will continue to consider feasible opportunities to use reclaimed water from its water reclamation facility.

3.5.5 Other Conservation Measures

Now that the City has updated its Engineering Standards and Specifications document, it is reviewing the Bend Development Code for opportunities to require more water-efficient landscaping standards in private development projects.

The City continues to develop and maintain partnerships that advance water conservation efforts. The City has partnerships with large customers, including the local school district, local parks district, state parks, churches, and homeowner associations. The City has public education partnerships with groups such as with Oregon State University Extension Service, Central Oregon Community College, and Central Oregon Builders Association. The City has also worked with the Transportation and Mobility's landscape department to upgrade controllers in City-owned right of way landscapes through the Large Landscape Program.

To continue to stay informed about the latest water conservation standards and technologies, the City is an EPA WaterSense Partner and is a member of the Alliance for Water Efficiency, Irrigation Association, and Oregon Landscape Contractors Association.

The City has been evaluating current and potential water savings from water conservation measures in an effort to maximize the cost-effectiveness of its Water Conservation Program. Since 2016, the City has been utilizing the Alliance for Water Efficiency Water Conservation Tracking Tool to quantify savings of existing conservation measures. As described in Section 3.3, the City conducted a Water Savings and Cost-effectiveness Analysis in 2020 as part of the IWSMP and WMCP efforts. The City used this analysis to identify a cost-effective Water Conservation Program that included a number of additional measures that, if implemented, may result in significant water savings and avoided infrastructure cost of $21,000,000 over 20 years. The conservation measures include outdoor and indoor conservation measures and accompanying rebates for new efficient equipment. The outdoor measures will focus on reducing the peak demands of irrigation season through water efficiency standards and specifications for new development. The outdoor rebates will provide the incentive for conversion to high-efficiency devices improving program participation. The indoor measures will focus on reducing the baseline water use by specifying high-efficiency indoor devices in homes and businesses. Indoor measures will also be coupled with rebates to incentivize the conversion to more efficient devices.

In addition, the City of Bend Code has irrigation regulations in place in an effort to increase water use efficiency and spread customer demand over the course of the day and week. No irrigation is allowed between 9 a.m. and 5 p.m. Customers with even addresses must irrigate on even days and with odd addresses must irrigate on odd days. Zero sprinkler overspray and runoff is allowed.

Five-Year Benchmarks

- The City will begin a code alignment and update process with the goal of increasing efficiency of outdoor water use through adoption of best management practices to promote irrigation efficiency in various related sections of the City of Bend Code and engineering specification documents.
- The City will explore the feasibility of updating and aligning indoor water use efficiency and related best management practices and other code improvements that will increase the water use efficiency inside of homes and businesses using nationally recognized standards that will work in Bend.
- Over the next five years City staff will work with City Management and the City Council to identify which of the new measures identified in the Water Conservation Program Water Savings and Cost-effectiveness Analysis (described in Section 3.3) to fund and implement.

3.6 Water Conservation Benchmarks Summary

A summary of the City's 5-year water conservation benchmarks by measure is presented in **Exhibit 3-6**.

Exhibit 3-6. Summary of 5-Year Water Conservation Benchmarks

Conservation Measures	Five-Year Benchmarks
Annual Water Audit	• The City will continue to conduct annual water audits utilizing the AWWA M36 Water Audit Methodology. • The City will consult with an external water loss control expert to perform a third-party validation of the M36 Water Audit results at least once in the next five years.
System-wide Metering	• The City will continue to install AMI meters on all new water connections.
Meter Testing and Maintenance	• The City will continue to develop a standardized production Meter Verification Program. • The City will continue to test all meters 3 inches and larger annually. • The City will develop a formal annual Testing and Meter Replacement Program for 1.5-inch to 2-inch meters. • The City will complete development of a Small Meter Testing and Replacement Program (3/4-inch and 1-inch meters) aligning with AWWA's M36 Water Audits and Loss Control Program standards. The program will allow gradual transition to use of new electromagnetic meters as adopted in the City of Bend Standards and Specifications.
Water Rate Structure	• The City will continue to bill customers based on the existing uniform rate structure, which charges customers based on the volume of water they consume. • The City will complete implementation of an updated utility billing system, which will provide the administrative feasibility to change rate structures in the future. • The City will continue to review existing customer categories and rate classes as part of the City's annual rate review process to promote efficiency and equity. • The City will investigate the feasibility of increasing tiered water rates based on water budgets to promote water conservation and to provide consistent revenue to meet operational, financial, and rate objects set by the City Council.

Conservation Measures	Five-Year Benchmarks
Water Loss Analysis	• The City will continue its efforts to minimize water loss by continuing the Distribution System Leak Detection Program and completing an annual Leak Detection Report as part of the City's M36 Water Audit Program. • The City will evaluate the feasibility of developing a pipe replacement program to identify and replace aging and failing pipe segments on an annual basis as outlined in the City's Capital Improvement Plans, to be adopted in late 2020 or early 2021.
Public Education	• The City will continue to update its educational resources for customers and the landscape industry through the City's WaterWiseTips.org website, workshops, and related educational outreach activities.
Technical and Financial Assistance	• The City will continue the Large Landscape Program. • The City will continue to offer the Sprinkler Inspection Program to its residential customers during the irrigation season. • The City will continue to evaluate the feasibility and effectiveness of the use of Home Water Use Reports as a customer outreach and awareness tool.
Supplier Financed Retrofit or Replacement of Inefficient Fixtures	• The City will continue to offer free indoor water conservation kits that include water-efficient faucet aerators and a showerhead. • The City will implement new supplier financed measures to replace inefficient fixtures identified in the Water Savings and Cost-effectiveness Analysis to the extent they are approved by City Council and funded in future City budgets.
Rate Structure and Billing Practices that Encourage Water Conservation	• The City will continue to bill customers monthly based, in part, on the volume of water consumed. • The City will investigate the feasibility of moving from uniform rates, to tiered water rates based on water budgets to promote water conservation and to provide consistent revenue to meet operational, financial, and other rate objectives set by the City Council.
Water Reuse, Recycling, and Non-potable Opportunities	• The City will continue to consider feasible opportunities to use reclaimed water from its water reclamation facility.
Other Conservation Measures	• The City will begin a code alignment and update process with the goal of increasing efficiency of outdoor water use through adoption of best management practices to promote water use efficiency in various related sections of City of Bend codes and specification documents. • The City will explore the feasibility of updating and aligning indoor water use efficiency and related best management practices and other code improvements that will increase the water use efficiency inside of homes and businesses using nationally recognized EPA WaterSense standards that will work in Bend. • Over the next five years City staff will work with City Management and the City Council to identify which of the new measures identified in the Water Conservation Program Water Savings and Cost-effectiveness Analysis (described in Section 3.3) to fund and implement.

Notes
AWWA = American Water Works Association
EPA = U.S. Environmental Protection Agency

4. 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.

4.1 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 fire, lightning strikes, 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).

4.2 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, mechanical or electric equipment failure, or insufficient flows in Tumalo Creek. Over this period, during brief interruptions to the City's surface water supply from turbidity events, lightning strikes, and planned and unplanned maintenance, the City has increased its reliance on its groundwater sources. The City's new membrane filtration plant has also nearly eliminated the need for the City to shut down its surface water treatment due to high turbidity during high-flow events. The City is currently able to use its groundwater rights to meet water demands. Future groundwater use may be limited by system (well) capacities and groundwater restrictions in the Deschutes Study Area. The City's previous curtailment plan included four stages. The City has regularly issued service announcements when there are forecasts for below-normal streamflows and above-normal temperatures. The City initiated Stage 1 water shortage alerts in 2015, 2020, and 2021 when the Governor declared a drought emergency for Deschutes County.

The City also has experienced occasional short-duration interruptions to normal service delivery as a result of pipe or water main breaking, lightning 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.

4.3 Curtailment Stages and Initiating Conditions

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

The City's curtailment plan includes three curtailment stages to be invoked in the event of a water supply shortage. These stages are of increasing severity and could be initiated and implemented in progressive steps or a later stage could be implemented directly. The plan includes both voluntary and mandatory measures, depending upon the cause, severity, and anticipated duration of the shortage. The goal of the City's curtailment plan is to describe the potential actions under each stage of alert that will provide the greatest assurance of maintaining emergency fire flows and potable water supplies for human consumption.

Stages of curtailment are therefore centered on a declining trend in system storage and a failure to maintain a minimum of 20 psi throughout the City's distribution system, as well as minimum levels of storage for fire flow in one or more reservoirs for extended periods of time. The reservoir level required for fire flow varies by reservoir, with some reservoirs having a greater amount of storage available for flexibility in meeting short-term demands. Other curtailment triggers are centered on water quality considerations for human consumption.

Exhibit 4-1 presents a summary of the potential initiating conditions for the three curtailment stages. Initiation of a curtailment stage is based on the specific circumstances of the actual event. The decision to implement curtailment will also consider the knowledge and judgment of City staff members familiar with the water system. Staff members may evaluate such considerations as assessments of the extent of system damage or contamination, duration of repair, costs, fire hazards, and weather forecasts.

In addition to the curtailment stages described below, the City also issues Seasonal Advisory Alerts. Seasonal Advisory Alert messages are intended to heighten awareness regarding seasonal outdoor landscape and irrigation water use efficiency and to inform water customers of the potential for higher-than-normal water demands and/or the need to pay close attention to their landscape and irrigation consumption to help manage peak-season water use. This program is described in more detail in Section 3.4.6.

Exhibit 4-1. Summary of Potential Initiating Conditions for Curtailment Stages 1 through 3

Curtailment Stage	Potential Initiating Conditions	Potential Triggers
Curtailment Stage 1: Potential Water Shortage Alert	• Minor damage to the distribution system. • Mechanical or electrical failure at source supplies. • Extensive periods of high water demand. • Planned reduction in supply capacity resulting from extended disruption in supply chain for chlorine or other water treatment chemicals.	• Over any period of 3 days, a declining trend in storage and failure to recover in one or more reservoirs above the operational level required to maintain minimum fire flows.
Curtailment Stage 2: Serious Water Shortage Alert	• Significant damage to water source supplies and/or distribution system. • A credible threat against key utility infrastructure. • Threat of fire to the Bend Municipal Watershed utility infrastructure.	• Over any period of 5 days, a declining trend in reservoir storage and failure to refill one or more reservoirs above operational level required to maintain fire flows.
Curtailment Stage 3: Severe Water Shortage Alert	• Extensive damage to water supply or distribution infrastructure. • Contamination of water sources. • Fire in the Bend Municipal Watershed.	• Failure to refill more than one storage reservoir above level required to maintain fire flows for a period of 7 days or more. • Loss of multiple sources of supply or significant distribution infrastructure leading to loss of system pressure and/or reservoir storage.

4.4 Curtailment Plan Implementation

OAR 690-086-0160(4)

4.4.1 Stage 1: Potential Water Shortage Alert

Stage 1 of the City's Curtailment Plan will activate a program to reduce nonessential water use as needed. Activation of Stage 1 may include (1) reiterating communication under the City's Seasonal Advisory Alert public outreach program, which requests voluntary water use reductions, and (2) any mandatory direction to specific customer groups, geographic areas, or pressure zones regarding reductions in water use. Potential initiation conditions include minor damage to the distribution system, mechanical or electrical failure at source supplies, extensive periods of high water demand, or disruption in the supply chain for chlorine or other chemicals required for water treatment. These and other conditions may cause one or more of the City's reservoirs to operate below required fire flow storage for extended periods of time. The City may activate Stage 1 curtailment if over any period of 3 days, there is a declining trend in reservoir storage and the one or more reservoirs cannot be refilled to a level greater than that required to maintain fire flows.

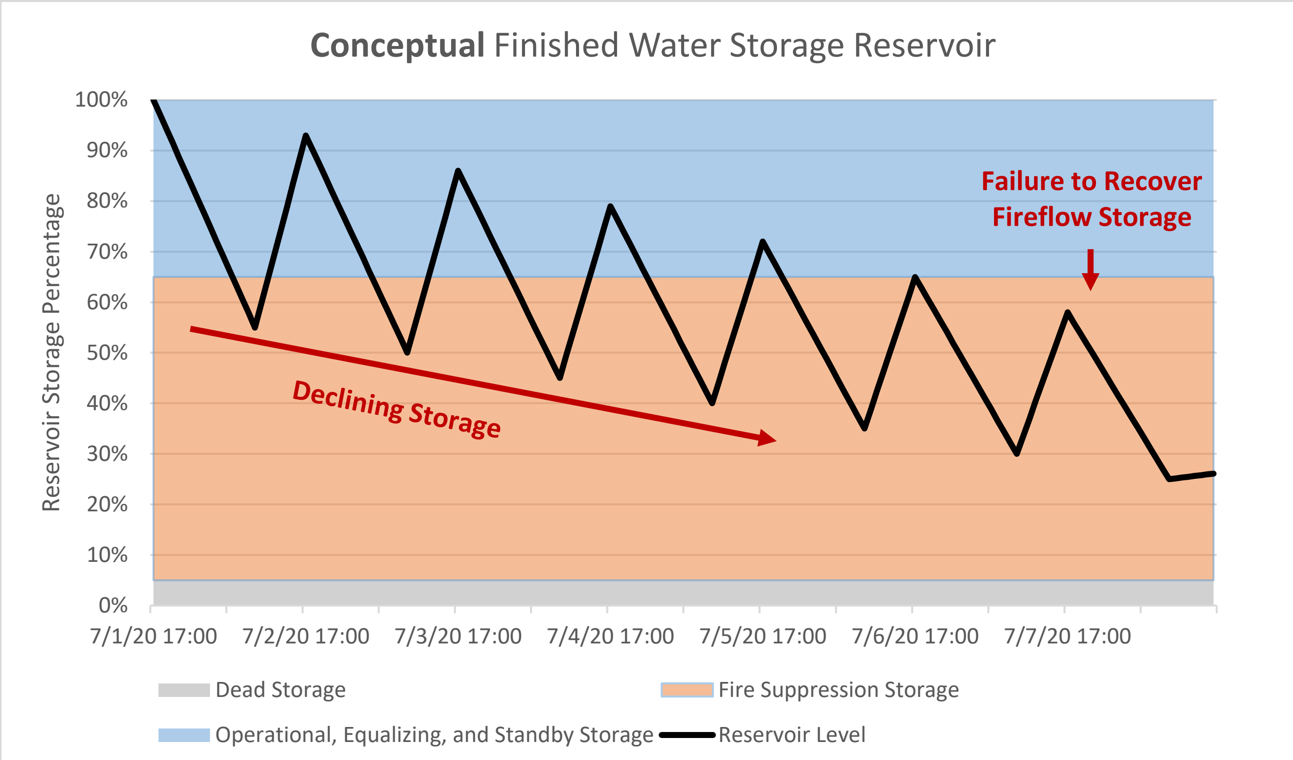
Elements of Stage 1 may include the following:

- Prohibiting the use of water that would impede the City's ability to meet the requirements of the Safe Drinking Water Act.
- Temporary reductions to, or prohibition of, landscape irrigation.
- Temporary prohibitions on filling swimming pools or ponds; operating water features; and washing sidewalks, driveways, and patios.

The purpose of Stage 1 curtailment actions is to reduce water demands in a specific area or throughout the City in order to prevent further declines in reservoir storage, and to allow reservoir storage to recover to a volume greater than that required to maintain minimum fire flows.

Exhibit 4-2 provides a conceptual example of a declining storage trend and failure to recover fire flow storage and minimum system pressure requirements.

Exhibit 4-2. Conceptual reservoir storage operation over the course of one week during periods of high demand, illustrating a pattern of declining storage and a failure to recover fire flow storage.



4.4.2 Stage 2: Serious Water Shortage Alert

Stage 2 of the City's Curtailment Plan will activate a program to eliminate all nonessential water use. Activation of Stage 2 may include activities listed in the Stage 1: Potential Water Shortage Alert, as well as any mandatory direction to specific customer groups, geographic areas, or pressure zones regarding reductions in water use. Potential initiating conditions include a fire in the Bend Municipal Watershed that poses a threat to the City's water supply infrastructure, a credible threat against key utility infrastructure, or significant damage to water supply or distribution infrastructure. These and other conditions may cause one or more of the City's reservoirs to operate below required fire flow storage for extended periods of time, or to drop significantly during a short period of time. The City may activate Stage 2 curtailment if over any period of 5 days, there is a declining trend in reservoir storage and the one or more reservoirs cannot be refilled to a level greater than that required to maintain fire flows.

Elements of Stage 2 may include the following:

- Prohibition of landscape irrigation.
- Prohibiting the use of water that would impede the City's ability to meet the requirements of the Safe Drinking Water Act.

Enforcement of mandatory water use restrictions will occur through the City's Code Enforcement Division.

The purpose of Stage 2 curtailment actions is to reduce water demands in a specific area or throughout the City in order to prevent loss of system pressure, further declines in reservoir storage, and to allow reservoir storage to recover to a volume greater than that required to maintain minimum fire flows.

4.4.3 Stage 3: Severe Water Shortage Alert

Stage 3 of the City's Curtailment Plan will activate a program intended to limit water use to that necessary for human consumption and sanitation needs. Activation of Stage 3 may include activities listed in the Stage 2: Serious Water Shortage Alert, as well as any mandatory direction to specific customer groups, geographic areas, or pressure zones regarding reductions in water use. Potential initiating conditions include a fire in the Bend Municipal Watershed resulting in damage to the City's surface water supply infrastructure, extensive damage to other water supply or distribution infrastructure, or contamination of multiple water sources.

In addition to significant emergencies impairing the City's ability to provide water. High demand conditions during supply interruptions may cause one or more of the City's reservoirs to operate below required fire flow storage for extended periods of time, or to drop significantly during a short period of time. The City may activate Stage 3 curtailment if:

- Failure to refill more than one storage reservoir above level required to maintain fire flows for a period of 7 days or more.
- Loss of supply leading to rapid loss of system pressure and/or reservoir storage.

If the event renders water in the system unsafe to drink, the City will activate the appropriate response protocols in accordance with the City's Emergency Management Plan, Wildfire Preparedness Plan, and/or National Incident Management System.

Under Stage 3, the City may prohibit all water uses except those necessary for human consumption and sanitation needs.

The purposes of Stage 3 curtailment is to maintain system pressure of 20 psi, potable water supply for human consumption and sanitation needs and, to the extent possible, to return reservoir storage to levels required for fire flow.

4.5 Authority and Enforcement

The City Manager is authorized to determine the need for water curtailment and to declare a water curtailment stage under Bend Municipal Code 14.20.040. 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 customer categories, geographic areas, or pressure zones 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.

4.6 Notifications of Curtailment

The City has several communication channels for relaying important information about a supply shortage, including voluntary or mandatory measures. The City may rely on social media, local television, radio, and print media; strategically located sandwich boards or road signs; and the City of Bend's website to communicate with customers on an ongoing basis about a supply shortage. Notices and other forms of communication may include a description of the current water situation, the reason for the requested conservation measures, and a warning that mandatory restrictions may be necessary if voluntary measures are not sufficient to achieve water-use reduction goals.

4.7 Drought Declaration

In the event the Governor of Oregon declares a drought emergency in Deschutes County, the City's conservation and curtailment elements of this WMCP meet the requirements of ORS 536.720. If the City is within a drought area declared by the Governor, the City will consider whether mandatory or voluntary curtailment measures are needed to meet system demands and the stage of curtailment that should be initiated. Regardless of whether curtailment is needed, the City will encourage customers to conserve and use water efficiently as part of their regular Seasonal Advisory Alerts and other WaterWise Program efforts.

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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.

5.1 Delineation of Service Area

OAR 690-086-0170(1)

The City's existing water system serves the current UGB, excluding those areas served by Avion and Roats, as shown in **Exhibit 2-2**. The City also serves water to the Tetherow destination resort and the Tree Farm rural residential development outside the UGB to the west. As part of the City's IWSMP, the City developed a 20-year forecast of growth within the City's existing service area that considers customer category (single family residential, multi-family residential, commercial). The City does not anticipate changes to the footprint of the service area during the 10-year term of this WMCP.

5.2 Population Projections

OAR 690-086-0170(1)

The City's water service area population for 2018 was estimated using the method described in Section 2. Future populations (2018 to 2040) within the City's service area rely on the Coordinated Population Forecast for Deschutes County as the basis for population projections.[7] The City assumed that the proportion of the UGB population within the City's water service area would remain constant at approximately 75 percent. The City's projected water service area population in 2030 and 2040 is summarized in **Exhibit 5-1**. These projections equate to an average annual growth rate (AAGR) of 2.52 percent from 2018 through 2030 and 2.18 percent from 2030 to 2040.

Exhibit 5-1. Projected Water Service Area Population, 2030 and 2040

Year	Population
2018	67,187
2030	92,681
2040	115,272

[7] Portland State University. Population Research Center; Chun, Nicholas; Rancik, Kevin; Haggerty, Rhey; Ollinger, Joshua; and Rynerson, Charles, "Coordinated Population Forecast for Deschutes County, its Urban Growth Boundaries (UGB), and Area Outside UGBs 2018-2068" (2018). Oregon Population Forecast Program. 39.
https://archives.pdx.edu/ds/psu/26643

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 land-use planning and customer meter data.

5.3 Demand Forecast

OAR 690-086-0170(3)

OAR 690-086-0170(3) requires water demand projections for 10 and 20 years and, at the option of the Municipal Water Supplier, longer periods. Future water demand projections for 2030 and 2040 were developed for the City's IWSMP using City planning data for existing and future housing units, AMI data for customer demand information, and water production data. The City has also included water demand projections for 2041 and 2050 in this WMCP. As described in greater detail in Section 5.4, demand projections for these years are pertinent to the City's evaluation of the need for access to water under Permit G-11379, for which an extension application is currently pending, and the potential need for a new water right. The City projected demands for 2041 and 2050 by extending the average annual growth rate from 2030 through 2040.

The City's water demands vary throughout the day, particularly during the peak season. For the purposes of these projections, the City's "maximum operational demand" is the maximum 4-hour rolling average rate of the City's groundwater and surface water production. The use of the 4-hour rolling average demand reduces the impact of brief and anomalous spikes in source water demand. The City's maximum operational demand is approximately 17 percent higher than the City's MDD. Typically, during an MDD scenario, the City's demands are higher than the daily average during the night, peak during the morning hours, and then fall during the afternoon. **Exhibit 5-2** shows the City's maximum 4-hour rolling average demand on August 11, 2018, the date on which the maximum operational demand occurred in 2018. This pattern reflects, in part, the City's regulations regarding landscape irrigation, which restrict irrigation to the hours of 5 p.m. to 9 a.m. and encourage irrigation from 7 p.m. to 6 a.m. The City projected that the maximum operational demand will grow at the same rate as the City's MDD.

Exhibit 5-2. Four-hour Rolling Average Demand on August 11, 2018, Including Maximum Operational Demand of 50.8 cfs

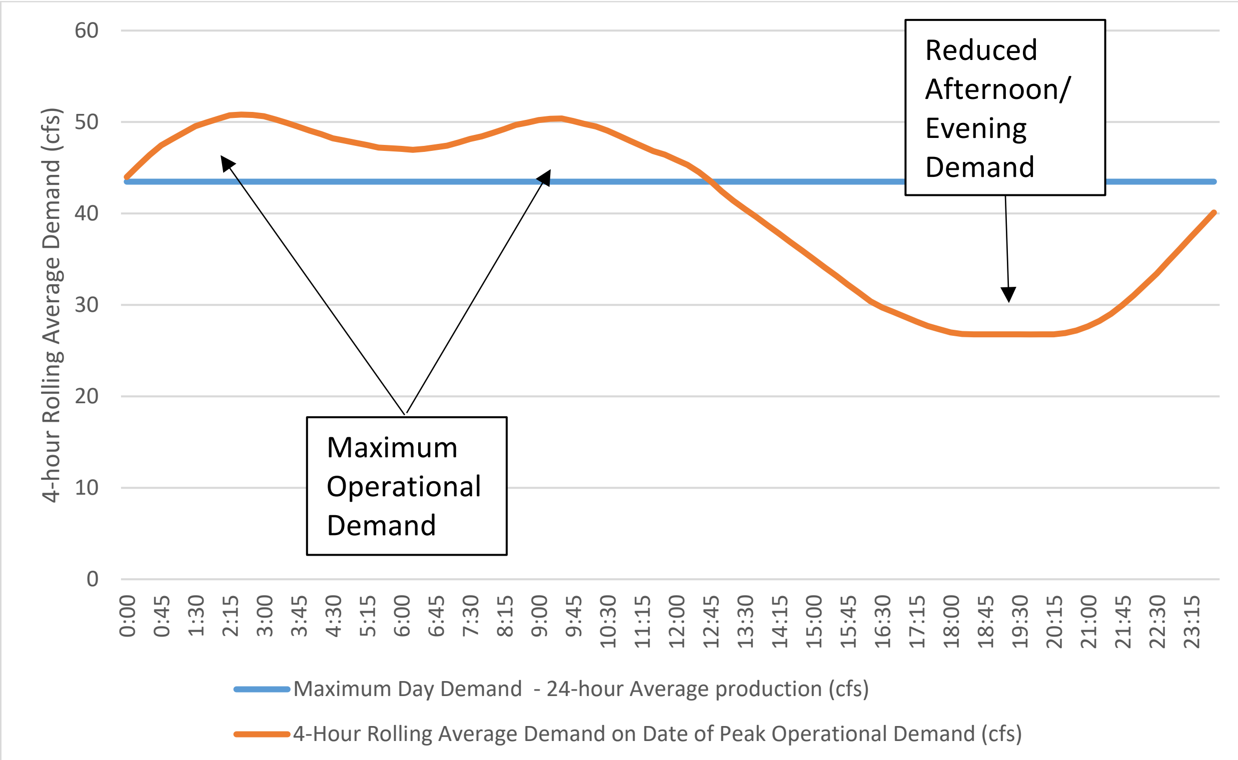


Exhibit 5-3 below shows the 2018 actual and 2030 and 2040 projected ADD, MDD, and maximum operational demand, along with the associated average annual growth rate for the City's water demand. The growth rates for MDD and ADD are slightly different, due to differences in the forecasted growth of different customer categories during the forecast period. For example, the ADD grows more quickly from 2018 to 2030 than from 2030 to 2040 due to increased growth in residential water use compared to commercial water use. For comparison, the Deschutes County Coordinated Population Forecast[8] projects population growth rates of 2.52 percent from 2018 through 2030 and 2.18 percent from 2030 to 2040. The lower growth in the City's demand from 2030 through 2040 is attributable to the anticipated slower growth of the City's water service area, particularly commercial water users, compared to the UGB as a whole during that period. Maximum operational demand is projected to be 83.3 cfs in 2041 and 97.4 cfs in 2050.

[8] Portland State University. Population Research Center; Chun, Nicholas; Rancik, Kevin; Haggerty, Rhey; Ollinger, Joshua; and Rynerson, Charles, "Coordinated Population Forecast for Deschutes County, its Urban Growth Boundaries (UGB), and Area Outside UGBs 2018-2068" (2018). *Oregon Population Forecast Program*. 39. Available at https://archives.pdx.edu/ds/psu/26643. (Accessed November 18, 2020.)

Exhibit 5-3. Projected Average Day, Max Day, and Peak-Hour Demand and Associated AAGRs, 2018 through 2050

Year	ADD (cfs)	ADD AAGR	MDD (cfs)	MDD AAGR	Maximum Operational Demand (cfs)
2018	20.3	N/A	43.5	N/A	50.8
2030	27.5	2.55%	58.8	2.52%	68.8
2040	32.6	1.70%	69.9	1.74%	81.8
2041	33.2	1.70%	71.2	1.74%	83.3
2050	38.7	1.70%	83.2	1.74%	97.4

Notes
ADD = average day demand
AAGR = average annual growth rate
cfs = cubic feet per second
MDD = maximum day demand

5.4 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 actual amount of surface water available to the City is limited by a number of factors, including a limitation of 18.2 cfs under the City's SUP from USFS for the operation of the surface water facilities. The City's WFF is a membrane treatment facility consisting of racks of filter tubes. For the purposes of planning for the firm capacity of the City's surface water supply, the City assumed that one existing filter rack would be out of service, limiting the City to a surface water capacity of 14.7 cfs (6,600 gpm). With respect to groundwater, the City has assumed that the limiting factor is the rate of appropriation authorized by the City's water rights. The City holds groundwater rights authorizing use of up to 68.2 cfs (44.1 mgd), including the full 3.84 cfs rate of Permit G-11379, for which an extension application remains pending. The City's groundwater rights and planning-level firm capacity of surface water supply of 14.7 cfs provide a planning-level reliable water supply of 82.9 cfs (53.67 mgd). Although two of the City's permits require mitigation under the Deschutes Basin Groundwater Mitigation Program, for the purposes of this analysis, the City has assumed the rate of these two permits will be fully developed and has evaluated the rate of all groundwater rights together.

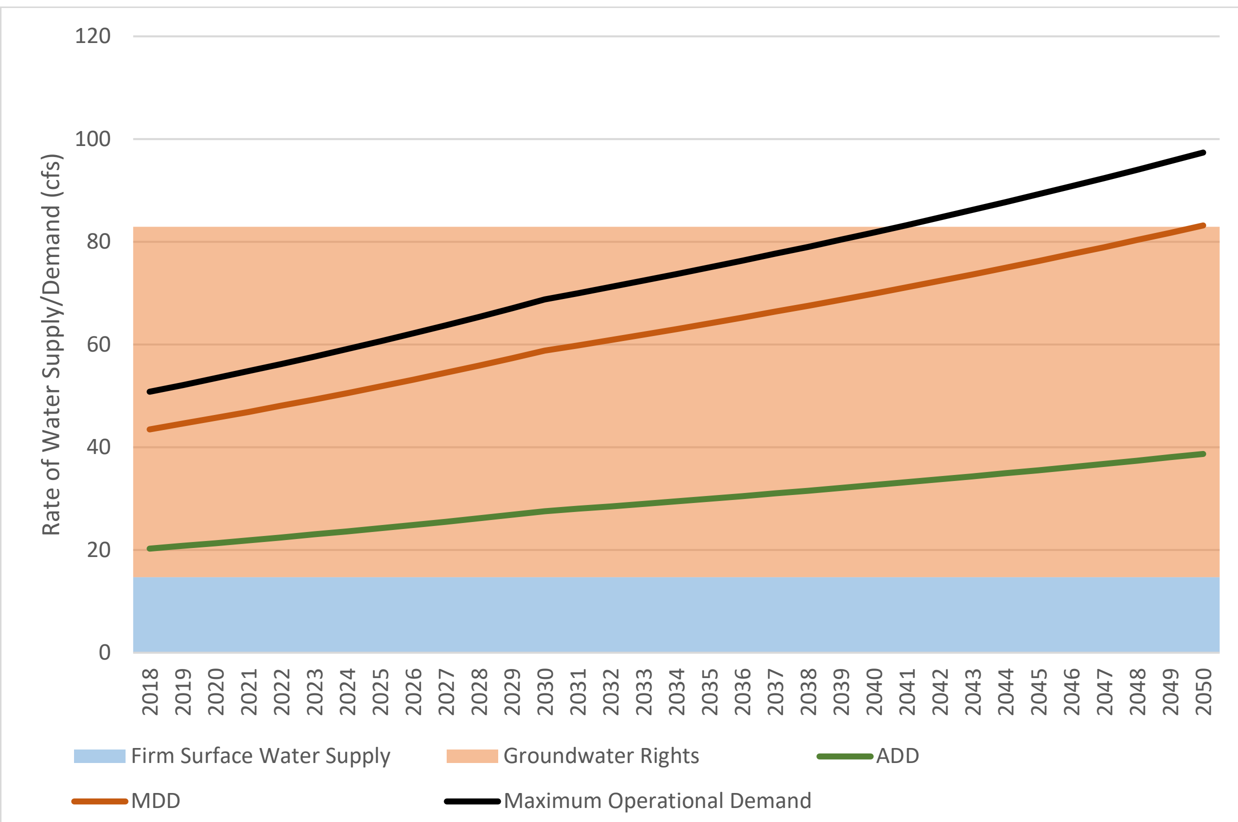
Exhibit 5-4 shows the City's projected ADD, MDD, and maximum operational demand superimposed on the City's firm surface water supply and groundwater rights.

As this exhibit shows, based on the assumptions described above, the City expects to narrowly have sufficient water rights to meet projected demands through 2040. However, extending the 2030 through 2040 projected annual average growth rate of 1.74 percent for maximum operational demand one additional year through 2041, the projected maximum operational demand is 83.3 cfs, slightly exceeding the total reliable water supply. Because this WMCP likely will not be approved by OWRD until mid-2021, the City is using projected demand through 2041 for its 20-year demand projection. The reliable supply includes the full 3.84 cfs rate of Permit G-11379., including 1.49 cfs not developed prior to 2005. Therefore, the City projects that access to water under Permit G-11379 will be required prior to 2041. However, the City's permit extension application is still pending, so the City cannot request access to the undeveloped portion of the permit in this WMCP.

Similar to Permit G-11379, the City's extension application for Permit S-49823 is still pending, so the City cannot request access to the undeveloped portion of the permit in this WMCP. However, use of water under Permit S-49823 is an important part of the City's water supply portfolio during winter and spring. Moreover, surface water treated at the City's WFF costs substantially less than water pumped from the City's groundwater wells. Development of new groundwater supplies also requires significant infrastructure investments. The City currently has the demand to utilize the remaining 2.8 cfs under Permit S-49823, and intends to complete development of the permit prior to October 1, 2032 as described in the pending extension application.

Extending the projection further, through 2050, the City's maximum operational demand is projected to be 97.4 cfs, exceeding the City's reliable supply by 14.5 cfs. Therefore, the City will likely need to apply for a new groundwater right within the next 10 years to ensure adequate time to obtain a new permit, obtain required mitigation credits, and develop the infrastructure needed to apply the water to beneficial use.

Exhibit 5-4. Projected Average Day, Maximum Day, and Maximum Operational Demand and Reliable Water Supply



5.5 Alternative Sources

OAR 690-086-0170(5) requires an analysis of alternative sources of additional water if expansion or initial diversion of water allocated under existing permits is necessary to meet the needs shown in Section 5.3. 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. Although the City is not seeking access to water under an extended permit, the analysis above shows that the City does require access to the full 3.84 cfs rate of Permit G-11379, including the 1.49 cfs portion subject to fish persistence conditions, to meet its projected demands through 2041.

5.5.1 Conservation

OAR 690-086-170(5)(a) & OAR 690-086-170(8)(a)

OAR 690-86-170(5)(a) requires an assessment of whether projected water needs can be satisfied through implementation of conservation measures identified under OAR 690-86-150. As described in Section 3, the implementation of the City's water conservation measures under OAR-690-86-150(4) and (5) have been effective at promoting water conservation, both by reducing water loss and reducing authorized consumption, particularly for irrigation of large landscapes. The City incorporated AMI meter data into its 20-year demand projections for the IWSMP, which form the basis of the City's projections described in Section 5.3. The City proposes to continue the same conservation measures that have already been implemented, meaning that projected demands already reflect much of the water savings from these programs. This does not preclude the City's need for access to its extended permits and potentially seeking a new groundwater right within 10 years.

Section 3.3 and **Appendix C** discuss the City's efforts to evaluate the potential water savings and cost-effectiveness of water conservation measures beyond those the City has already adopted. The potential impact of those conservation measures on projected water demands is discussed in greater detail below in Section 5.5.3.

5.5.2 Interconnections

OAR 690-086-170(5)(b) & OAR 690-086-170(8)(b)

OAR 690-86-170(5)(b) requires an assessment of whether projected water needs can be satisfied through interconnection with other municipal water supply systems and cooperative regional water management. The City does not have any usable interconnections that would allow nearby water suppliers to serve water to the City of Bend. With the exception of Avion and Roats, interconnection would be cost-prohibitive due to a variety of issues such as pressure, water quality (neither Avion nor Roats uses chlorine), and related additional water quality testing requirements. The City's request for access to the undeveloped portion of extended Permit G-11379 (1.49 cfs) is based on projected maximum operational demands. During the period that the City would benefit from access to the undeveloped portion of Permit G-11379, it is unlikely that Avion or Roats would consistently have excess capacity available to provide water via an interconnection. As a result, the City has not explored the possibility of an interconnection with Avion or Roats. An interconnection with Avion or Roats would not be expected to be cost-effective compared with the use of water under Permits G-11379 and S-49823 and does not preclude the potential need to apply for a new groundwater right within 10 years.

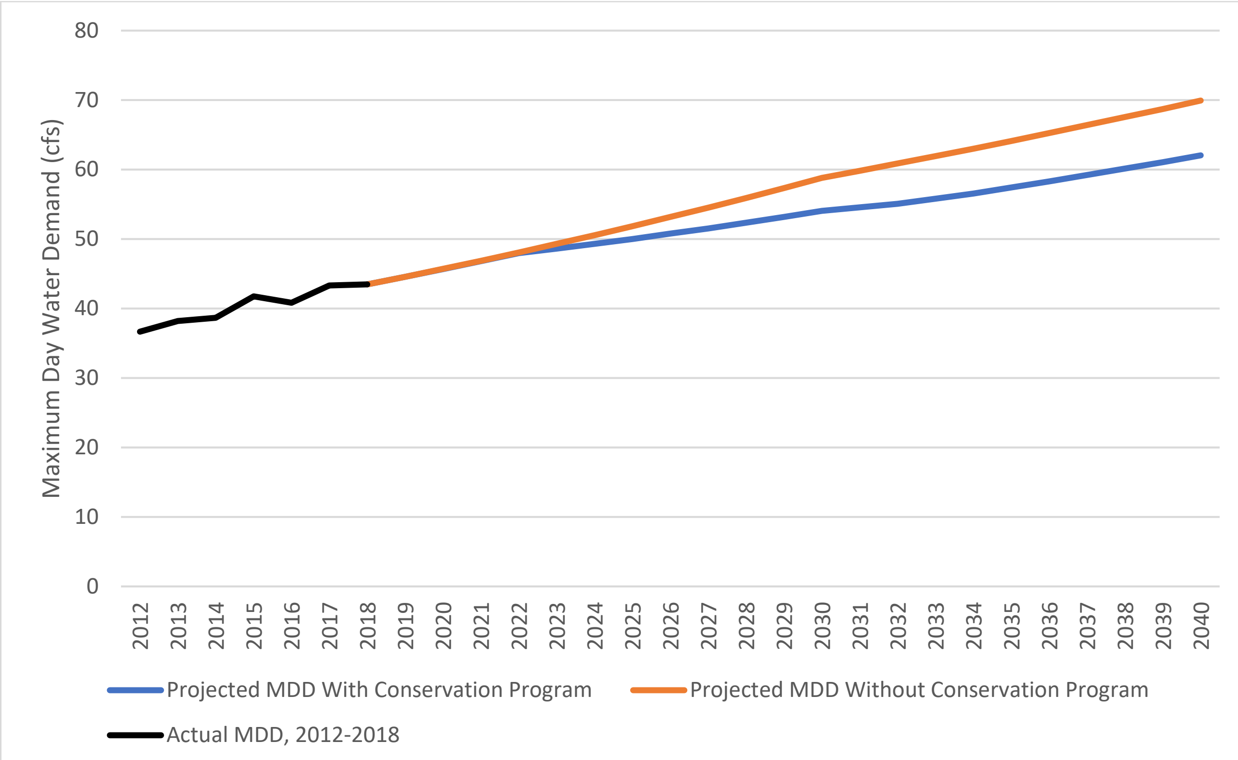
5.5.3 Other Water Conservation Measures

OAR 690-086-170(5)(c) & OAR 690-086-170(8)(c)

OAR 690-086-170(5)(c) requires an assessment of whether projected water needs can be satisfied through additional conservation measures that would provide water at a cost that is equal to or less than the cost of other identified sources. As described in Section 3 above, and in **Appendix C**, the City completed an evaluation of the potential costs and water savings from various conservation measures. The City developed a package of water conservation measures that was analyzed through the Maddaus Water Management Inc.'s DSS Model. This analysis indicates the package of water conservation measures would reduce the City's projected 2040 MDD by 5.1 mgd (7.9 cfs; 3,540 gpm). The City did not specifically evaluate the impact of water savings on maximum operational demands, but projected that water savings would be realized primarily from reductions in outdoor water use, which tends to be concentrated during the part of the day in which maximum operational demands occur. The City also evaluated water savings through 2040 only, but water savings would be expected to continue, to the extent that conservation programs prove cost-effective.

For the purposes of the IWSMP, the City assumed that future new wells would have production rates of 1,150 gpm. Therefore, the projected maximum-day water savings of 3,540 gpm would eliminate the need to construct three wells (and one above-ground reservoir) over the next 20 years at an estimated cost of $21 million. Additional savings may also be realized through reductions in operational costs (primarily the cost to pump water). The estimated cost of implementing the package of conservation measures is approximately $11 million. Therefore, the $11 million investment in the conservation program would reduce water demands at a lower cost than the cost to construct the infrastructure alone needed to meet projected MDDs through 2040 without conservation. **Exhibit 5-5** shows projected maximum-day water demands through 2040 with and without the conservation program.

Exhibit 5-5. Actual MDD, 2012-2018, and Projected MDD With and Without Implementation of Conservation Program, 2018-2040



The conservation program City staff determined as the preferred option (Program C) requires allocation of budget, creation of staff positions, and the approval of the City Council. Individual elements of the conservation program would also require specific changes to City ordinances. As shown in Exhibit 5-6, the City has assumed that the implementation of the expanded conservation program, if funded and approved by City Council, would not begin until 2023. This will allow adequate time for City staff to develop specific proposals for Council review and public input.

Until the expanded conservation program is funded and approved by Council, the City cannot assume that the projected water and financial savings can be realized. As a result, the City will continue to plan for the need to access the undeveloped portions of extended Permits S-49823 and G-11379 and the potential need to seek a new groundwater permit within the next 10 years.

5.6 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. Although extensions of time for Permits S-49823 and G-11379 have not yet been approved, The City anticipates expanding its use under Permits S-49823 and G-11379 during the 20-year planning horizon.

Assuming the 2.8 cfs undeveloped portion of Permit S-49823 is used at the maximum rate for 24 hours per day over 31 days during the maximum demand month, the maximum monthly volume of use would be approximately 56.1 MG.

The City projects that by 2041, the 1.49 cfs undeveloped portion of Permit G-11379 will be required to meet maximum operational demands. Assuming this 1.49 cfs is used at the maximum rate for 24 hours per day over 31 days during the maximum demand month, the maximum monthly volume of use would be approximately 29.9 mgd.

5.7 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. As described above, the City's SUP (BEN1158) for the operation of the Bend Municipal Watershed facilities limits the City's diversion rate to no more than 18.2 cfs, however, 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 Groundwater Mitigation Program to offset the impacts to surface water from use of groundwater under Permit G-18123 and G-18124. The City has an approved incremental mitigation plan on file with OWRD and will continue to use water under these two permits in compliance with the mitigation plan.

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Appendix A

City Request for Comment and Comments Received on Draft WMCP

GSI Water Solutions, Inc.
1600 SW Western Blvd.
Suite 240
Corvallis, OR 97333

November 16, 2020

Peter Gutowsky
Planning Manager
Deschutes County Community Development
117 NW Lafayette Avenue
Bend, OR 97703

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

To whom it may concern:

The City of Bend Utility Department has developed a Draft Water Management and Conservation Plan. 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 provide comments to me within 30 days from the date of this letter. 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 comments to me at the address on this letterhead or e-mail them to me directly at: omcmurtrey@gsiws.com

If you have any questions, please feel free to contact me at 541-257-9005. Thank you for your interest.

Sincerely,

Owen McMurtrey

Owen McMurtrey
GSI Water Solutions, Inc.

Owen McMurtrey

From:	Peter Gutowsky <Peter.Gutowsky@deschutes.org>
Sent:	Tuesday, November 17, 2020 1:18 PM
To:	Owen McMurtrey
Cc:	Adam Sussman; Suzanne de Szoeke; Katherina Barguil
Subject:	RE: Water Management and Conservation Plan for the City of Bend

Owen,

Yes, Tree Farm and Miller Tree Farm are the same. Westgate is the first plat recorded in the Westside Transect Zone. The City of Bend agreed to serve this development and other lands within the zone with municipal water.

Peter Gutowsky, AICP | Planning Manager
DESCHUTES COUNTY COMMUNITY DEVELOPMENT
117 NW Lafayette Avenue | Bend, Oregon 97703
Tel: (541) 385-1709

Enhancing the lives of citizens by delivering quality services in a cost-effective manner.

From: Owen McMurtrey <OMcMurtrey@gsiws.com>
Sent: Tuesday, November 17, 2020 12:08 PM
To: Peter Gutowsky <Peter.Gutowsky@deschutes.org>
Cc: Adam Sussman <asussman@gsiws.com>; Suzanne de Szoeke <SDeSzoeke@gsiws.com>; Katherina Barguil <kbarguil@bendoregon.gov>
Subject: RE: Water Management and Conservation Plan for the City of Bend

[EXTERNAL EMAIL]

Thanks for the quick response Peter,

I had to look up the Westside Transect Zone, but I see what you mean. As those areas are outside the UGB, and there is no water supply contract in place, the City did not address them as part of their projected water demands or water service population. The current Plan does address the provision of water to what we call "The Tree Farm," which I believe is equivalent to Miller Tree Farm, south and west of the south transect property, outside the UGB, as the City already serves water to that rural residential neighborhood. The Plan identifies this as a water supply contract in section 2.4, along with provision of water to Tetherow, but these do not factor significantly in the water demand projections. The City's next WMCP will be due in 2030 or 2031.

Thanks,

Owen

Owen McMurtrey
Water Resources Consultant
direct: 541.257.9005 | mobile: 541.740.5619
1600 SW Western Boulevard, Suite 240, Corvallis, OR 97333
GSI Water Solutions, Inc. | www.gsiws.com

Please note: GSI is open for business, although most of us are working remotely. I'm available by phone or email, as always.

From: Peter Gutowsky [mailto:Peter.Gutowsky@deschutes.org]
Sent: Tuesday, November 17, 2020 8:21 AM
To: Owen McMurtrey <OMcMurtrey@gsiws.com>
Cc: Adam Sussman <asussman@gsiws.com>; Suzanne de Szoeke <SDeSzoeke@gsiws.com>; Katherina Barguil <kbarguil@bendoregon.gov>
Subject: RE: Water Management and Conservation Plan for the City of Bend

Owen,

Thanks for the opportunity to review the WMCP. The Deschutes County Planning Division has no comments.

Just a fyi. The next iteration of the WMCP will likely need to address two rural residential areas served by Bend municipal water: Miller Tree Farm and the Westside Transect Zone (example: Westgate).

Peter Gutowsky, AICP | Planning Manager
DESCHUTES COUNTY COMMUNITY DEVELOPMENT
117 NW Lafayette Avenue | Bend, Oregon 97703
Tel: (541) 385-1709

Enhancing the lives of citizens by delivering quality services in a cost-effective manner.

From: Owen McMurtrey <OMcMurtrey@gsiws.com>
Sent: Monday, November 16, 2020 6:19 PM
To: Peter Gutowsky <Peter.Gutowsky@deschutes.org>
Cc: Adam Sussman <asussman@gsiws.com>; Suzanne de Szoeke <SDeSzoeke@gsiws.com>; Katherina Barguil <kbarguil@bendoregon.gov>
Subject: Water Management and Conservation Plan for the City of Bend

[EXTERNAL EMAIL]

Hi Peter,

The City of Bend has developed a Draft Water Management and Conservation Plan. 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 provide comments to me within 30 days from the date of this letter. If the plan appears consistent with your agency's Comprehensive Land Use Plan, a letter or email 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: omcmurtrey@gsiws.com

If you have any questions, please feel free to contact me at 541-257-9005 or at 541-740-5619. Thank you.

Sincerely,

Owen McMurtrey
Water Resources Consultant
direct: 541.257.9005 | mobile: 541.740.5619
1600 SW Western Boulevard, Suite 240, Corvallis, OR 97333
GSI Water Solutions, Inc. | www.gsiws.com
Please note: GSI is open for business, although most of us are working remotely. I'm available by phone or email, as always.

Appendix B

M36 Water Audit Reporting Worksheets (2014 through 2019) and Performance Indicators (2019)

AWWA Free Water Audit Software: Water Balance

WAS v5.0

American Water Works Association.

Water Audit Report for:	City of Bend / Utility Department
Reporting Year:	2014 | 1/2014 - 12/2014
Data Validity Score:	64

Own Sources (Adjusted for known errors) 4,460.645	System Input 4,460.650	Water Exported 0.000			Billed Water Exported	Revenue Water 0.000
		Water Supplied 4,460.650	Authorized Consumption 4,370.556	Billed Authorized Consumption 4,358.246	Billed Metered Consumption (water exported is removed) 4,358.246	Revenue Water 4,358.246
					Billed Unmetered Consumption 0.000	
				Unbilled Authorized Consumption 12.310	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 102.404
					Unbilled Unmetered Consumption 12.310	
			Water Losses 90.094	Apparent Losses 43.948	Unauthorized Consumption 11.152	
					Customer Metering Inaccuracies 21.901	
					Systematic Data Handling Errors 10.896	
Water Imported 0.005				Real Losses 46.146	Leakage on Transmission and/or Distribution Mains Not broken down	
					Leakage and Overflows at Utility's Storage Tanks Not broken down	
					Leakage on Service Connections Not broken down	

AWWA Free Water Audit Software: Water Balance

WAS v5.0

American Water Works Association.

Water Audit Report for: City of Bend / Utility Department

Reporting Year: 2015 | 1/2015 - 12/2015

Data Validity Score: 64

Own Sources (Adjusted for known errors) 4,745.630	System Input 4,745.635	Water Exported 0.000			Billed Water Exported	Revenue Water 0.000
		Water Supplied 4,745.635	Authorized Consumption 4,454.736	Billed Authorized Consumption 4,444.316	Billed Metered Consumption (water exported is removed) 4,444.316	Revenue Water 4,444.316
					Billed Unmetered Consumption 0.000	
				Unbilled Authorized Consumption 10.420	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 301.319
					Unbilled Unmetered Consumption 10.420	
			Water Losses 290.899	Apparent Losses 45.308	Unauthorized Consumption 11.864	
					Customer Metering Inaccuracies 22.333	
					Systematic Data Handling Errors 11.111	
Water Imported 0.005				Real Losses 245.591	Leakage on Transmission and/or Distribution Mains Not broken down	
					Leakage and Overflows at Utility's Storage Tanks Not broken down	
					Leakage on Service Connections Not broken down	

AWWA Free Water Audit Software: Water Balance

WAS v5.0

American Water Works Association.

Water Audit Report for:	City of Bend / Utility Department	
Reporting Year:	2016	1/2016 - 12/2016
Data Validity Score:	65	

Own Sources (Adjusted for known errors): *4,726.614*

Water Imported: *0.000*

System Input: *4,726.614*

Water Exported: *0.000*

Billed Water Exported — **Revenue Water**: 0.000

Water Supplied: *4,726.614*

Authorized Consumption: *4,448.990*

- **Billed Authorized Consumption**: *4,438.570*
  - **Billed Metered Consumption (water exported is removed)**: *4,438.570*
  - **Billed Unmetered Consumption**: *0.000*
  - **Revenue Water**: 4,438.570
- **Unbilled Authorized Consumption**: *10.420*
  - **Unbilled Metered Consumption**: *0.000*
  - **Unbilled Unmetered Consumption**: *10.420*

Water Losses: *277.624*

- **Apparent Losses**: *45.217*
  - **Unauthorized Consumption**: *11.817*
  - **Customer Metering Inaccuracies**: *22.304*
  - **Systematic Data Handling Errors**: *11.096*
- **Real Losses**: *232.407*
  - **Leakage on Transmission and/or Distribution Mains**: *Not broken down*
  - **Leakage and Overflows at Utility's Storage Tanks**: *Not broken down*
  - **Leakage on Service Connections**: *Not broken down*

Non-Revenue Water (NRW): 288.044

AWWA Free Water Audit Software: Water Balance

WAS v5.0

American Water Works Association.

Water Audit Report for:	City of Bend / Utility Department
Reporting Year:	2017 — 1/2017 - 12/2017
Data Validity Score:	65

		Water Exported 0.000			Billed Water Exported	Revenue Water 0.000
Own Sources (Adjusted for known errors) 4,746.113	System Input 4,746.113	Water Supplied 4,746.113	Authorized Consumption 4,452.514	Billed Authorized Consumption 4,440.884	Billed Metered Consumption (water exported is removed) 4,440.884	Revenue Water 4,440.884
					Billed Unmetered Consumption 0.000	
				Unbilled Authorized Consumption 11.630	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 305.229
					Unbilled Unmetered Consumption 11.630	
			Water Losses 293.599	Apparent Losses 45.283	Unauthorized Consumption 11.865	
					Customer Metering Inaccuracies 22.316	
					Systematic Data Handling Errors 11.102	
Water Imported 0.000				Real Losses 248.316	Leakage on Transmission and/or Distribution Mains Not broken down	
					Leakage and Overflows at Utility's Storage Tanks Not broken down	
					Leakage on Service Connections Not broken down	

AWWA Free Water Audit Software: Water Balance

WAS v5.0

American Water Works Association.

Water Audit Report for:	City of Bend / Utility Department	
Reporting Year:	2018	1/2018 - 12/2018
Data Validity Score:	65	

Source						
Own Sources (Adjusted for known errors) 4,792.910	System Input 4,792.910	Water Exported 0.000			Billed Water Exported	Revenue Water 0.000
		Water Supplied 4,792.910	Authorized Consumption 4,548.914	Billed Authorized Consumption 4,537.064	Billed Metered Consumption (water exported is removed) 4,537.064	Revenue Water 4,537.064
					Billed Unmetered Consumption 0.000	
				Unbilled Authorized Consumption 11.850	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 255.846
					Unbilled Unmetered Consumption 11.850	
			Water Losses 243.996	Apparent Losses 46.124	Unauthorized Consumption 11.982	
					Customer Metering Inaccuracies 22.799	
					Systematic Data Handling Errors 11.343	
Water Imported 0.000				Real Losses 197.872	Leakage on Transmission and/or Distribution Mains *Not broken down*	
					Leakage and Overflows at Utility's Storage Tanks *Not broken down*	
					Leakage on Service Connections *Not broken down*	

AWWA Free Water Audit Software: Water Balance

WAS v5.0

Water Audit Report for:	City of Bend / Utility Department	
Reporting Year:	2018	1/2018 - 12/2018
Data Validity Score:	65	

		Water Exported *0.000*			Billed Water Exported	Revenue Water 0.000
Own Sources (Adjusted for known errors) *4,792.910*	System Input *4,792.910*	Water Supplied *4,792.910*	Authorized Consumption *4,548.914*	Billed Authorized Consumption *4,537.064*	Billed Metered Consumption (water exported is removed) *4,537.064*	Revenue Water 4,537.064
					Billed Unmetered Consumption *0.000*	
				Unbilled Authorized Consumption *11.850*	Unbilled Metered Consumption *0.000*	Non-Revenue Water (NRW) 255.846
					Unbilled Unmetered Consumption *11.850*	
			Water Losses *243.996*	Apparent Losses *46.124*	Unauthorized Consumption *11.982*	
					Customer Metering Inaccuracies *22.799*	
					Systematic Data Handling Errors *11.343*	
Water Imported *0.000*				Real Losses *197.872*	Leakage on Transmission and/or Distribution Mains *Not broken down*	
					Leakage and Overflows at Utility's Storage Tanks *Not broken down*	
					Leakage on Service Connections *Not broken down*	

AWWA Free Water Audit Software: Water Balance

WAS v5.0

American Water Works Association.

Water Audit Report for:	City of Bend Utility Department	
Reporting Year:	2019	1/2019 - 12/2019
Data Validity Score:	58	

Own Sources (Adjusted for known errors)
4,369.733

Water Imported
0.000

System Input
4,369.733

Water Exported
0.000

Water Supplied
4,369.733

Billed Water Exported

Revenue Water
0.000

Authorized Consumption
4,118.832

Billed Authorized Consumption
4,115.920

Billed Metered Consumption (water exported is removed)
4,115.920

Billed Unmetered Consumption
0.000

Revenue Water
4,115.920

Unbilled Authorized Consumption
2.912

Unbilled Metered Consumption
0.000

Unbilled Unmetered Consumption
2.912

Non-Revenue Water (NRW)
253.813

Water Losses
250.901

Apparent Losses
41.897

Unauthorized Consumption
10.924

Customer Metering Inaccuracies
20.683

Systematic Data Handling Errors
10.290

Real Losses
209.004

Leakage on Transmission and/or Distribution Mains
Not broken down

Leakage and Overflows at Utility's Storage Tanks
Not broken down

Leakage on Service Connections
Not broken down

AWWA Free Water Audit Software:
System Attributes and Performance Indicators

WAS v5.0

Water Audit Report for: City of Bend Utility Department
Reporting Year: 2019 | 1/2019 - 12/2019

*** YOUR WATER AUDIT DATA VALIDITY SCORE IS: 58 out of 100 ***

System Attributes:

Apparent Losses:	41.897	MG/Yr
+ Real Losses:	209.004	MG/Yr
= Water Losses:	250.901	MG/Yr
? Unavoidable Annual Real Losses (UARL):	171.90	MG/Yr
Annual cost of Apparent Losses:	$109,771	
Annual cost of Real Losses:	$48,451	Valued at Variable Production Cost

Return to Reporting Worksheet to change this assumpiton

Performance Indicators:

Financial:	Non-revenue water as percent by volume of Water Supplied:	5.8%	
	Non-revenue water as percent by cost of operating system:	0.9%	Real Losses valued at Variable Production Cost
Operational Efficiency:	Apparent Losses per service connection per day:	4.00	gallons/connection/day
	Real Losses per service connection per day:	19.94	gallons/connection/day
	Real Losses per length of main per day*:	N/A	
	Real Losses per service connection per day per psi pressure:	0.29	gallons/connection/day/psi
	From Above, Real Losses = Current Annual Real Losses (CARL):	209.00	million gallons/year
	? Infrastructure Leakage Index (ILI) [CARL/UARL]:	1.22	

* This performance indicator applies for systems with a low service connection density of less than 32 service connections/mile of pipeline

Appendix C

DSS Model Report

City of Bend, Oregon

Water Conservation Program Water Savings and Cost-effectiveness Analysis

Water Management and Conservation Plan Version

December 2020

Prepared by:
GSI Water Solutions, Inc.
1600 SW Western Boulevard, Suite 240, Corvallis, OR 97333

MADDAUS WATER MANAGEMENT INC.

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Contents

Exhibits

Abbreviations and Acronyms

cfs	cubic feet per second
DSS Model	Demand Side Management Least Cost Planning Decision Support System
gpf	gallons per flush
gpm	gallons per minute
HEW	high-efficiency washer
IWSMP	Integrated Water System Master Plan
MDD	maximum day demand
MG	million gallons
mgd	million gallons per day
MGY	million gallons per year
PV	present value
WMCP	Water Conservation and Management Plan

SECTION 1: **Executive Summary**

1.1 Introduction

In an effort to find the most cost-effective approach to meeting water demands over the next 20 years, the City of Bend, Oregon (City) has been developing an Integrated Water System Master Plan (IWSMP) that incorporates analyses of the City's water supply sources, water system infrastructure, water demand projections, and water conservation potential. To determine its water conservation potential, the City conducted a water conservation program water savings and cost-effectiveness analysis. GSI Water Solutions, Inc. (GSI), partnered with Maddaus Water Management, Inc. (Maddaus), to help the City conduct the water savings and cost-effectiveness analysis utilizing Maddaus' Demand Side Management Least Cost Planning Decision Support System (DSS Model). The City evaluated 16 individual water conservation measures and three water conservation programs consisting of different combinations of water conservation measures. The objective of the analysis was to identify a cost-effective water conservation program aimed at reducing water demand in the peak summer season and to estimate water savings produced by that program. This analysis allowed the City to subsequently determine the extent to which development of water system infrastructure could be avoided over the next 20 years.

1.2 Water Savings and Cost-effectiveness Analysis Results Summary

The City analyzed three water conservation programs: Program A, consisting of outdoor water conservation measures plus one measure contributing to indoor and outdoor water conservation; Program B, consisting of only indoor water conservation measures; and Program C, consisting of a combination of indoor and outdoor water conservation measures. These programs contained measures that the City determined it would most likely implement based on initial analysis of 16 individual measures. Program C is a more diverse and extensive approach to conserving water through indoor and outdoor measures, which is also consistent with how the City has been encouraging water conservation in recent years. Program C had the greatest water savings of the three programs as well. Consequently, the City determined that Program C is its preferred program.

Program C consists of 11 water conservation measures: 6 outdoor measures, 1 indoor and outdoor measure, and 4 indoor measures. Nearly all of the measures would be new initiatives for the City, except for the outdoor water surveys and the free faucet aerators and showerheads measures.

Exhibit 1 presents Program C water conservation measures and identifies them as indoor or outdoor and current or new measures.

Exhibit 1. Program C Water Conservation Measures

Conservation Measure	Outdoor (O) or Indoor (I)	Current (C) or New (N)
Retrofit on resale or account change ordinance	I	N
High-efficiency toilet rebate	I	N
Free faucet aerators and showerheads	I	C
Indoor plumbing fixture ordinance	I	N
Landscape and irrigation ordinance	O	N
Outdoor water surveys	O	C
Weather-based irrigation controller rebate	O	N
Pressure-regulation rebate	O, I	N
Drip irrigation kits	O	N
Rotating sprinkler nozzles rebate	O	N
Pressure-regulating sprinkler bodies rebate	O	N

Program C is projected to result in a total of 7,939 million gallons (MG) in water savings from 2020 through 2040. In 2040, Program C is projected to result in 558.7 MG in outdoor water savings, concentrated during the irrigation season of April through October, and 121.6 MG in indoor water savings, spread out equally throughout the year. The estimated present value cost to the City (utility cost) of Program C from 2020 through 2040 is approximately $11 million total.

The results of the water savings and cost-effectiveness analysis are intended to do the following:

- Guide the City's decision-making about the water conservation measures to include in its water conservation program moving forward. These results are also intended to help the City develop new 5-year water conservation benchmarks for its Water Management and Conservation Plan update in 2020.
- Inform the City's water infrastructure planning process. The City is in the process of developing an IWSMP, and the results of the water savings and cost-effectiveness analysis can help the City estimate infrastructure that it could avoid building due to potential water savings.

Implications of Results on Infrastructure Planning

GSI used the 2040 Program C indoor and outdoor water savings results to calculate that Program C would result in water savings of 5.1 million gallons per day (mgd) (7.9 cubic feet per second [cfs]; 3,540 gpm) in a maximum-day demand (MDD) scenario in 2040. The methodology used to estimate the reduction in MDD is described in greater detail in Section 4.3. The projected MDD drives the need for development of new wells and reservoirs; therefore reductions in the MDD can affect the City's projected infrastructure needs.

The City is assuming that future new wells would have production rates of 1,150 gpm for its IWSMP, which means the projected MDD water savings of 5.1 mgd (equivalent to 3,540 gpm over 24 hours) would eliminate the need to construct three wells (as well as one aboveground reservoir) saving approximately $21 million over the next 20 years. In addition, operational costs, such as the cost to pump water, would also be avoided. Thus, the $11 million estimated cost of producing those water savings is far less than the $21 million that would be needed to meet the MDD in 2040 without conservation.

SECTION 2: **DSS Model Overview**

2.1.1 DSS Model Background

The City's water savings and cost-effectiveness analysis used the Maddaus' Demand Side Management Least Cost Planning Decision Support System (DSS Model).

The DSS Model:

- Prepares short- and long-range detailed water demand and conservation water savings projections to quantify the estimated impact of water conservation programs on demand over time.
  - The analysis can use either a statistical approach to forecast demands (e.g., an econometric model) or forecasted increases in population and employment to evaluate future demands.
- Is an end-use model that breaks down total water production (i.e., water demand in the service area) into specific water end-uses (e.g., toilets, faucets, irrigation) to more accurately assess the impact of water conservation programs on demand.
  - This "bottom-up" approach allows for detailed criteria to be considered when estimating future demands, such as the effects of natural fixture replacement, plumbing codes, and conservation efforts.
- Evaluates conservation measures using a benefit-cost analysis, with the economic indicators being present value of the cost of water saved and benefit-to-cost ratio.
  - The utility and the community (i.e., utility plus its customers) perspectives are included in the analysis.
- Compares the present value of water savings, present value of utility costs, and benefit-to-cost ratio of different conservation programs, which are constituted of individual conservation measures.
- Takes into account savings from passive conservation in its demand projections.
  - Passive conservation refers to water savings resulting from customer actions and activities that do not depend on direct assistance from a utility's water conservation programs. This includes water savings resulting from the following:
    1. The natural replacement of existing plumbing fixtures with water-efficient models required under current plumbing code standards
    2. The installation of water-efficient fixtures in new buildings and retrofits as required under federal and state law

The DSS Model involves three major steps to arrive at the results: data collection, a demand analysis, and a conservation analysis.

- **Data Collection**
  - Data collected include historical surface water and groundwater production (i.e., demand), historical consumption, historical population levels, census housing characteristics, as well as growth projections.

- **Demand Analysis**
  - Develops demand projections by incorporating the following:
    - Data collected as described above
    - A base-year profile for projections based on historical data and professional judgment
    - A percentage breakdown of end uses by customer categories
    - Water fixtures' average water use, useful life, and replacement rates
    - Current and future proportional use of fixtures by different water efficiencies for plumbing fixtures with codes/standards
- **Conservation Analysis**
  - Develops conservation measure and conservation program benefit-cost information, as well as demand projections with conservation, by incorporating the following:
    - Results of the demand analysis described above
    - Avoided costs (e.g., the cost of construction of new wells and associated reservoirs, assuming some costs are "sunk costs" that would be incurred regardless of water conservation)
    - Inflation rates
    - Assumptions about conservation measures, including the following:
      - Period of implementation
      - Measure life (i.e. how long the savings are expected to continue)
      - Measure costs for the utility and customer as well as administrative costs
      - End uses affected by the measure, by customer category
      - Percent end use savings per account
      - Percent of accounts targeted per year or number of accounts targeted per year

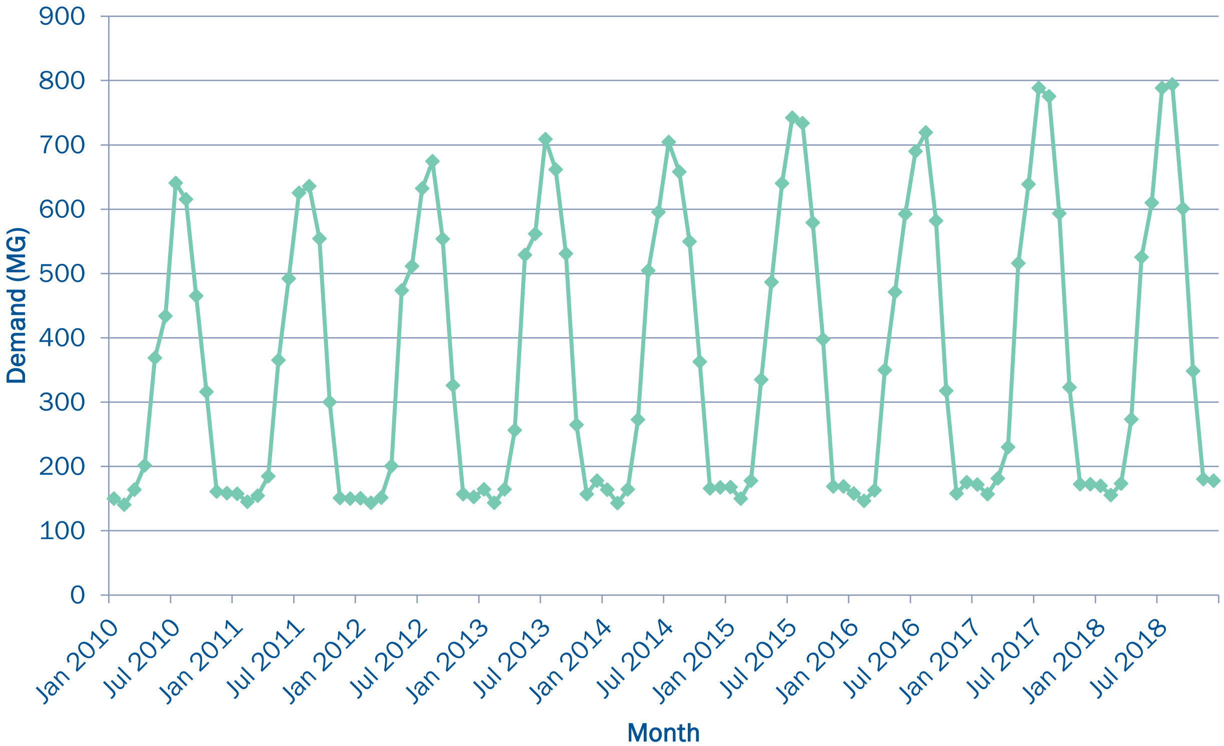
More details about the DSS Model are provided in the full Water Savings and Cost-effectiveness Report.

2.1.2 Model Inputs and Assumptions

2.1.2.1 Historical Production and Consumption

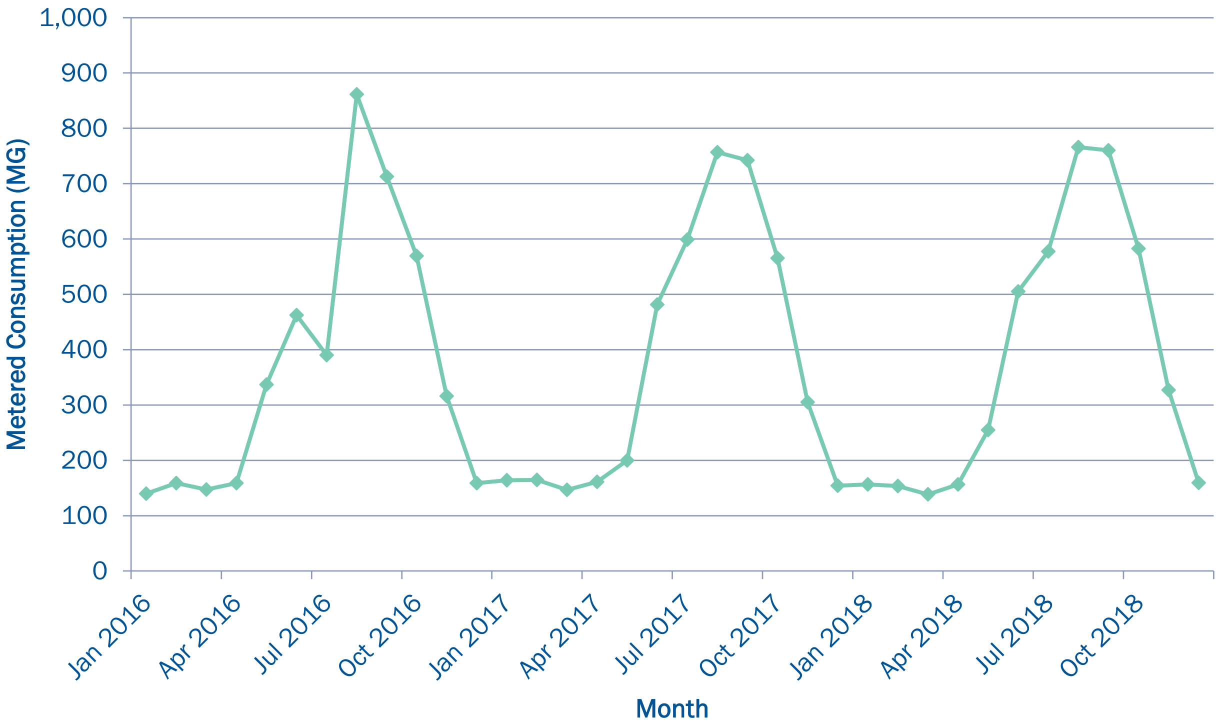
The DSS Model uses historical surface water and groundwater production data (i.e., demand) and historical metered consumption data in its demand projections. The City provided historical surface water and groundwater demand data from 2010 through 2018. Exhibit 2 shows historical monthly demand.

Exhibit 2. Historical Total Monthly Demand, 2010–2018



Historical monthly metered consumption is presented in Exhibit 3. The metered consumption data used in the DSS Model spans from January 2016 through December 2018, which are the most recent years with complete data available for consumption and number of accounts. The DSS Model also included analyses of water consumption by customer category, which are described below. The City's five customer categories are single family residential, multi-family residential, commercial, irrigation, and hydrant meters.

Exhibit 3. Historical Total Monthly Metered Consumption, 2016–2018



2.1.2.3 Inputs and Assumptions for Demand Projections

A number of assumptions and inputs are used to develop the DSS Model demand projections, which are outlined in **Exhibit 4**. Some of the parameters refer to a "start" (i.e., base) year, meaning the first year of the projections. The start year forms the foundation of subsequent annual demand projections. The City of Bend Utility Department reviewed these assumptions and considers them reasonable.

Exhibit 4. DSS Model Input Values and Assumptions

Parameter	Model Input Values and Assumptions
Model start year for conservation analysis	2019
Water demand factor year (start year for demand projections)	Annual demand in 2018 represents the total start year demand in 2019 (4,796 MG)
Start year accounts by category	2018 accounts data
Non-revenue water in start year	5.4 percent (2018)[1]
Population projection source	Draft IWSMP (2020), developed by Murraysmith ▪ Population projection represents the service area population (approximately 75 percent of the City of Bend UGB population)
Start year customer category consumption breakdown ▪ Consumption percentage and consumption volume per account	2018 consumption data ▪ Customer categories: single family residential, multi-family residential, commercial, irrigation only, and hydrant meters
Start year customer category indoor consumption percent breakdown	Single family residential, multi-family residential, and commercial: 2018 (lowest months) Irrigation only and hydrant meters: Categorized as outdoor use only, so not included in indoor water use

Notes

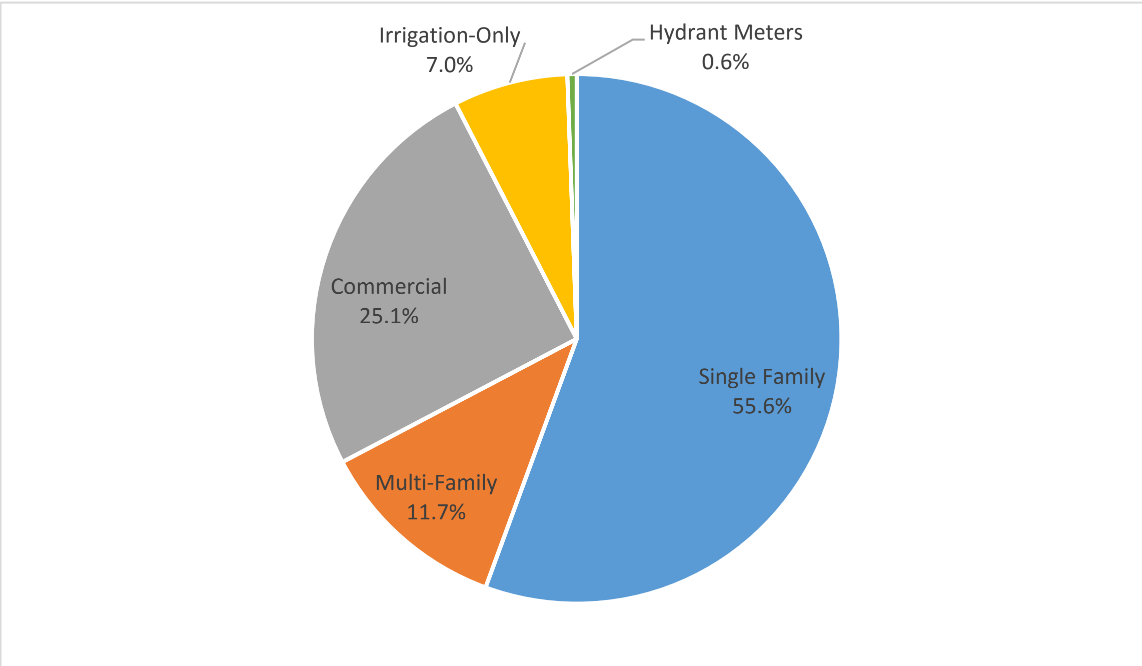
[1]The City's 2018 M36 water audit reported 5.3 percent non-revenue water and 5.1 percent water loss. The non-revenue water input to the model for 2018 was 5.4 percent. The small difference in non-revenue water is attributable to the City's surface water and groundwater production numbers that appear in the 2018 M36 water audit varying slightly from the annual sum of monthly production totals input to the model.

MG = million gallons

UGB = urban growth boundary

The start year is based on 2018 data. The percentage breakdown of metered consumption by customer category in 2018 is shown in **Exhibit 5.**

Exhibit 5. Percent Annual Consumption by Customer Category, 2018



SECTION 3: **Conservation Measures Evaluated**

3.1 Water Conservation Measures Analyzed

The City selected 16 water conservation measures for the water savings and cost-effectiveness analysis, which are described in Exhibit 6. The City's process to select these measures involved first reviewing a comprehensive list of water conservation measures created by Maddaus and then selecting indoor and outdoor water conservation measures for which the City wanted more information about the water savings and costs of implementation. All of the chosen measures were new measures except for the outdoor water audits and free faucet aerators and showerheads. The selection was based on institutional knowledge of the City's existing water conservation program and water management efforts, City resources, and customer water use. The City was especially interested in measures that provide a financial incentive to customers to voluntarily reduce water use, particularly in the peak season given that MDD is the primary driver for additional infrastructure needs.

The City staff were also interested in ordinances that require water fixtures have greater indoor and outdoor water use efficiency, which are considered an important component of a water conservation program in the water industry, as evidenced by feedback the City received from the Alliance for Water Efficiency. In 2017, the City's Water Conservation Program successfully achieved a Silver Rating from the Alliance for Water Efficiency for meeting the American Water Works Association (AWWA) G480 Water Conservation Program Operation and Management Standard. The Alliance for Water Efficiency explained that the City did not achieve a Gold or Platinum Rating (the highest ratings) due to the need for City building codes or ordinances that do more to promote water conservation. While the Bend Code addresses water waste, irrigation timing, and efficient use in public projects under its Engineering Standards and Specifications, it does not address water efficiency of indoor water and outdoor water fixtures and landscaping in private development.

The City chose to exclude some of the water conservation measures that it is currently implementing (e.g., AMI with WaterSmart Software; annual water audits using the AWWA M36 methodology; water conservation communications; and public outreach events, such as workshops for landscapers), because some of the excluded measures were too complex to analyze and the City requires more data regarding water savings outcomes for other measures.

Exhibit 6. Water Conservation Measures Analyzed

	Measure	Description
1	**Clothes Washer Rebate - Residential**	Provide a rebate for EPA ENERGY STAR-labeled washing machines to single family homes and apartment complexes that have common laundry rooms. It is assumed that the rebates would remain consistent with relevant state and federal regulations (i.e., the U.S. Department of Energy and EPA ENERGY STAR) and only offer the best available technology. Only applicable on eligible models and for replacing an existing high-water-using washer.
2	**Clothes Washer Rebate - Commercial**	Provide a rebate for the installation of a high-efficiency commercial washer (HEW). Rebate amounts would reflect the incremental purchase cost.
3	**Retrofit on Resale or Account Change Ordinance**	Require installation of WaterSense-approved fixtures in conjunction with any construction that requires a permit or in the course of resale of the property: lavatory faucets that flow at no more than 1.0 gpm (public restrooms are 0.5 gpm), kitchen faucets no more than 1.8 gpm, showerheads no more than 1.5 gpm, urinals no more than 0.125 gpf, and toilets no more than 1.28 gpf. Work with the real estate industry to require a certificate of compliance be submitted to the City that verifies that a qualified inspector has inspected the property and water-efficient fixtures were either already there or were installed before close of escrow.
4	**High-efficiency Toilet Rebate**	Provide customers a rebate for replacing a toilet that uses 1.6 gpf or more with an EPA WaterSense-approved ultra-high-efficiency toilet that uses 1.28 gpf or less. For single family, multi-family, and commercial customers.
5	**High-efficiency Urinal Rebate**	Provide a rebate to commercial customers for the installation of a high-efficiency urinal (0.125 gpf). The WaterSense standard is 0.5 gpf or less, although models flushing as low as 0.125 gpf are available and function well. Rebate amounts would reflect the incremental purchase cost and have been about $100.
6	**Free Faucet Aerators and Showerheads**	Provide free water-efficient showerheads (1.5 gpm) and faucet aerators (1.5 gpm for bathrooms and kitchens) to single family, multi-family, and commercial customers by mail upon customer request or as a prize for signing up for WaterSmart. (This is an existing water conservation measure; the fixtures are distributed in the indoor water conservation kits.)
7	**Indoor Plumbing Fixture Ordinance**	Require developers to install the following WaterSense-approved fixtures in new developments: lavatory faucets that flow at no more than 1.0 gpm (public restrooms are 0.5 gpm), kitchen faucets no more than 1.8 gpm, showerheads no more than 1.5 gpm, urinals no more than 0.125 gpf, and toilets no more than 1.28 gpf. Work with the real estate industry to require a certificate of compliance be submitted to the City that verifies that the property has been inspected and water-efficient fixtures were installed before close of escrow.
8	**Turf Removal Rebate**	Provide single family customers a $1-per-square-foot rebate (up to $2,000) to remove turf and replace it with low-water-use plants, mulch, or permeable hardscape. Rebates are confirmed with site visits.
9	**Landscape and Irrigation Ordinance**	Develop and enforce Water Efficient Landscape Design Standards. Standards specify that new development projects and renovations of existing units subject to design review be landscaped according to water-efficient best management practices including, appropriate plant selection and placement, water-efficient irrigation systems, and smart irrigation controllers. The ordinance could require certification of landscape professionals.

	Measure	Description
10	**Outdoor Water Surveys**	Provide free landscape water surveys to existing single family and multi-family residential customers upon request and to high-water-use single family and multi-family customers identified by the City. The City provides a customized report (a water budget generated using WaterSmart Software)[1] to the customer on how to save water. The water budget will be updated annually based on the lot square footage and weather. No devices will be given away as part of this program. (This is an existing water conservation measure; these surveys are provided under the Sprinkler Inspection Program and the Large Landscape Program.)
11	**Weather-based Irrigation Controller Rebate**	Provide a rebate of $100 for the purchase of a WaterSense approved weather-based irrigation controller. These controllers have on-site weather sensors or rely on a signal from a central weather station that modifies irrigation times at least weekly.
12	**Pressure Regulation Rebate**	Provide a $100 rebate for the installation of an in-line pressure regulator. This device is meant to regulate the incoming service pressure to the entire property affecting indoor and outdoor end uses, such as faucets, showers, clothes washers, and irrigation.
13	**Drip Irrigation Kits**	Offer free drip irrigation kits to single family residential customers.
14	**Rotating Sprinkler Nozzles Rebates**	Provide rebates to replace standard spray sprinkler nozzles with high-efficiency nozzles. Rebates will be $4 per nozzle up to a maximum purchase of 20 nozzles.
15	**Soil Amendment Rebate**	Provide a $70 rebate for irrigated areas to have soil amended to be more water-efficient (covers the cost of delivery but could cover soil costs if customers pick up the soil themselves).
16	**Pressure-regulating Sprinkler Bodies Rebate**	Rebate customers $3 per pressure-regulating sprinkler body (e.g., Rainbird PRS/Hunter PR40 or similar) to regulate pressure at the sprinkler head on individual irrigation zones.

Notes:
[1] The City of Bend partners with WaterSmart Software to provide customers with the ability to track their water use, receive notifications of potential leaks, and compare their use with other similar customers. More information is available at the City of Bend website, https://www.bendoregon.gov/government/departments/utilities/watersmart-software-2867. (Accessed November 24, 2020.)

3.2 Conservation Measure Analysis

This subsection presents the assumptions and calculations used to analyze each conservation measure described above.

Assumptions

The DSS Model conservation measure analysis involved making assumptions about the following variables for each conservation measure:

- **Targeted water user group end use**
  - End uses (e.g., indoor or outdoor water uses) of each water user group (e.g., single family residential).

- **Utility unit cost**
  - Cost of rebates, incentives, materials/technology, and contractors hired to implement measures.
- **Retail customer unit cost**
  - Cost for implementing measures that is paid by retail customers, which consists of the portion of a measure's cost not covered by a City rebate or incentive.
- **Utility administration and marketing cost**
  - Cost to the utility for administering the measure, including staff time, consultant contract administration, marketing, participant tracking, general expenses, and overhead.

The City of Bend Utility Department reviewed these assumptions and considered them reasonable. The full Water Savings and Cost-effectiveness Analysis Report provides details about each conservation measure, including comments describing assumptions about end use percent water savings per account and fixture costs. As a whole, assumptions about a water conservation measure's end use percent water savings per account, fixture costs, percentage of accounts targeted per year, and period of measure implementation are based on empirical data, field experience, online research, and/or professional judgment.

Calculations

Below are formulas the DSS Model uses to calculate measure costs:

- Annual utility cost = annual market penetration rate (i.e., percentage of accounts targeted per year) x total accounts in category x unit cost per account x (1 + administration and marketing markup percentage)
- Annual customer cost = annual number of participants x unit customer cost
- Annual community cost = annual utility cost + annual customer cost

Analyses

The full Water Savings and Cost-effectiveness Analysis report contains additional information about DSS Model analyses, as well as key references.

3.3 Comparison of Water Conservation Measures

The DSS Model calculated water savings, present value costs, and present value benefits for each conservation measure in 2040, corresponding with the 20-year planning period of the IWSMP and WMCP. Exhibit 7 presents the values used by the City in its decision-making of measures to include in the individual program analysis.

Parameters Analyzed by the DSS Model

The following are parameters included in the DSS Model and Exhibit 7:

- **Present value utility costs:** the present value of the 20-year (2020 through 2040) stream of annual costs discounted to the base year.
  - **Utility costs:** the costs that the City's water utility will incur to operate the water conservation measure/program, including administrative costs and staff time.
- **Present value community costs:** the present value of the 20-year (2020 through 2040) stream of annual costs discounted to the base year.
  - **Community costs:** utility costs plus customer costs, with customer costs being the costs customers will incur to implement a water conservation measure and maintain its effectiveness over the life of

the measure(s). Community costs were not evaluated outside of the DSS Model and values from the DSS Model were not used by the City.

- **Five years of water utility costs (2023 through 2028) ($):** the sum of the annual utility costs for the years from 2023 to 2028. The year 2023 is the first year when all measures are implemented. Note that some measures start before 2023. The measures start in the years as specified for each measure shown in the full Water Savings and Cost-effectiveness Analysis report.
- **Water savings in 2040 (MGY):** water saved in million gallons per year (MGY). The year 2040 is provided, as both the City's IWSMP and WMCP have 20-year planning periods.
- **Utility cost of water savings ($/MG):** present value of utility costs over 20 years divided by the 20-year water savings. The analysis period is 2020 through 2040. This value is compared to the City's avoided cost of water as one indicator of the cost-effectiveness of conservation efforts. It should be noted that the value somewhat undervalues the cost of savings because program costs are discounted to present value and the water benefit is not.

The following are additional parameters included in the DSS Model:

- **Present value utility benefits:** the present value of the 20-year (2020 through 2040) time stream of annual benefits discounted to the base year.
  - **Utility benefits:** the avoided future costs of producing water (including operational and avoided infrastructure costs). However, instead of using utility benefits calculated by the DSS Model, utility benefits were evaluated outside of the DSS model and included consideration of avoided infrastructure costs only, information generated by Murraysmith as part of the IWSMP.
- **Present value community benefits:** the present value of the 20-year (2020 through 2040) time stream of annual benefits discounted to the base year.
  - **Community benefits:** utility benefits plus customer benefits, with customer benefits being the savings other than from reduced water/sewer utility bills, such as energy savings resulting from reduced use of hot water. Conservation program participants will see lower water and sewer bills, but in general, there will be no net customer benefit. Community benefits were not evaluated outside of the DSS Model and values from the DSS Model were not used by the City.
- **Water utility benefit to cost ratio:** present value of utility costs divided by present value (PV) of Utility Benefits over 20 years (2020 through 2040).
- **Community benefit to cost ratio:** (PV of Utility Benefits plus PV of customer energy savings) divided by (sum of PV of Utility Costs plus PV of Customer Costs), over 20 years (2020 through 2040).

Important Points about DSS Model Conservation Measures Results

- These results do not incorporate savings associated with the plumbing code.
- The conservation measures results assume the measures are independent of each other.
  - The present value benefits are the cost of saved water per unit volume if the conservation measures were implemented on a standalone basis (without interaction or overlap from other conservation measures that may address the same end use[s]).
  - Given that the interactions between conservation measures have not been considered in the comparison, totals have not been included at the bottom of Exhibit 7 to avoid double counting water savings estimates.
  - Given that savings from measures that address the same end use(s) are not additive, the conservation program analysis later in this report does consider interactions between conservation measures.

- The DSS Model uses impact factors to avoid double counting in estimating the water savings from programs of measures.
- For example, if two measures are planned to address the same end use and both save 10 percent of the prior water use, then the net effect is not the simple sum (20 percent). Rather, it is the cumulative impact of the first measure reducing the use to 90 percent of use without the first measure in place, then reducing the use another 10 percent, resulting in the use being 81 percent of what it was originally. In this example the net savings is 19 percent, not 20 percent. Using impact factors, the model computes the reduction in the example as follows, 0.9 x 0.9 = 0.81, or 19 percent water savings.

Exhibit 7. Comparison of Water Conservation Measures

	Measure	Present Value of Water Utility Costs	5 Years of Water Utility Costs 2023-2028	Water Savings in 2040 (MG per Year)	Utility Cost of Water Savings per Unit Volume ($/MG)
1	Clothes Washer Rebate - Residential	$141,419	$15,760	0.003838	$9,796
2	Clothes Washer Rebate - Commercial	$48,276	$5,380	0.004926	$2,824
3	Retrofit on Resale or Account Change	$214,059	$115,200	0.113560	$355
4	High-efficiency Toilet Rebate	$552,985	$297,600	0.065457	$1,581
5	High-efficiency Urinal Rebate	$37,710	$12,390	0.003551	$2,179
6	Free Faucet Aerators and Showerheads	$212,330	$51,982	0.030052	$1,789
7	Indoor Plumbing Fixture Ordinance	$3,113,304	$1,633,138	0.130752	$4,522
8	Turf Removal Rebate	$1,915,590	$524,000	0.048621	$9,380
9	Landscape and Irrigation Ordinance	$4,983,654	$1,539,508	0.747737	$1,908
10	Outdoor Water Surveys	$573,351	$150,000	0.026313	$3,140
11	Weather-based Irrigation Controller Rebates	$685,325	$212,000	0.660652	$299
12	Pressure Regulation Rebate	$119,665	$64,400	0.021709	$525
13	Drip Irrigation Kits	$91,049	$49,000	0.007480	$1,169
14	Rotating Sprinkler Nozzle Rebate	$259,983	$131,812	0.053226	$508
15	Soil Amendment Rebate	$282,439	$152,000	0.110109	$520
16	Pressure-regulating Sprinkler Bodies Rebate	$265,347	$110,852	0.055414	$507

SECTION 4: **Conservation Program Evaluation**

4.1 Conservation Program Descriptions

The DSS Model analyzed three water conservation programs (Programs A, B, and C) consisting of different combinations of the 16 individual conservation measures presented in the previous section. The City chose to compare a program with outdoor water conservation measures plus one measure that conserves water indoors and outdoors (Program A), a program with only indoor water conservation measures (Program B), and a program with a combination of the City's preferred indoor and outdoor water conservation measures (Program C).

Regardless of whether the measure was an indoor measure or outdoor measure, the City decided not to include individual measures with low returns on investment. For example, the City chose not to include four measures in any of the programs: clothes washer rebates for residential customers, high efficiency urinal rebates, turf removal rebates, and soil amendment rebates.

Descriptions of each program and the measures that comprise each program are presented in Exhibit 8. A breakdown of whether the conservation measures selected for each conservation program are indoor ("I") or outdoor ("O") measures and are existing ("E") or new ("N") measures is presented in Exhibit 9.

Exhibit 8. Descriptions of Conservation Programs

<table>
<tr><th>Conservation Program</th><th>Program Description</th></tr>
<tr><td>Program A</td><td>Outdoor water conservation measures only, except for one measure with dual indoor and outdoor benefits
Seven measures, including one existing measure (outdoor water surveys) and six new measures:
One giveaway of a free drip irrigation kit
One ordinance addressing water-efficiency of landscapes and irrigation
Three rebates to increase irrigation system water-efficiency
One pressure regulation rebate that conserves water indoors and outdoors</td></tr>
<tr><td>Program B</td><td>Indoor water conservation measures only
Five measures, including one existing measure (free faucet aerators and showerheads, which are made available in the City's free indoor water conservation kits), and four new measures:
Two rebates to encourage replacement of inefficient commercial clothes washers and toilets (for residential and commercial customers)
Two ordinances focused on ensuring that new homes, existing homes for resale or having any construction that requires a permit, and homes with changing accounts have water-efficient fixtures (e.g., faucet aerators, showerheads, and toilets)</td></tr>
<tr><td>Program C</td><td>A combination of outdoor and indoor water conservation measures preferred by the City
Eleven measures consisting of two existing measures and nine new measures:
Four indoor-only water conservation measures:
One giveaway of free faucet aerators and showerheads (existing measure)
One rebate to increase toilet water efficiency
Two ordinances focused on ensuring that new homes, existing homes for resale or having any construction that requires a permit, and homes with changing accounts have water-efficient fixtures (e.g., faucet aerators, showerheads, and toilets)
Six outdoor-only water conservation measures:
Outdoor water surveys (existing measure)
One giveaway of free drip irrigation kits
One ordinance addressing water-efficiency of landscapes and irrigation
Three rebates to increase irrigation system water efficiency
One pressure regulation rebate that conserves water indoors and outdoors</td></tr>
</table>

Exhibit 9. Conservation Measures Comprising Conservation Programs and Type of Conservation

Conservation Measure	Existing (E) or New (N)	Outdoor or Indoor	Program		
			A	B	C
Clothes washer rebates - commercial	N	Indoor		X	
Retrofit on resale or account change ordinance	N	Indoor		X	X
High-efficiency toilet rebate	N	Indoor		X	X
Free faucet aerators and showerheads	E	Indoor		X	X
Indoor plumbing fixture ordinance	N	Indoor		X	X
Landscape and irrigation ordinance	N	Outdoor	X		X
Outdoor water surveys	E	Outdoor	X		X
Weather-based irrigation controller rebate	N	Outdoor	X		X
Pressure regulation rebate	N	Indoor/ Outdoor	X		X
Free drip irrigation kits	N	Outdoor	X		X
Rotating sprinkler nozzles rebate	N	Outdoor	X		X
Pressure regulating sprinkler bodies rebate	N	Outdoor	X		X

4.2 Conservation Program Analysis

Selected results of the DSS Model analysis of the three conservation programs (Programs A, B, and C) are presented in Exhibits 10 through 14. More detailed results are presented in the full Water Savings and Cost-effectiveness Analysis Report.

Typical values for assessing and selecting a particular conservation program are water savings, utility and community costs, and benefit-cost ratios, which incorporate the preceding values and provide a view of the entire program. A benefit-cost ratio greater than 1.2 is ideal as it indicates the utility has some financial buffer in case the costs of the conservation program are slightly higher than anticipated. Programs A, B, and C all had benefit-cost ratios greater than 1.2. Given that water savings and cost of the programs were the outputs needed from the DSS Model to assess whether implementing a water conservation program would be cost-effective, the remainder of this section focuses on water savings and costs.

Exhibit 10. Projected Annual Water Savings (MG) by Conservation Program

Conservation Program	Projected Annual Water Savings (MG)			Projected Total Water Savings (MG)
	2023	2030	2040	(2020-2040)
Program A	46.4	325.6	559.9	6,228.5
Program B	15.3	105.1	122.3	1,729.0
Program C	61.7	430.0	680.4	7,939.5

Note MG = million gallons

Exhibit 11. Projected Annual Water Savings (MG) by Conservation Program

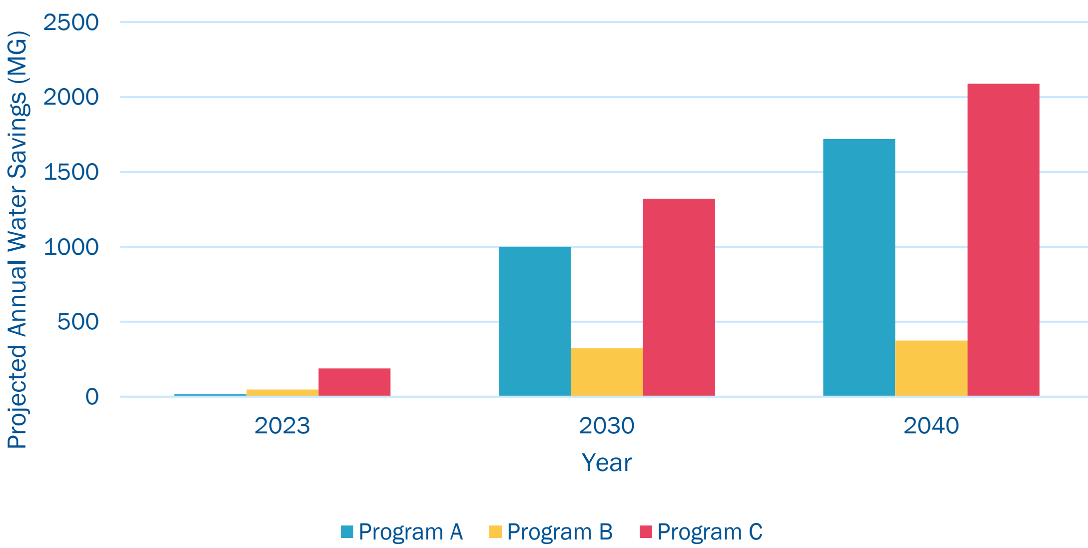


Exhibit 12. Indoor and Outdoor Water Savings (MG) by Conservation Program

Conservation Program	Year	Projected Annual Water Savings (MG)		
		Indoor	Outdoor	Total
Program A	2023	0.3	46.0	46.3
	2030	2.4	323.1	325.5
	2040	1.1	558.7	559.9
Program B	2023	15.4	0.0	15.4
	2030	105.2	0.0	105.2
	2040	122.3	0.0	122.3
Program C	2023	15.7	46.0	61.7
	2030	106.9	323.1	430.0
	2040	121.6	558.7	680.3

Note MG = million gallons

Estimated utility costs in 2023, 2030, and 2040 are presented in **Exhibit 13**. The costs are lower in 2040 than in 2023 and 2030, because some conservation measures end before 2040. **Exhibit 14** presents the projected utility costs per year of each conservation program. Costs presented in these two exhibits are not adjusted for present value.

Exhibit 13. Projected Utility Costs and Community Costs by Conservation Program

Conservation Program	Projected Utility Costs ($)		
	2023	2030	2040
Program A	$435,538	$494,531	$339,813
Program B	$402,016	$472,335	$12,673
Program C	$837,554	$961,486	$412,486

Exhibit 14. Projected Utility Costs by Conservation Program

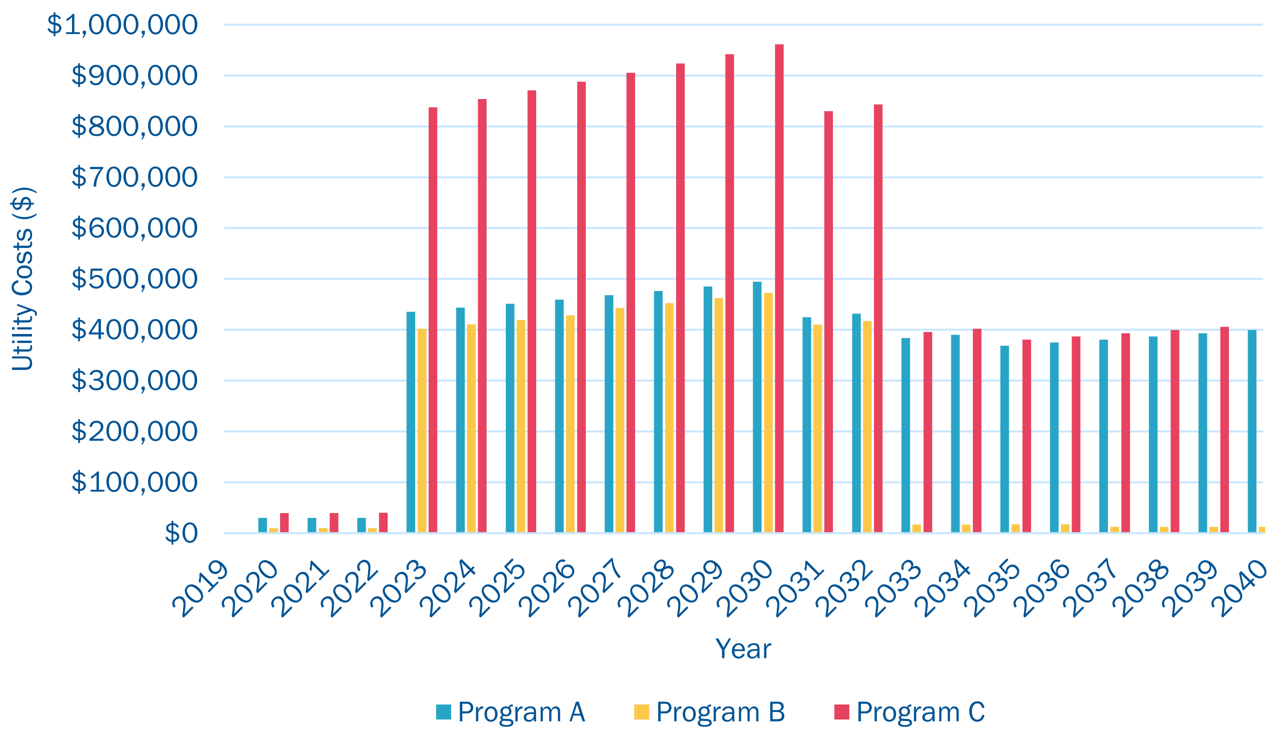


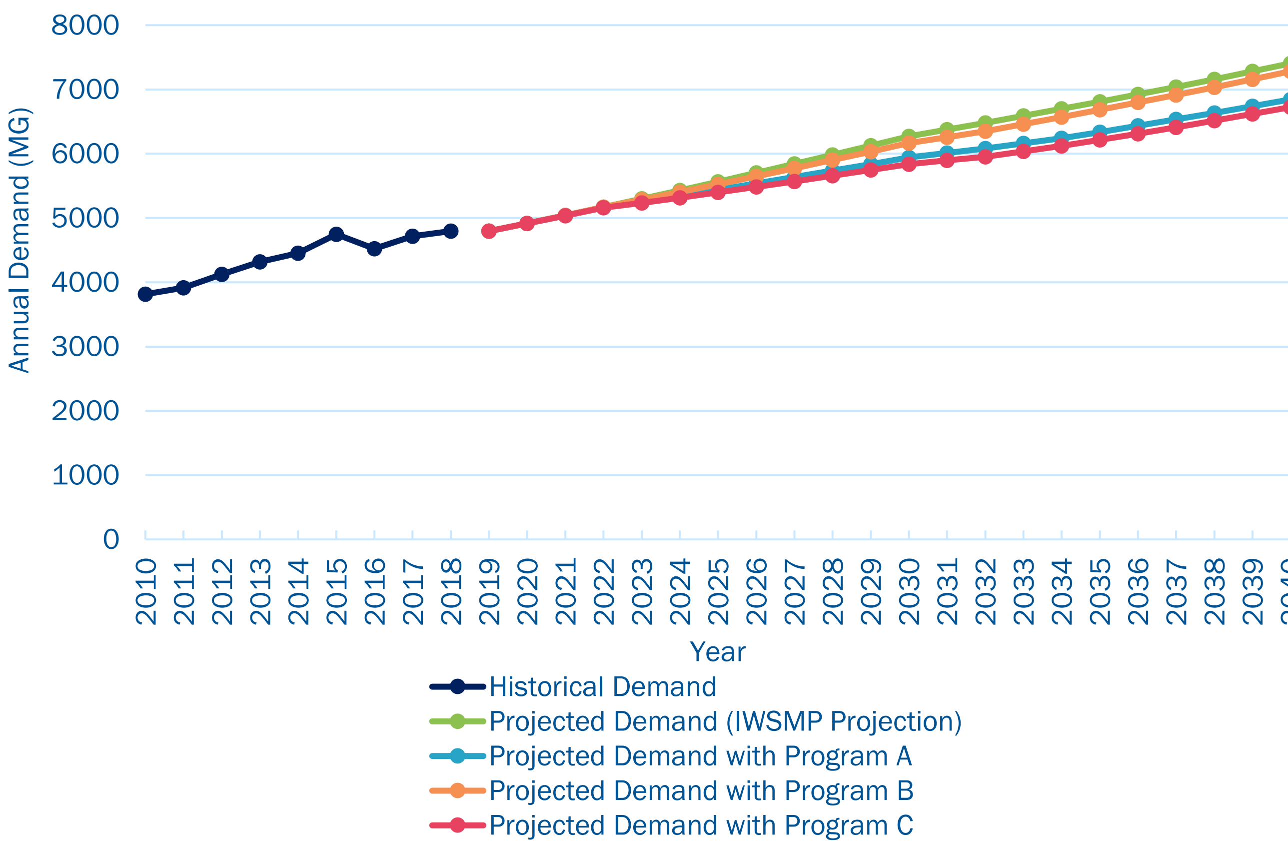
Exhibit 15 shows the present value costs for each conservation program over 20 years, considered the life of the program for the purposes of this analysis. The current value of future costs uses the real interest rate of 0.87 percent. This reflects the difference in the projected nominal interest rate and assumed rate of inflation for the City Utility's capital expenditures over the 20 year period of implementation. These results include water savings from plumbing codes and standards. Plumbing codes consist of current state and federal standards for water fixtures, such as toilets, faucet aerators, showerheads, and clothes washers.

Exhibit 15. Present Value Costs for the Water Utility by Conservation Program (With Plumbing Code)

Conservation Program	Present Value of Utility Costs
Program A	$6,978,373
Program B	$4,140,954
Program C	$11,071,052

Annual demand projections for each conservation program are presented in Exhibit 16. The projected annual demand developed for the IWSMP (IWSMP Projection) is 6,497 MG in 2030 and 7,702 MG in 2040. For comparison, the annual demand projection if Program C is implemented is 6,067 MG in 2030 and 7,021 MG in 2040, a reduction of 9 percent. The baseline IWSMP projection incorporates information about current water use, which has been influenced by some of the City's existing conservation programs, and should not be considered a "no conservation" scenario.

Exhibit 16. Projected Annual Demand with Conservation Programs



4.3 Program Selection and Cost-effectiveness

Program C is the City's preferred program, as it includes indoor and outdoor water conservation measures that produce substantial water savings at a reasonable cost. Program C is projected to result in a total of 7,939 MG in water savings from 2020 through 2040 and 680.3 MG in outdoor water savings in 2040. The estimated present value cost to the City (utility cost) of Program C from 2020 through 2040 is a total of $11,071,052.

The water savings and cost results of Program C were then used to (1) assess the extent to which the City could avoid building infrastructure as a result of water savings and (2) determine whether water conservation was more cost-effective than building infrastructure to meet future demands without implementing Program C.

To assess the extent to which water savings could avoid building new water system infrastructure, projected water savings under an MDD scenario must be considered. The need for development of new wells and reservoirs is driven primarily by increases in the MDD. GSI Water Solutions, Inc. (GSI), used the indoor and outdoor water savings in 2040, an output from the water savings and cost-effectiveness analysis, to calculate the reduction in the MDD in 2040 realized as a result of conservation. Existing indoor water use was estimated to be 6.0 mgd, based on demand during the months of November through March. Indoor water use is assumed to be constant throughout the year (1/365 = 0.27 percent of indoor water use occurs each day). GSI estimated outdoor water use by subtracting the indoor water use from the 2018 MDD of 28.1 mgd, resulting in outdoor water use of 22.1 mgd on the date of the MDD. GSI subtracted annual indoor demand (6 mgd × 365 = 2,190 MG) from the 2018 total annual demand of 4,796 MG to calculate total outdoor water demand (4,796 MG − 2,190 MG = 2,606 MG). Therefore, outdoor water demand on the date of MDD in 2018 is 0.85 percent of the total annual outdoor water use (22.1 MG / 2,606 MG = 0.85 percent).

GSI assumed that the reduction in indoor and outdoor water use on the date of the MDD would be proportional to the volume of water used. As a result, 0.85 percent of outdoor water conservations savings and 0.27 percent of indoor water conservation savings would occur on the date of MDD. Based on the projected annual outdoor and indoor water savings of 558.7 MG and 121.6 MG, respectively, GSI estimated that the reduction in the City's water use as a result of Program C would result in conservation savings of 5.1 mgd (7.9 cfs; 3,540 gpm) compared with the projected MDD without conservation (121.6 MG × 0.27% + 558.7 × 0.85% = 5.1 mgd on the date of MDD).

To determine whether implementing the water conservation program would be cost-effective, the cost of Program C was compared to the cost of constructing new infrastructure without Program C. For the purposes of its IWSMP, the City assumed that future new wells would have production rates of 1,150 gpm. Using that production rate, the projected MDD water savings of 5.1 mgd (equivalent to 3,540 gpm) would eliminate the need to construct three new wells, as well as one aboveground reservoir. The estimated cost of constructing three wells and one aboveground reservoir is approximately $21 million over the next 20 years. This does not include additional operational costs associated with groundwater production (e.g., cost of pumping groundwater), which would also be avoided. Consequently, the $11 million estimated cost to implement Program C is projected to be less than the $21 million cost of infrastructure anticipated to meet the projected 2040 MDD.

Results from the water savings and cost-effectiveness analysis will be incorporated into the City's IWSMP and WMCP, which are currently under development. The projected MDD water savings will inform the demand projections for both plans and related analyses. The identification of Program C with its suite of conservation measures will inform the WMCP water conservation 5-year benchmarks.

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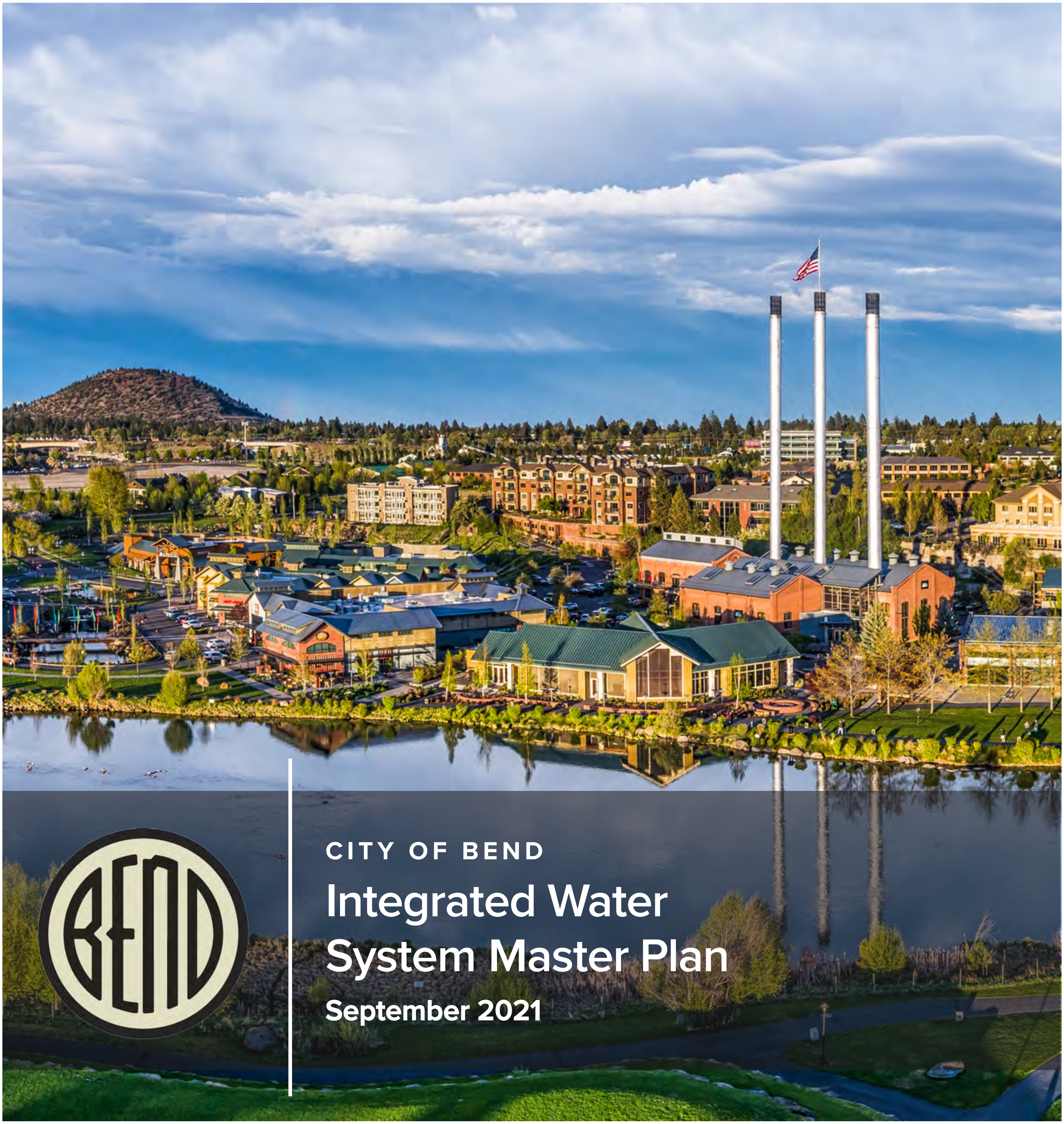

CITY OF BEND

Integrated Water System Master Plan

September 2021

RESOLUTION NO. 3275

A RESOLUTION ADOPTING THE 2021 INTEGRATED WATER SYSTEM MASTER PLAN

Findings

A. The water system of the City of Bend (City) provides reliable, high quality water and service to customers.

B. The City operates a public drinking water system within the City of Bend, that supplies water to its customers from both surface and ground water sources.

C. The Integrated Water System Master Plan (the iWSMP) evaluates the ability of the City's water system to meet desired Level of Service Standards under existing and future conditions. It is a comprehensive update resulting in a complete Water Master Plan as defined under Chapter 333, Division 61 of the Oregon Administrative Rules (OAR). City engineering and legal staff will be further reviewing the need to submit the updated iWSMP to OHA for approval in compliance with OAR 333-061-0060, and will do so as required.

D. The last water master planning effort at the City was conducted in 2007 (the Water System Master Plan Update, Final report), and the Water System Master Plan Update Optimization Study in 2011, and yielded a 10-year capital implementation plan to the year 2020. This updated iWSMP is intended to build upon previous master plans, incorporate the latest changes to growth and maintenance needs of the system, and continue to build upon the successful completion of prior Capital projects.

E. The system is robust; having both surface and groundwater supply sources provides a system that is resilient, reliable and supplies high-quality drinking water. Adding pretreatment to the surface water supply will increase its resilience and reliability.

F. The City's water system includes existing extensive infrastructure that requires significant investment to address deferred maintenance in facilities and pipe to extend its useful life.

G. The City's water needs are projected to continue increasing, requiring investments in new pipe, storage, and wells.

H. Optimization hydraulic modeling was used to test millions of solutions to improve system performance for lower cost.

I. Reductions in water use from increased conservation measures could decrease the required investment in new infrastructure.

J. To implement the $391 million (2020 dollars) in improvements, the iWSMP includes a 30-year financial plan that identifies a need to use existing reserves, raise customer water rates, and issue new bonds.

K. The implementation of the iWSMP moving forward should be informed by the current system conditions and include detailed project designs, refinements to costs and budget, and regular updates to system data.

L. In May 2021, the City Council held an informational work session where City staff provided a water system overview, water conservation efforts to date, a summary of the engineering, technical, and modeling work that went into developing the iWSMP, and preliminary outreach results.

M. Council gave direction to Staff to create an online Open House with a short survey for community members to share their thoughts on the iWSMP. Council further directed that further discussions related to water conservation efforts should continue separately through the end of the year with the Environment & Climate Committee (ECC).

N. With this direction, the City of Bend hosted an online Open House for the iWSMP from June 28 through August 6, 2021. The Open House included a 5-minute community survey to gather feedback on priority values for water system and water conservation planning. Two hundred twenty survey responses were collected.

O. Based on results of the community outreach efforts, the City found a high level of interest from the public in exploring opportunities for additional conservation efforts. Therefore, over the next several months, City staff will be engaging with the ECC and interested public to explore additional conservation possibilities, and will bring options back to the City Council based on the ECC recommendations.

Based on these findings,

THE CITY COUNCIL OF THE CITY OF BEND RESOLVES AS FOLLOWS:

1. The 2021 Integrated Water System Master Plan is adopted.
2. By this adoption, Council authorizes any minor, clarifying or needed changes/amendments to the iWSMP as a result of review, if needed, of the iWSMP by the Oregon Health Authority, without further Council approval.
3. The resolution takes effect immediately upon adoption.

Adopted by City Council on October 6, 2021

YES: Mayor Sally Russell
Mayor Pro Tem Gena Goodman-Campbell
Councilor Barb Campbell
Councilor Melanie Kebler
Councilor Anthony Broadman
Councilor Megan Perkins
Councilor Rita Schenkelberg

NO:

Sally Russell

Sally Russell, Mayor

ATTEST:

Robyn Christie, City Recorder

APPROVED AS TO FORM:

Mary Winters, City Attorney

Integrated Water System Master Plan

City of Bend

September 2021

Renews: 6/30/2022

Renews: 6/30/2023

Murraysmith

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Boise, ID 83706

Acknowledgements

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Stantec

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Acronyms & Abbreviations

A	
AACE	American Association of Cost Engineers
ADD	average day demand
AMI	automated metering infrastructure
Avion	Avion Water Company
AWIA	America's Water Infrastructure Act
AWWA	American Waterworks Association
B	
BMW	Bend Municipal Watershed
C	
CCL	Contaminant Candidate List
CCR	Consumer Confidence Report
cfs	cubic feet per second
CI	Cast Iron
CIP	Capital Improvement Plan
City	City of Bend
CT	Contact Time
CWSRF	Clean Water State Revolving Fund
D	
DBPR	Disinfection Byproduct Rule
D/DBP	Disinfectant/Disinfection Byproduct
DI	Ductile Iron
DSS Model	Decision Support System Model
DWS	Drinking Water Services
E	
EMP	Employee
ENR CCI	Engineering News Record Construction Cost Index
EPA	U.S. Environmental Protection Agency
EPS	Extended Period Simulation
ERU	Equivalent Residential Unit
EUAC	Equivalent Uniform Annual Cost
F	
FCLV	flow control and level valve
FCV	flow control valve
fps	feet per second
FY	Fiscal Year
G	
GIS	geographic information system

gpcpd	gallons per capita per day
gpm	gallons per minute
GWUDI	groundwater under the direct influence of surface water
H	
HAA5	Five Haloacetic Acids
HGL	hydraulic grade line
hp	horsepower
HU	Housing Unit
I	
IOC	inorganic contaminants
iWSMP	Integrated Water System Master Plan
L	
LCR	Lead and Copper Rule
LF	linear feet
LOS	Level of Service
LRAA	Locational Running Annual Averages
M	
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MDD	maximum day demand
mg/L	milligrams per liter
MG	million gallons
mgd	million gallons per day
MRDL	maximum residual disinfectant levels
MRDLG	maximum residual disinfectant level goals
µg/L	microgram per liter
N	
NPDWR	National Primary Drinking Water Regulations
NSDWR	National Secondary Drinking Water Regulations
O	
O&M	Operations and Maintenance
OAR	Oregon Administrative Rules
OHA	Oregon Health Authority
P	
pCi/L	picoCuries per liter
PER	Preliminary Engineering Report
pH	hydrogen potential
PHD	peak hour demand
PRC	Portland State University Population Research Center
PRV	pressure reducing valve
psi	pounds per square inch
PSV	pressure sustaining valve
PVC	polyvinyl chloride

R	
Roats	Roats Water System
RR	Radionuclides Rule
RTCR	Revised Total Coliform Rule
S	
SCADA	supervisory control and data acquisition
SDWA	Safe Drinking Water Act
Siting Study	Outback Siting Study
SMCL	secondary maximum contaminant level
SOC	synthetic organic contaminants
Stage 1 DBPR	Stage 1 Disinfectants/Disinfection Byproducts Rule
Stage 2 DBPR	Stage 2 Disinfectants/Disinfection Byproduct Rule
SWTR	Surface Water Treatment Rule
T	
TC	total coliform
TCR	Total Coliform Rule
TOC	total organic carbon
TTHM	Total Trihalomethanes
U	
UCMR	Unregulated Contaminant Monitoring Rule
UGB	Urban Growth Boundary
USFS	United States Forest Service
V	
VOC	volatile organic contaminants
W	
WDS	Water Distribution System
WFF	Water Filtration Facility
WIFIA	Water Infrastructure Funding Innovation Act
WMCP	Water Management and Conservation Plan

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Executive Summary

CITY OF BEND

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INTRODUCTION

The City of Bend (City) is located east of the Cascade Mountains in Central Oregon with a population of approximately 90,000 people. This Integrated Water System Master Plan (iWSMP) documents key water system information and provides analysis and recommendations to inform infrastructure investments and system operations to continue providing high quality water to existing and future customers.

Considerations for How This Plan Should Be Used

This iWSMP serves as a guiding document for the City's water system improvements. Use of this iWSMP should be supplemented with:

- Annual reviews to prioritize and budget needed improvement projects.
- Regular updates to the water geographic information system data, corresponding hydraulic model, and system mapping to reflect ongoing water system improvements and expansion.
- Detailed engineering of conceptual projects recommendations. (The location, size and timing of projects may change as additional site-specific details and potential alternatives are investigated and analyzed in the preliminary engineering phase of project design.)
- Updates and refinements to cost estimates during preliminary engineering and final project designs.

Components of the Integrated Water System Master Plan:

ES Executive Summary

a. Purpose and scope of the iWSMP
b. Summary of each section and overall recommendations

1 Existing Water System

a. Outline of the existing service area and Urban Growth Boundary
b. Inventory of existing system infrastructure including supply sources, storage reservoirs, booster pump stations, control valves, and pipe network
c. Illustration of the hydraulic and geographic relationship of the system

2 Population and Demand Forecast

a. Historic population and customer data
b. Historic water production and demand data
c. Outline of future growth areas
d. Comparison of future demand projection methodologies
e. Future system-wide and pressure zone demand projections

3 Level of Service and Design Standards

a. Standards to provide reliable, high quality water and contribute to City's mission
b. Criteria to evaluate system water rights, supply, storage, pumping facilities, and piping
c. Guidelines for determining infrastructure life cycles and redundancy

4 System Analysis

a. Overview of system performance under existing and future conditions relative to level of service and design standards
b. Comprehensive analysis of existing system and future needs including:
   iii. Condition and maintenance assessment of existing facilities and pipes
   iv. Capacity analysis of existing water rights, facilities, and pipes to meet existing and future system demands
   v. Criticality assessment of supply, pipes, and valves (to evaluate whether redundant or secondary service infrastructure exists to inform essential or critical rating of system components)
   vi. Optimization of system operations and condition and capacity improvements

5 Water Quality and Regulations

a. Review of the City's compliance with state and federal water quality standards

6 Capital Improvement Plan

a. Project recommendations to address improvement needs identified through system analysis
b. Timing and cost estimates for project implementation

7 Financial Plan

a. Summary of water fund revenue and expenditures
b. Projected needs for rates, reserves, and debt to support proposed capital improvement plan

EXISTING WATER SYSTEM

The City's existing Urban Growth Boundary is served by three primary water suppliers, the City of Bend, Avion Water Company, and Roats Water System. The City also serves water to the Tetherow destination resort, the Westside Transect area including the Tree Farm rural residential development and Awbrey Meadows, which are located outside the UGB. The City has the capability to supply treated water to customers by utilizing groundwater and surface water. The groundwater is supplied by the Deschutes Regional Aquifer and is primarily used to supply peak demands. The City's existing surface water system begins in the Bend Municipal Watershed established by agreement with the USFS in 1926. It includes the Prowell Springs Diversion and a surface water intake facility, a water filtration facility, eight groundwater sites consisting of 20 active wells, 15 finished water storage reservoirs, six booster pump stations, approximately 440 miles of transmission and distribution mains, nearly 10 miles of raw water pipeline, and associated appurtenances including various valves, hydrants, and meters. The system includes six primary pressure zones with an additional 23 subzones.

Figure ES-1. *Existing System Components*

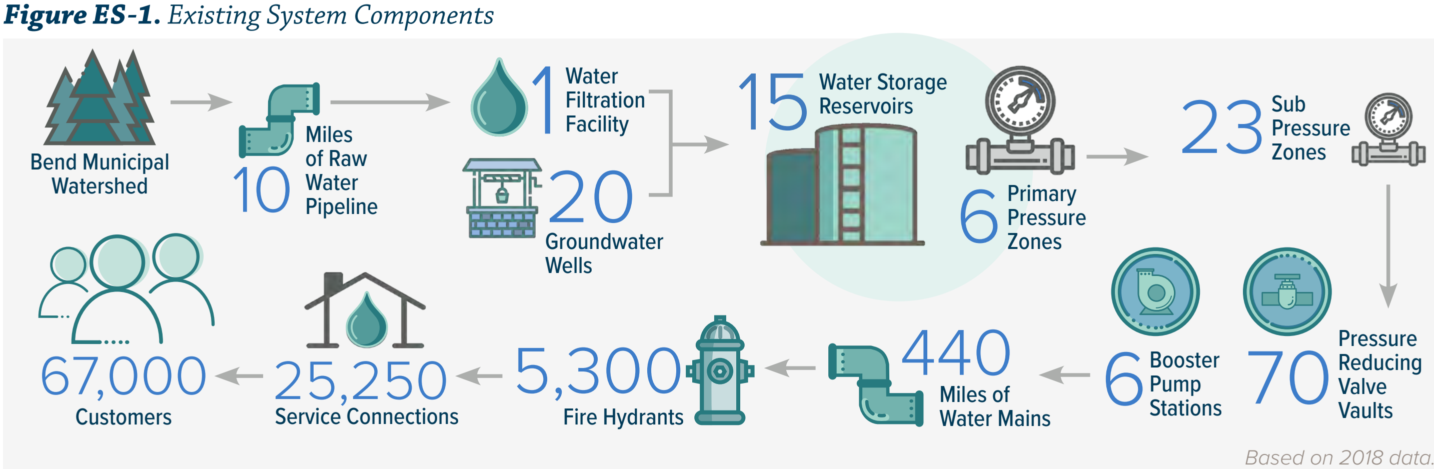

Exhibit 26
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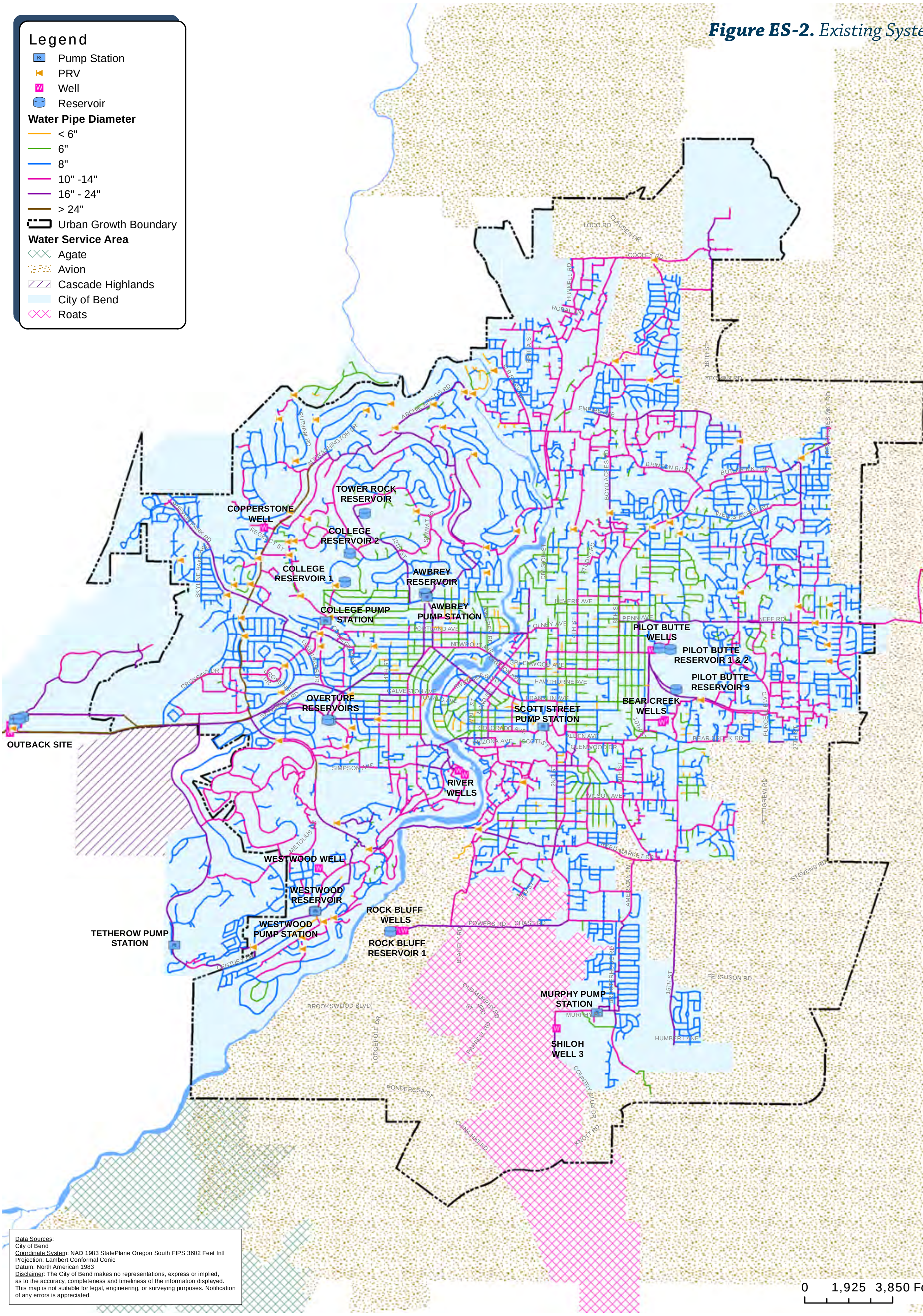
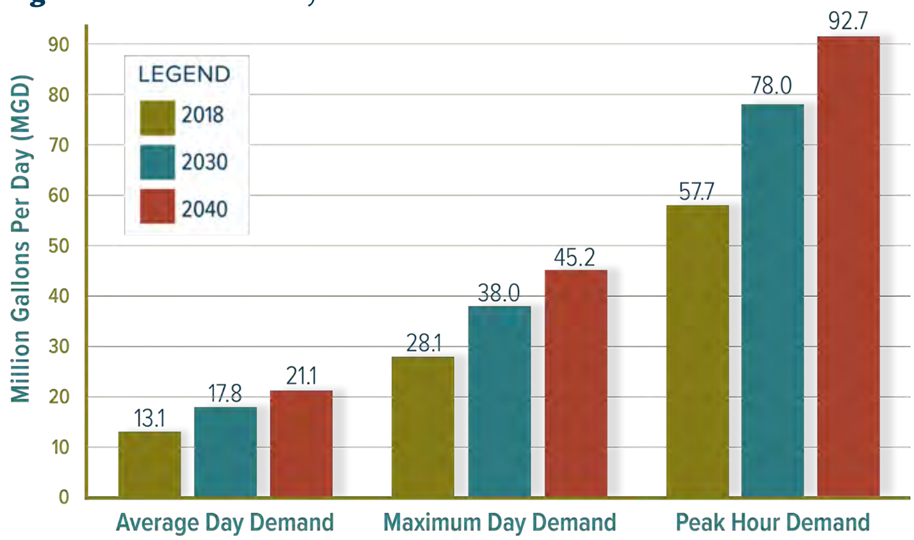


Figure ES-2. *Existing System*

POPULATION AND DEMAND FORECAST

The City's historical customer accounts, service area population, water production, use, and loss were evaluated to determine trends in the system water requirements. The customer base of the service area is estimated at 75% of the City population. The City is regularly improving its data collection and methodologies and as a result the historical data will continue to improve understanding of past and future system requirements. The future and projected number of employees and housing units, previously developed for the City (by Angelo Planning Group during the 2016 Urban Growth Boundary Study) on a parcel basis, was used to project growth in the water service area boundary. Unit demand factors based on 2018 consumption and production data were then applied to the employee and housing unit projections for each timeframe. This growth does not reflect potential declines due to less water use from increased conservation program measures. Projections reflect 20-year increases in average day demand (ADD) from 13.1 to 21.1 million gallons per day, maximum day demand (MDD) from 28.1 to 45.2 million gallons per day and peak hour demand (PHD) from 57.7 to 92.7 million gallons per day. The City currently updates their plan every 10 years which gives the opportunity to track the population and demand trends and update projections. The projected demands for the next 20 years are used to evaluate the hydraulic capacity of the system and identify improvements. The actual timing of any improvements should be based primarily on when the system reaches certain demand thresholds versus specific predetermined timelines.

Figure ES-3. *Demand Projections*



LEVEL OF SERVICE AND DESIGN STANDARDS

The City's Level of Service criteria for the water system aim to provide reliable, high quality water and service that meet regulatory standards and support the City's numerous objectives and considerations. The Level of Service criteria and planning assumptions define the framework for analysis of the system including water rights, supply, storage, pumping facilities, and piping to meet existing and future requirements. The specific criteria are in Table ES-1. Even where specific criteria are not defined, guidelines for determining infrastructure life cycles for maintenance and improvements as well as considering infrastructure redundancy is important in determining system improvements. As individual criteria are used to evaluate the system, consideration is also given more generally to City objectives such as financial and environmental stewardship, compliance with America's Water Infrastructure Act (AWIA), and energy efficiency. Additional consideration is also given to collaboration with the Deschutes National Forest including measurement and other compliance tasks such as maintaining and replacing fish screens, that are required as part of the United States Forest Service (USFS) Special Use Permit.

Table ES-1 Level of Service Summary

ATTRIBUTE	EVALUATION CRITERIA	VALUE
Water Supply	Firm Supply Capacity	Greater than MDD assuming storage is adequate for equalization and fire suppression
	Emergency Power	At least two independent sources if adequate standby storage is not available
Storage	Total Storage Capacity	Sum of dead, equalization, fire, operational, and standby
	Dead Storage	Storage that is unavailable for use or that can provide only substandard quality, flows and pressures
	Equalization Storage	Difference of PHD and max supply capacity for 150 min
	Fire Suppression Storage	Largest fire flow in a zone for duration of that flow
	Operational Storage	The volume of water before sources turn on to prevent excess pump operation or cycling
	Standby Storage	48 hours of ADD minus firm supply capacity with backup power, with a minimum of 200 gallons per ERU
Pump Stations	Minimum No. of Pumps	2
	Firm capacity pumping to storage	ADD
	Total capacity when pumping to storage	MDD
	Firm capacity pumping to system (no storage)	MDD plus fire flow or PHD, whichever is greater
	Emergency Power	At least two independent sources adequate to serve ADD plus largest fire flow (where standby power and fire suppression storage are not adequate/available)
Service Pressure	Minimum during MDD plus fire flow	20 psi
	Minimum during PHD	30 psi
	Standard Range	40-100 psi
	Maximum	120 psi[1]
Distribution Piping[2]	Maximum Velocity for ADD or MDD	5 feet per second
	Maximum Velocity for PHD	8 feet per second
	Maximum Velocity during Fire Flow	12 feet per second
	Minimum Future Pipe Diameter	8-inch
Fire Suppression	Minimum Fire Flow Requirements[3]	Residential: 1,500 gpm for 2 hours Commercial/Public: 2,500 gpm for 3 hours Central Business District: 3,500 gpm for 5 hours

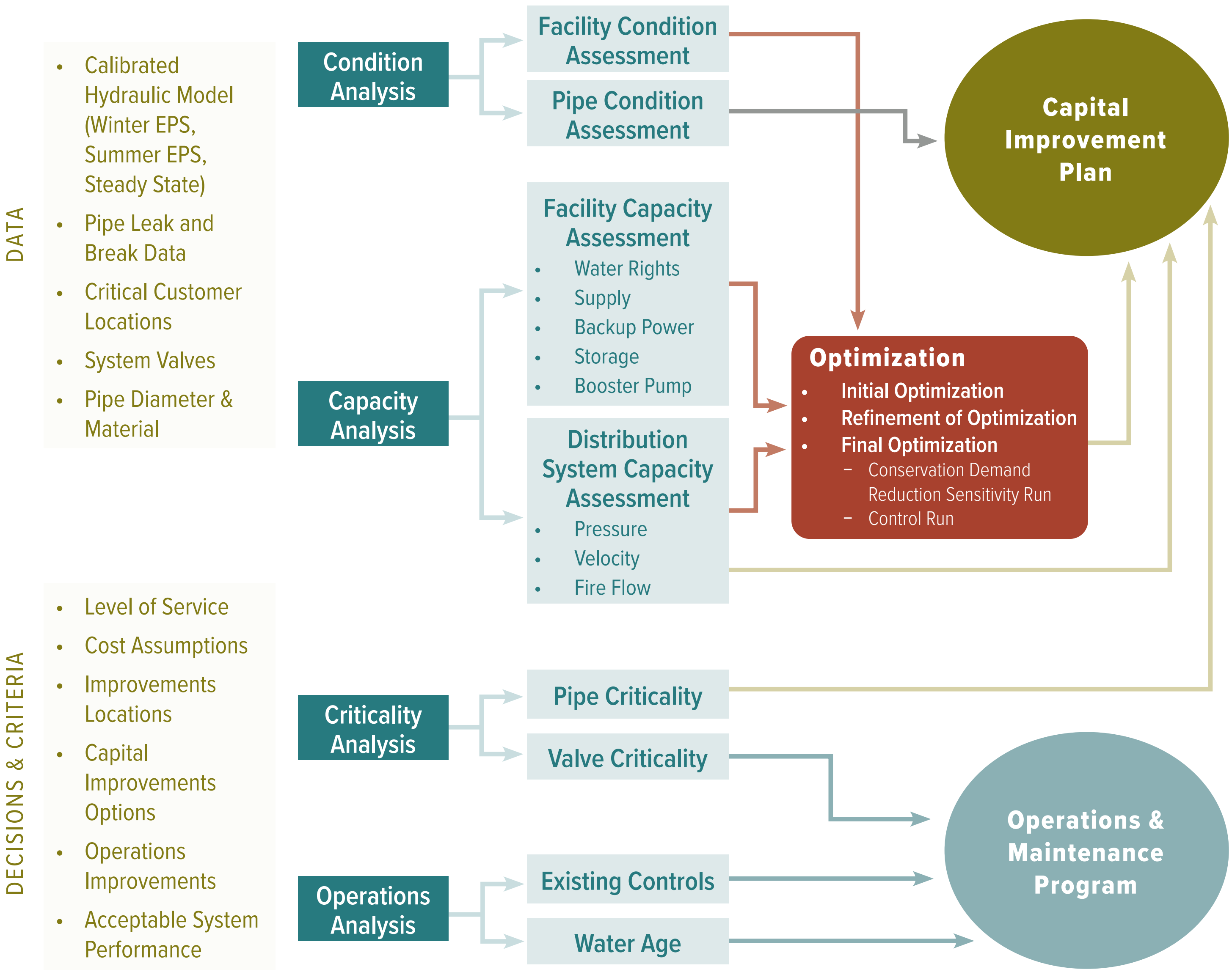
Notes:

1. For pressures greater than 80 psi, installation of individual pressure reducing valves is recommended for compliance with plumbing code.
2. Velocity criteria are primarily for designing pipe improvements and these criteria alone will not typically result in recommendations for existing system improvements.
3. For all fire flow evaluations, it is assumed that flow for only one fire at a time must be available.

SYSTEM ANALYSIS

The comprehensive system analysis of the City's water system included assessments of current infrastructure conditions, existing and future system capacity, asset criticality, and existing operations. Extensive hydraulic modeling and optimization were utilized, in addition to standard qualitative and quantitative assessments of the system. Overall, the City has a robust system that provides many ways to convey water. In addition, the value of having both surface and groundwater sources cannot be overstated from a resiliency standpoint. However, significant investment is needed to address deferred maintenance on the existing pipe and facilities to provide adequate fire flow and increase redundancy to continue service in the event of a critical asset failure.

Figure ES-4. *Comprehensive System Analysis Components*



STORAGE

Does storage volume cover operational, emergency, fire, & peak demands? Where is additional storage most needed?

WATER RIGHTS

Is the water rights portfolio & the reliably available water adequate?

SUPPLY

Where can existing surface water & groundwater supply serve & when does the system start to run short on supply?

PUMPING CAPACITY

For zones served by pump stations, is the station capacity adequate to meet typical & peak demand conditions?

BACKUP POWER

If power goes down, is there adequate backup power and emergency storage to meet minimum system needs?

DISTRIBUTION SYSTEM

Is the network sized to meet velocity & pressure level of service criteria? Where do pipes need to be replaced & new pipe added?

Condition Analysis Summary

The condition analysis focused on the existing system infrastructure to identify what improvements are required at each facility to extend its useful life and comply with current standards as well as develop a long-term pipe replacement program. Condition analysis and improvements are important to ensure investment in the existing infrastructure to maintain its performance and extend its useful life. The City system has over 440 miles of pipe, 20 active wells, six booster pump stations, and 15 storage facilities, in addition to the Water Filtration Facility and dozens of control valve vaults. These assets range in age, but the oldest facilities are approaching 100 years. The City conducts regular and proactive maintenance of the system. However, as the infrastructure ages and safety, structural, and security standards change over time, the maintenance required to repair and replace the existing infrastructure increases. Additionally, as the pipe network ages the City will need to increase the replacement rate and target undersized and substandard pipe to avoid pipe failures and maintain consistent service.

Capacity Analysis Summary

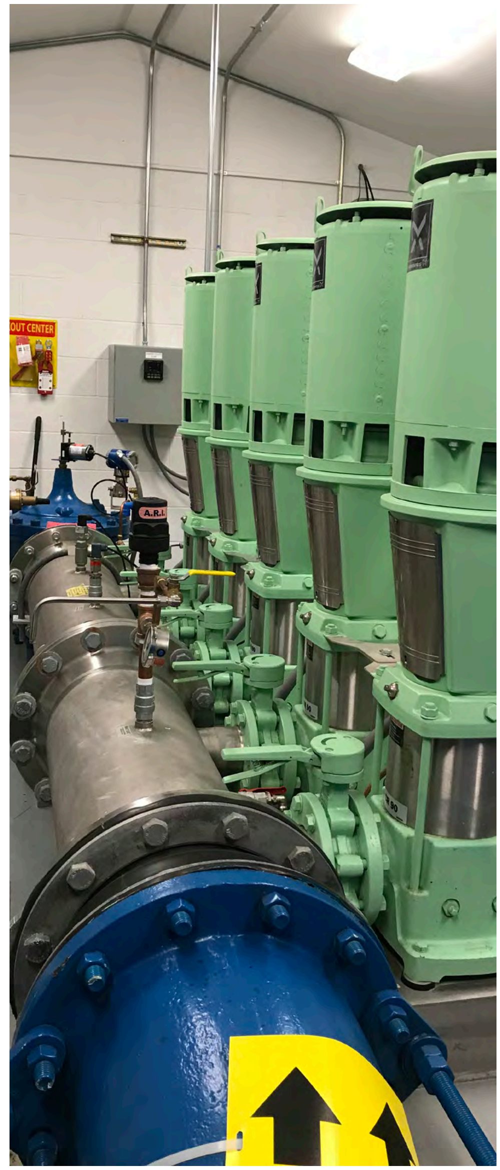
The capacity analysis identifies how much additional supply, storage volume, or pipe upsizing is required to meet Level of Service criteria for existing and future demand conditions. In addition to maintaining the existing pipe and facilities, the system also requires investment in new and upsized pipe to address existing fire flow, velocity, and pressure deficiencies, as well as future improvements to provide capacity for growth. No new well or storage facilities are needed to meet existing system capacity requirements, however, by the 10-year horizon, additional well supply with backup power and storage will be needed. Additional new wells and storage are required to meet 20-year projected demands. Facilities are needed to meet demand thresholds and if demands are lower than those projected (i.e., due to reductions from the conservation program) the number of new facilities will be reduced. The City has adequate water rights to meet 20-year demand projections but will need existing groundwater rights to be available at all facilities across the system to have operational flexibility and optimally utilize its wells.

Criticality Analysis Summary

The criticality analysis is focused on identifying critical infrastructure without redundancy or secondary service options that could significantly disrupt system operations and impact a substantial amount of demand or customers if it were out of service. The criticality analysis focused on determining which assets would have a significant impact or consequence if they were unavailable to serve the system due to failure, reduced capacity, or other unanticipated issues. Most areas of the system have redundancy, where two or more system elements (i.e., looped pipe, multiple PRV vaults, etc.) can provide water to the area and could continue to serve customers for a period if one component of the system was offline. So, although every asset in the system adds value and is important for long-term system performance, identifying the areas without multiple service options is critical to build a more resilient system that can maintain service in the event part of the system was offline.

The Water Filtration Facility capacity is critical to providing reliable supply to the system and the construction of a pretreatment facility is recommended in the near-term as a solution to provide resilience for a wildfire or other water quality event that might cause high total dissolved solids and/or sediment loads that without pretreatment could reduce or nearly eliminate the capacity of the Water Filtration Facility. Pipe improvements are recommended to address areas where single pipe breaks could result in a significant disruption to service, including the Awbrey and Outback transmission mains. Valve criticality can be used to inform ongoing maintenance programs to target locations to exercise existing valves and add new valves to the system to reduce how large an area must be isolated from service during maintenance.

Optimization Analysis Summary



The optimization analysis uses advanced hydraulic modeling techniques to evaluate and determine optimal improvements and modifications to the system to balance the cost of improvements with the improvements to Level of Service. The optimization included extensive setup of improvement alternatives, ranges of operational decisions, and establishing costs for system improvements and hydraulic penalties. The analysis included numerous refinements, resulting in millions of combinations of improvement options. The optimization process reduced the many inputs and iterations to a single recommended solution to meet 2040 projected demands. This solution includes over twenty miles of pipe projects, seven new wells, six new pressure reducing valves, and 14 million gallons of new storage. In addition, four existing storage reservoirs, one well, and one pump stations can be considered for decommissioning or used in standby or backup status with reduced investment in deferred and ongoing maintenance. As the City continues to expand its Conservation Program it should continually assess the impact on demands and the potential reduction in required facility improvements. In addition to the existing conservation programs, newly proposed conservation measures in the draft WMCP could eliminate the need for three of the new wells and 4 million gallons of the additional storage.

Operations Analysis Summary

The operations analysis indicates that the City is doing a good job of leveraging its existing facility operations to maximize surface water use and meet hydraulic requirements. Water age will continue to be an issue in portions of the system during low demand conditions and will improve as demand increases due to growth but can also be improved through operational modifications during low demand periods to circulate water in different ways throughout the system. Operational modifications to address water age should be balanced with increased energy costs due to pumping and reduced water cycling and operations costs associated with making operational changes, as well as any water quality concerns associated with reversing flow in pipes.

WATER QUALITY AND REGULATIONS

By State law (OAR 333-061-0036), the City is required to maintain an ongoing water quality testing and monitoring program. This program is administered by Oregon Health Authority and is comprised of monitoring the water supply for specified chemical and physical contaminants. Oregon Health Authority requires that the source water supply be monitored for the primary and secondary contaminants. Primary contaminant levels are not to be exceeded for health reasons, while secondary contaminants should not be exceeded to improve water color, taste, and odor.

The City is required to monitor inorganic compounds, volatile organic compounds, synthetic organic compounds, and radiological constituents. Distribution system water quality testing requirements include monitoring of many types of components including bacteriological, inorganic chemical, physical, disinfection by-products and disinfection residual, radionuclides, organic chemicals, and any other chemicals for which the state board of health determines maximum contaminant levels.

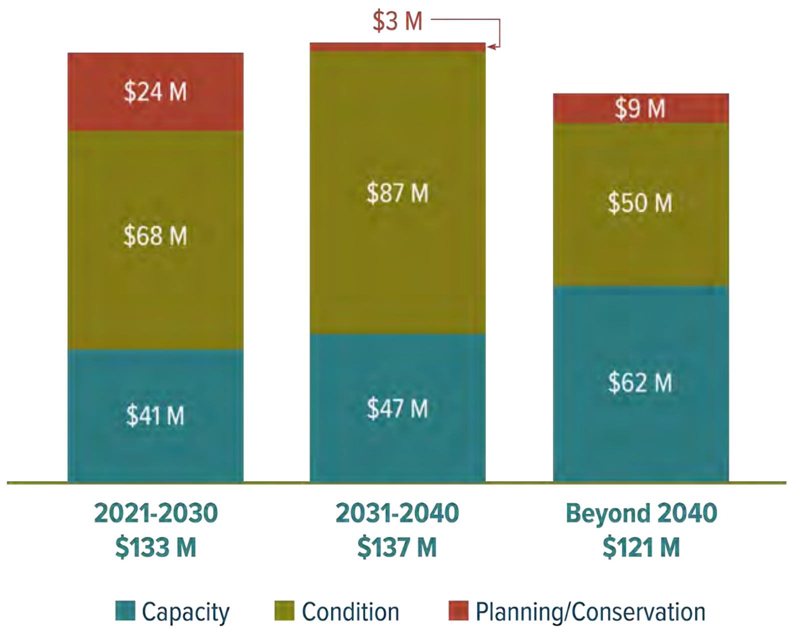
The City water system is of high quality in meeting or exceeding all water quality regulations. The most immediate change in the City's water quality sampling could be reaching the threshold of 70,000 people served, which will trigger an increase from 70 to 80 required total coliform samples per month.

CAPITAL IMPROVEMENT PLAN

The Capital Improvement Plan identifies projects to address existing system condition and hydraulic capacity deficiencies and serve future growth. It includes recommendations to provide capacity through the 20-year growth projections, which are based on historic demands. However, the improvement timeline extends beyond 20 years due to constraints in funding and staff resource availability to implement the plan. Recommended projects are divided across three timeframes, those within the 10-year, 20-year, and beyond 20-year horizon.

Some of the projects, such as new supply and storage may need to be accelerated to meet demands and other improvements deferred to keep within budget. Or projects may be delayed if demands are lower than projected, for example due to the continuing trend of decreasing per capita demands, or increased conservation program efforts. Projects should be evaluated annually through City reviews of growth in water demand, available budget, and where development is occurring.

Figure ES-5. *Capital Improvement Plan Cost by Timeframe (in 2020 Dollars)*



The projects prioritized over the next 10 years are intended to address facility condition and piping condition and capacity deficiencies. There are several condition and maintenance projects at current facilities that include the Awbrey Pump Station, Outback Reservoir 1, Awbrey Reservoir, Outback Wells 1 and 2, and the River Wells. Included in facility condition projects is the decommissioning of the Outback Contact Time Basin. The intent is that the contact time requirements can be met by Outback Reservoir 1 or the Outback Facility Plan will identify another configuration to meet contact time. Additionally, interior coating is slated for the Rock Bluff Reservoir and Outback Reservoir 2.

Also included in the 10-year horizon are some major piping projects including a new 30-inch Awbrey transmission main, and upsizing portions of piping along Newport Avenue. Many smaller pipe projects to address fire flow deficiencies and a yearly pipe replacement program are planned. Planning projects include updates to this Integrated Water System Master Plan and the Water Management and Conservation Plan, and an Outback Facility Plan along with additional improvements at Outback including pretreatment that would allow the City to continue operating in the event of a wildfire or other water quality event, incorporation of required federal security recommendations, and land acquisition for the recommended facilities. Future planning projects could include an analysis and possible implementation of hydropower generation that would work in conjunction with pretreatment. Implementation of the expanded conservation program and Standards and Specifications document are planned for the 2021-2030 timeframe as well.

Projects focus on replacing and installing new pipe to address distribution system deficiencies and work towards a greater annual pipe replacement rate to attain a program more consistent with expected pipe replacement life cycles. Considerable investment in existing infrastructure will be required at most existing facilities to address deferred maintenance and extend useful life. New facilities will serve growth and be required as demands increase. The total Capital Improvement Plan cost is approximately $391 million (in 2020 dollars), with $133 million scheduled for 2021-2030, $137 million in years 2031-2040 and $121 million beyond 2040.

FINANCIAL PLAN

The financial plan was prepared by FCS Group to determine the funding requirements to provide water service to the City customers and demonstrate the financial plan to fund ongoing system operations and the escalated costs of the recommended Capital Improvement Plan. The financial analysis demonstrates the ability of the water utility to maintain sufficient funds to construct, operate, and manage the system on a continuing basis based on a 30-year implementation timeframe of the CIP.

The water utility is responsible for funding all of its costs and the primary funding source is derived from ongoing monthly charges for service (or user rates), with additional revenues coming from system development charges and other miscellaneous revenue. The City controls the level of user charges and, subject to the City Council, can adjust user charges as needed to meet financial objectives.

The proposed financial forecast will support $164 million (escalated) of capital expenditures within the 10-year planning period and $581 million (escalated) to fund the full Capital Improvement Plan within a 30-year period. The financial forecast indicates that the utility is currently covering all financial obligations under existing rates, however, to fund the Capital Improvement Plan, rates will need to increase annually. The financial plan proposes the following rate increases and debt issuances during the FY 2021 through FY 2030 period to satisfy the identified future obligations of the utility. Although the financial plan is completed for a 30-year time horizon, the rate strategy focuses on the shorter-term planning period of FY 2021 through FY 2030.

FY 2021 - FY 2030 Proposed Annual Rate Increases:

- 3.0 percent in FY 2022 – FY 2023
- 4.0 percent from FY 2024 – FY 2026
- 4.5 percent from FY 2027– FY 2030

FY 2021 - FY 2030 Proposed New Revenue Bond Insurance:

- $23.9M in FY 2026
- $33.9M in FY 2029
- Annual new debt service payments are forecast to increase from $2.0 million with the first issuance to $4.7 million by the second new debt issuance. Including this new debt, total debt service will increase from $5.6 million in FY 2021 to $8.9 million by FY 2030.

Table ES-2 shows a summary of the projected Undesignated Operating Reserve and residual Capital Reserve ending balances through FY 2030 based on the rate forecasts. The operating fund is maintained at a minimum of three months of O&M expenses, and the capital reserve balance fluctuates depending on the level of CIP funded; however, it never falls below the capital contingency target of $5.0 million.

Table ES-2 Ending Reserve Balance Summary ($ in millions)

ENDING RESERVE BALANCES	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Undesignated Operating	$3.2	$3.6	$3.7	$4.2	$4.2	$4.6	$4.7	$4.9	$5.2	$5.2
Capital	$57.3	$53.2	$47.8	$37.1	$14.7	$20.5	$16.1	$15.3	$39.7	$25.5
Total	**$60.5**	**$56.8**	**$51.5**	**$41.3**	**$18.9**	**$25.1**	**$20.8**	**$20.2**	**$44.9**	**$30.7**

The analysis performed assumes revenue growth and expense inflationary factors. If the forecasting factors change significantly, the existing rate strategy may need to be updated and revised. The City will continue to annually review and update the key underlying assumptions and revisit the proposed rates to ensure that adequate revenues are collected to support the Capital Improvement Plan and meet the City's total financial obligations.

SUMMARY

This iWSMP constituted a significant investment of time and resources for City staff and includes a comprehensive analysis of the water system integrated to incorporate growth, Level of Service, capacity, conservation, planning, and other considerations for the existing and future system needs. It is the City's first Integrated Water System Master Plan to include a full condition assessment of the existing facilities and pipe replacement program. It utilized advanced optimization modeling and the Capital Improvement Plan and Financial Plan are intended to improve the system over the next 30 years at a sustainable pace that addresses ongoing maintenance and growth requirements. The Integrated Water System Master Plan provides a valuable resource for how to continue providing quality water to the system's customers.

As a result of this Integrated Water System Master Plan, the following recommendations are made:

- Continue to operate and improve the system to provide reliable, high quality water to customers.
- Make significant investments to maintain existing facilities and add pretreatment to the surface water supply.
- Develop a formal replacement program and continue to accelerate replacement rates.
- Construct new supply, storage, and pipe as the system approaches identified demand thresholds.
- Update planning regularly including an Outback Facility Plan, the Integrated Water System Master Plan and the Water Management and Conservation Plan.
- Implement additional conservation measures.
- Evaluate and update the Financial Plan annually.

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Section 1

Section 1

Existing Water System

1.1 Introduction

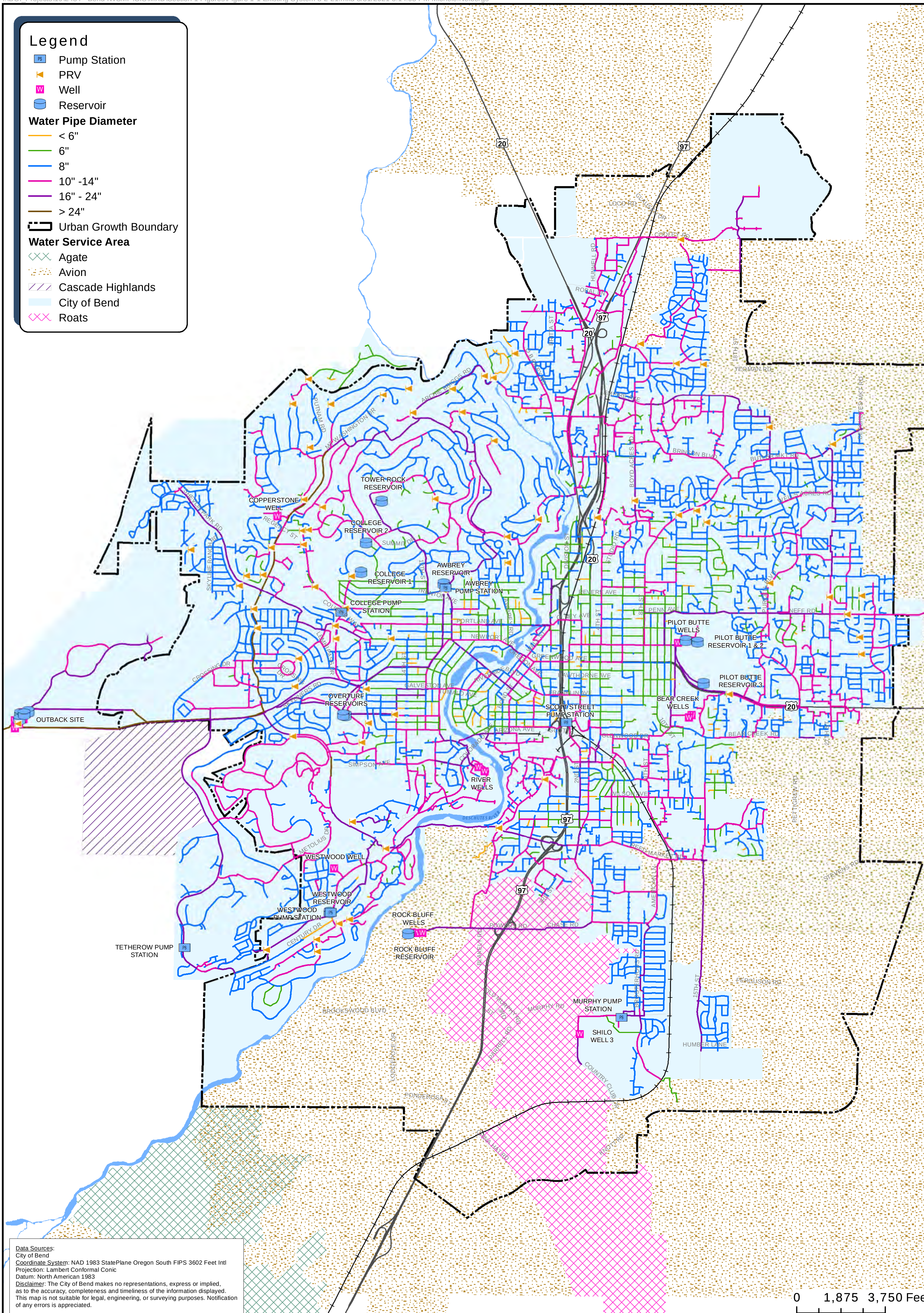
The City of Bend (City) is located east of the Cascade Mountains in Central Oregon with a population of approximately 90,000 people. The climate is considered high desert typically known for mild winters and warm, dry summers. The City's water supply, transmission and distribution system is responsible for the delivery of treated water to approximately 25,500 service connections to residential, commercial, and industrial customers. The City's existing Urban Growth Boundary (UGB) is served by three primary water suppliers, the City, Avion Water Company (Avion), and Roats Water System (Roats). Both Avion and Roats are rate and service regulated utilities under the Oregon Public Utility Commission. The City also serves water to the Tetherow destination resort, the Westside Transect area including the Tree Farm rural residential development and Awbrey Meadows, which are located outside the UGB. The study area for this master plan includes the area within the UGB served by the City and the three areas served outside the UGB. This report excludes the water infrastructure at the City Airport which is owned and operated by the City outside of the UGB and not connected to the City system.

The City has the capability to supply treated water to customers by utilizing groundwater and surface water. The groundwater is supplied by the Deschutes Regional Aquifer and is primarily used to supply peak demands. The City's existing surface water system begins in the Bend Municipal Watershed (BMW) established by agreement with the United States Forest Service (USFS) in 1926. It includes the Prowell Springs Diversion and a surface water intake facility. Surface water is the primary source year-round. Both sources are known to have excellent water quality. The City's existing water system consists of a surface water intake facility, a water filtration facility, 8 groundwater facilities consisting of 20 active wells, 15 finished water storage reservoirs, 6 active booster pump stations, approximately 440 miles of transmission and distribution mains, nearly 10 miles of raw water pipeline, and associated appurtenances including various valves, hydrants, and meters. The system includes six primary pressure zones with an additional twenty-three subzones.

The current UGB, City and private utility service areas, and existing City water system are in Figure 1-1.

1.2 Inventory of Existing Infrastructure

This section provides a description and inventory of the City's existing raw and treated water system facilities.



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City of Bend
Integrated Water System Master Plan

Figure 1-1
Existing System

1.2.1 Sources

The City currently has dual supply sources from a combination of surface water and groundwater to supply customers within its service area, each with associated water rights, infrastructure, and capacity. The City's Water Filtration Facility (WFF) is located west of the City at a location identified as the Outback Site. The site also has seven active groundwater wells. Other groundwater sources are located throughout the service area.

1.2.1.1 Water Rights

The City holds numerous surface water and groundwater rights which are in **Table 1-1**. The City holds 36.1 cubic feet per second (cfs), equivalent to 23.3 million gallons per day (mgd) of surface water rights and 68.2 cfs (44.1 mgd) in groundwater rights. The availability and restrictions on these rights is included in the discussion of each supply source.

Table 1-1|Water Rights

Source Type	Certificate or Permit	Priority Date	Authorized Rate (cfs)	Maximum Daily Volume (mgd)
Groundwater	Cert. 85414	9/7/1900	10	6.46
	Cert. 94100	11/8/1968	7.75	5.01
	Cert. 68702	10/13/1971	0.9	0.58
	Cert. 85415	10/13/1971	2.7	1.74
	Cert. 85412	10/13/1971	7.57	4.89
	Cert. 85413	10/13/1971	4.87	3.15
	Cert. 85411	12/22/1978	1.51	0.97
	Cert. 85559	6/30/1989	4.16	2.69
	Cert. 87416	5/1/1991	0.94	0.61
	Permit G-11379	6/30/1989	3.84	1.54
	Permit G-18123	8/27/1992	12	7.76
	Permit G-18124	8/27/1992	12	7.76
Surface Water	85526	Unrestricted	6.0	11.76[1]
	31411	8/5/1900 9/1900 6/1/1907	2.0 4.5 0.02	
	31665	9/1900 4/28/1905 6/1/1907	1.31 0.19 1.10	
	B-112	9/1900 6/1/1907 10/29/1913	1.62 0.39 Varies by time of year (2.43-5.99)	
	85713	12/12/1983	12.2	
	S-49823	12/12/1983	2.8	

Note:
1. The City's surface water diversion is currently limited to a maximum of 18.2 cfs (11.76 mgd) by Special Use Permit BEN1178 issued by the United States Forest Service.

1.2.1.2 Surface Water Supply

A 1926 agreement between the USFS and the City created the BMW, and subsequent USFS plans recognize and designate municipal use as the highest and best use of the watershed. The combined flows of natural springs (the Prowell Springs Diversion) and Bridge Creek in the BMW are diverted approximately 11.5 miles west of the City limits at the Heidi Lansdowne Intake Facility located on Bridge Creek near the confluence with Tumalo Creek. The BMW lies within the Deschutes National Forest, which is managed by the USFS. In addition, the USFS has issued several special use permits to the City that require significant environmental analysis and provide clear communication channels between signatories, control human activity, and protect water quality through regulations, restrictions, and ongoing monitoring. Raw water is routed from the Heidi Lansdowne Intake Facility on Bridge Creek to the City's Outback Site through approximately 9.5 miles of 30- and 36-inch transmission pipeline constructed in 2014 and 2015.

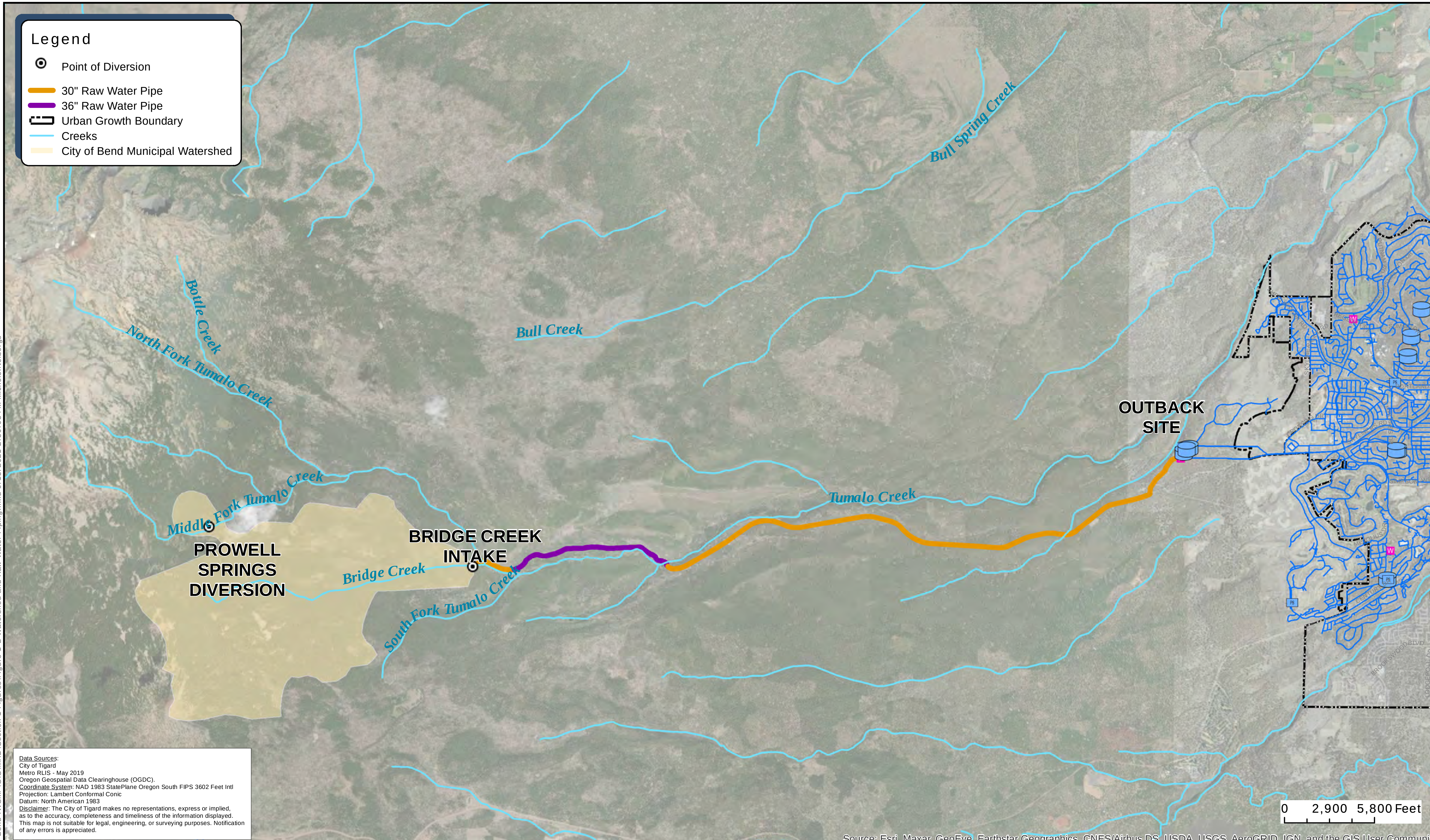
While the maximum rate of the City's combined surface water rights is 36.1 cfs, due to seasonal limitations, sharing of priority dates with other water users on Tumalo Creek, and seasonal low flows, the reliable rate of the City's water rights is significantly lower than 36.1 cfs. Furthermore, under the terms of the City's Special Use Permit authorizing operation of the surface water system on USFS lands, the City's diversion is currently limited to 18.2 cfs (11.76 mgd). Figure 1-2 shows a layout of the raw surface water supply system.

1.2.1.3 Groundwater Supply

The City currently has eight groundwater production sites that include 20 active wells located throughout the service area and at the Outback Site. Table 1-2 summarizes the groundwater production facilities, their approximate capacity in gallons per minute (gpm), and the pressure zones that they serve. In 2002, the Oregon Water Resources Commission adopted administrative rules requiring mitigation for the impacts of pumping under new groundwater permits (OAR 690-507). Two of the City's permits for groundwater use (G-18123 and G-18124) require the City to provide groundwater mitigation as part of the Deschutes Basin Groundwater Mitigation Program, and the City has an approved incremental groundwater mitigation plan for each permit.

1.2.2 Treatment

In 2014, the City constructed the WFF located at the Outback Site to filter and disinfect the surface water prior to entry into the distribution system. The WFF has 4 primary membrane filters each with approximately 3,300 gpm capacity for a total capacity of 13,200 gpm and one backwash recovery rack with approximately 1,200 gpm capacity. Normal operations utilize all five filter racks. After filtration, the source water is disinfected using a chlorine solution and flows through the Contact Time (CT) Basin, a baffled reservoir designed to increase contact time and ensure proper mixing with the disinfectant. The groundwater supply is also disinfected using chlorine at each of the eight well field sites.



I:\BOI_Projects\19\2484 - Bend IWSMP\GIS\MXD\Section 1 Figures\Figure 1-2 Watershed and Raw Water Piping.mxd 9/13/2021 2:56:03 PM Michele.Neibergs

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City of Bend
Integrated Water System Master Plan

Figure 1-2
Watershed and
Raw Water Piping

September 2021

19-2484

Table 1-2 | Existing Groundwater Facilities

Well	Status	Zone Served	Flow Rate[1] (gpm)	Facility Floor Elevation (feet)	Groundwater Surface Elevation (feet)
Bear Creek Well 1	Active	4B	1,050	3,656	3,027
Bear Creek Well 2	Active	4B	1,100	3,656	3,004
Copperstone Well	Active	3	950	3,810	3,300
Outback Well 1	Active	3	800	3,981	3,499
Outback Well 2	Active	3	950	3,981	3,499
Outback Well 3	Active	3	1,050	3,981	3,504
Outback Well 4	Active	3	1,150	3,981	3,503
Outback Well 5	Active	3	1,050	3,981	3,501
Outback Well 6	Active	3	1,100	3,981	3,501
Outback Well 7	Active	3	1,300	3,981	3,497
Pilot Butte Well 1	Active	5	750	3,754	2,969
Pilot Butte Well 2	Inactive	5	-	-	-
Pilot Butte Well 3	Active	5	900	3,781	3,026
Pilot Butte Well 4	Active	5	1,150	3,712	3,014
River Well 1	Active	5	1,800	3,606	3,045
River Well 2	Active	5	1,900	3,607	3,365
Rock Bluff Well 1	Active	4B	750	3,834	3,410
Rock Bluff Well 2	Active	4B	800	3,834	3,438
Rock Bluff Well 3	Active	4B	800	3,830	3,437
Shilo Well 1	Inactive	3	-	-	-
Shilo Well 2	Inactive	3	-	-	-
Shilo Well 3	Active	4B	1,200	3,764	3,422
Westwood Well	Active	4A	700	3,761	3,482

Note:
1. Flow rates were determined from available data sources including typical flow rates in SCADA data, GIS recorded data, model results, and pump curves to the nearest 50 gallons.

1.2.3 Treated Water Storage

The City has a total of 15 storage reservoirs located throughout the distribution system with a total capacity of approximately 30 million gallons (MG). Three of the reservoirs are configured in series at the Outback Site with the CT Basin, Outback 1, and Outback 2 each filling in that order from the WFF so that Outback 2 provides the direct storage to the distribution system. A summary of the existing storage reservoirs is provided in **Table 1-3**.

Table 1–3 | Existing Storage Reservoirs

Reservoir	Reservoir Type	Capacity (MG)	Overflow Height (feet)	Floor Elevation (feet)	Diameter (feet)	Pressure Zone Directly Served
Awbrey	Concrete	5.00	20.5	3,775	206.3	5
College 1	Welded Steel	0.50	23.3	4,096	60.8	2
College 2	Welded Steel	1.00	31.5	4,088	74.1	2
Outback CT Basin	Bolted Steel	1.50	31.0	3,980	91.5	3 (through Outback 2)
Outback 1	Bolted Steel	2.00	35.1	3,976	98.6	3 (through Outback 2)
Outback 2	Welded Steel	3.00	35.4	3,976	120.8	3
Outback 3	Welded Steel	3.63	29.4	3,982	146	3
Overturf East	Riveted Steel	1.45	28.0	3,843	94	4A
Overturf West	Riveted Steel	1.45	28.0	3,843	94	4A
Pilot Butte 1	Welded Steel	1.50	31.5	3,750	89.3	5
Pilot Butte 2	Welded Steel	1.00	39.5	3,840	65.2	4B
Pilot Butte 3	Concrete	5.00	24.3	3,757	188	5
Rock Bluff 1	Welded Steel	1.54	39.0	3,840	82	4B
Tower Rock	Welded Steel	1.00	31.0	4,213	74	1
Westwood	Welded Steel	0.50	31.5	3,845	53.3	4

1.2.4 Booster Pump Stations

The City's distribution system currently has six active booster pump stations. The pump stations' main functionality is to boost water from the lower pressure zones to the higher zones. The stations have varied means of operational controls (i.e., reservoir levels, discharge pressures, manual operation, etc.). **Table 1-4** provides a detailed list of the existing booster pump stations including their approximate flow rates, motor horsepower and the suction and discharge pressure zones.

Table 1-4 | Existing Booster Pump Stations

Station	Elevation (feet)	Pump	VFD	Motor Horsepower (hp)	Zone From-To	Flow Rate[1] (gpm)
Awbrey	3,778	Pump 1	No	200	5 to 1	1,200
		Pump 2	No	350	5 to 1	1,200
		Pump 3	No	350	5 to 1	1,200
College	3,723	Pump 1	No	50	3 to 2	1,100
		Pump 2	No	50	3 to 2	1,100
Murphy Road	3,746	Pump 1	Yes	25	4B to 3D	300
		Pump 2	Yes	25	4B to 3D	300
		Pump 3	Yes	25	4B to 3D	300
		Pump 4	Yes	25	4B to 3D	300
		Pump 5	Yes	25	4B to 3D	300
Scott Street	3,649	Pump 1	No	50	5 to 4B	1,000
		Pump 2	No	50	5 to 4B	1,000
		Pump 3	No	50	5 to 4B	1,000
Tetherow	3,877	Jockey	Yes	7.5	3 to 2A	120
		Pump 1	Yes	15	3 to 2A	300
		Pump 2	Yes	60	3 to 2A	700
		Pump 3	Yes	60	3 to 2A	700
		Pump 4	Yes	60	3 to 2A	700
		Pump 5	Yes	60	3 to 2A	700
		Pump 6	Yes	60	3 to 2A	700
Westwood	3,836	Pump 1	No	20	4A to 3C	275
		Pump 2	No	40	4A to 3C	550
		Pump 3	No	75	4A to 3C	900
		Pump 4	No	40	4A to 3C	550

Note:
1. Flow rates were determined from available data sources including typical flow rates in SCADA data, GIS recorded data, model results, and pump curves.

1.2.5 Control Valves

Control valves play an important role in the movement of water through the City's distribution system. Many pressure reducing valves (PRVs) within the system supply the subzones. The City standard is to provide a pressure reducing station that includes both a small (bypass) valve that supplies flow under typical flows and a larger (main) valve that provides flow under emergency conditions such as fire flows. The bypass valve will have a higher pressure setting than the main valve, which may be set 3 to 10 pounds per square inch (psi) lower. In most cases each pressure zone will be served by at least two PRV stations, though in the case of some smaller zones, a single station provides supply.

In addition, there are several important control valves that influence the transmission of water across primary zones in the system. These include flow control and level valves (FCLV) into Awbrey and Overturf Reservoirs (AWBREY_FCV and WAPRV086A), the Athletic Club PRV (WAPRV038B) that conveys water from Zone 3 to 4B, and the flow control valve from Zone 4B to Zone 5 (HWY20_FLOW) referred to as the "Highway 20 Valve." The FCLV at Outback into the CT Basin (CTBASIN_CONTROLVALVE) controls flow from the WFF and then a FCV (WAPRV074A) controls the supply of surface water into the system out of the Outback 2 Reservoir. The PRV (WAPRV075A) at Outback Reservoir 3 currently serves to supplement surface water supply from the Outback Wells as needed based on pressures in Zone 3. The settings of each of these valves can be remotely adjusted through Supervisory Control and Data Acquisition (SCADA) by operations staff as needed and are changed throughout the year to adjust to demand conditions or supply and operations preferences. Although the setting on these valves is adjusted seasonally based on demand, a representative range of setpoints are shown in **Table 1-5**.

Table 1-5 | System Valves

Valve	Valve Type	Elevation (feet)	Diameter (inches)	From Zone	To Zone	Setting (gpm or psi)
CTBASIN_CONTROL VALVE	FCV	3,979	12	Raw Water	Outback	8,169
WAPRV025A	PRV	4,069	2	1	2	16
WAPRV025B	PRV	4,069	8	1	2	14
WAPRV026A	PRV	4,050	2	1	2	24
WAPRV026B	PRV	4,050	6	1	2	22
WAPRV002A	PRV	3,750	2	2	3	90
WAPRV002B	PRV	3,750	8	2	3	95
WAPRV020A	PRV	3,788	3	1	3	77
WAPRV020B	PRV	3,788	10	1	3	72
WAPRV032A	PRV	3,885	2	2	3	37
WAPRV032B	PRV	3,885	6	2	3	32
WAPRV045A	PRV	3,835	10	2	3	59
WAPRV074A	FCV	3,976	24	Outback	3	8,900
WAPRV075A	PRV	3,980	24	Outback	3	7
AWBREY_FCV	FCV	3,783	12	3	5	4,500
HWY20_FLOW	FCV	3,675	12	4B	5	850
WAPRV015A	PRV	3,666	2	4B	5	47
WAPRV015B	PRV	3,666	8	4B	5	43
WAPRV024A	PRV	3,639	2	4A	5	62
WAPRV024B	PRV	3,639	6	4A	5	57
WAPRV036A	PRV	3,641	6	4A	5	58
WAPRV036B	PRV	3,641	16	4A	5	53
WAPRV037A	PRV	3,641	2	4A	5	44
WAPRV037B	PRV	3,641	6	4A	5	39
WAPRV039A	PRV	3,654	6	4B	5	52

Valve	Valve Type	Elevation (feet)	Diameter (inches)	From Zone	To Zone	Setting (gpm or psi)
WAPRV039B	PRV	3,654	10	4B	5	48
WAPRV057A	PRV	3,642	3	4B	5	58
WAPRV057B	PRV	3,642	10	4B	5	54
WAPRV005A	PRV	3,543	4	5	6	63
WAPRV005B	PRV	3,543	8	5	6	59
WAPRV007A	PRV	3,553	4	5	6	58
WAPRV007B	PRV	3,553	12	5	6	54
WAPRV008A	PRV	3,542	2	5	6	63
WAPRV008B	PRV	3,542	6	5	6	59
WAPRV009A	PRV	3,570	4	5	6	51
WAPRV009B	PRV	3,570	14	5	6	47
WAPRV011A	PRV	3,572	12	5	6	50
WAPRV012A	PRV	3,530	2	5	6	69
WAPRV012B	PRV	3,530	8	5	6	65
WAPRV013A	PRV	3,574	2	5	6	49
WAPRV013B	PRV	3,574	12	5	6	45
WAPRV018A	PRV	3,609	3	4A	6	34
WAPRV018B	PRV	3,609	8	4A	6	30
WAPRV041A	PRV	3,580	6	5D	6	47
WAPRV041B	PRV	3,580	12	5D	6	43
TETHEROW_PS_PSV	PSV	3,877	12	3	2A	86
WAPRV031A	PRV	3,831	2	2	3A	47
WAPRV031B	PRV	3,831	6	2	3A	42
WAPRV049A	PRV	3,817	10	2	3A	45
WAPRV049B	PRV	3,817	10	2	3A	45
WAPRV003A	PRV	3,838	2	2	3B	75
WAPRV003B	PRV	3,838	8	2	3B	73
WAPRV073A	PRV	3,865	2	2A	3C	65
WAPRV073B	PRV	3,865	8	2A	3C	60
WAPRV019A	PRV	3,728	2	3	4A	57
WAPRV019B	PRV	3,728	8	3	4A	52
WAPRV022A	PRV	3,808	2	3	4A	13
WAPRV022B	PRV	3,808	10	3	4A	8
WAPRV035A	PRV	3,760	2	3	4A	30
WAPRV035B	PRV	3,760	6	3	4A	25
WAPRV043A	PRV	3,758	2	3	4A	43
WAPRV043B	PRV	3,758	6	3	4A	39
WAPRV047A	PRV	3,726	3	3	4A	60
WAPRV047B	PRV	3,726	12	3	4A	55
WAPRV050A	PRV	3,761	3	3	4A	43
WAPRV050B	PRV	3,761	8	3	4A	38
WAPRV052A	PRV	3,730	3	3	4A	58

Valve	Valve Type	Elevation (feet)	Diameter (inches)	From Zone	To Zone	Setting (gpm or psi)
WAPRV052B	PRV	3,730	8	3	4A	53
WAPRV053A	PRV	3,743	3	3	4A	53
WAPRV053B	PRV	3,743	8	3	4A	47
WAPRV056A	PRV	3,667	3	3	4A	83
WAPRV056B	PRV	3,667	8	3	4A	78
WAPRV065A	PRV	3,730	6	3	4A	56
WAPRV065B	PRV	3,730	10	3	4A	54
WAPRV076A	PRV	3,735	6	3	4A	56
WAPRV076B	PRV	3,735	10	3	4A	51
WAPRV082A	PRV	3,750	3	3	4A	49
WAPRV082B	PRV	3,750	8	3	4A	44
WAPRV086A	FCV	3,844	6	Outback	4A	750
WAPRV086B	FCV	3,844	12	Outback	4A	1,500
WESTWOODPS_PSV	PSV	3,836	12	3C	4A	68
MURPHY_PRV	PSV	3,749	12	3D	4B	116
WAPRV038A	PRV	3,712	4	3	4B	71
WAPRV038B	PRV	3,712	12	3	4B	68
WAPRV059A	PRV	3,758	2	3	4C	53
WAPRV059B	PRV	3,758	6	3	4C	50
WAPRV084A	PRV	3,804	2	3	4C	42
WAPRV084B	PRV	3,805	6	3	4C	37
WAPRV046A	PRV	3,820	3	3	4D	61
WAPRV046B	PRV	3,820	8	3	4D	58
WAPRV001A	PRV	3,739	2	3	4E	52
WAPRV001B	PRV	3,739	8	3	4E	48
WAPRV067A	PRV	3,744	3	3	4E	49
WAPRV067B	PRV	3,744	8	3	4E	47
WAPRV044A	PRV	3,764	3	3	4F	47
WAPRV044B	PRV	3,764	10	3	4F	43
WAPRV027A	PRV	3,798	2	3C	4H	53
WAPRV028A	PRV	3,769	4	3C	4H	60
WAPRV029A	PRV	3,774	6	3C	4H	61
WAPRV064A	PRV	3,760	2	3C	4I	53
WAPRV064B	PRV	3,760	8	3C	4I	48
WAPRV021A	PRV	3,753	2	3	4K	68
WAPRV021B	PRV	3,753	8	3	4K	63
WAPRV023A	PRV	3,751	2	4D	5A	62
WAPRV062A	PRV	3,751	6	4D	5A	64
WAPRV030A	PRV	3,643	2	4E	5B	35
WAPRV030B	PRV	3,643	6	4E	5B	30
WAPRV034A	PRV	3,612	2	4E	5B	48
WAPRV034B	PRV	3,612	8	4E	5B	43

Valve	Valve Type	Elevation (feet)	Diameter (inches)	From Zone	To Zone	Setting (gpm or psi)
WAPRV077A	PRV	3,651	3	4E	5C	53
WAPRV077B	PRV	3,651	8	4E	5C	48
WAPRV078A	PRV	3,644	3	4E	5C	56
WAPRV078B	PRV	3,644	8	4E	5C	51
WAPRV040A	PRV	3,623	4	4F	5D	62
WAPRV040B	PRV	3,623	12	4F	5D	57
WAPRV040C	PRV	3,623	2	4F	5D	52
WAPRV014A	PRV	3,592	2	5	6A	57
WAPRV014B	PRV	3,592	12	5	6A	52
WAPRV016A	PRV	3,568	2	5	6A	67
WAPRV016B	PRV	3,568	6	5	6A	62
WAPRV017A	PRV	3,590	2	5	6A	57
WAPRV017B	PRV	3,590	6	5	6A	52
WAPRV048A	PRV	3,596	2	5	6A	55
WAPRV048B	PRV	3,596	6	5	6A	50
WAPRV033A	PRV	3,470	2	5B	6B	66
WAPRV033B	PRV	3,470	6	5B	6B	61
WAPRV004A	PRV	3,486	3	6	7A	59
WAPRV004B	PRV	3,486	10	6	7A	54
WAPRV054A	PRV	3,483	3	6	7A	60
WAPRV054B	PRV	3,483	8	6	7A	55
WAPRV061A	PRV	3,460	3	6	7A	70
WAPRV061B	PRV	3,460	8	6	7A	66
WAPRV080A	PRV	3,482	3	6	7A	61
WAPRV080B	PRV	3,482	8	6	7A	57
WAPRV006A	PRV	3,481	2	6	7B	62
WAPRV006B	PRV	3,481	6	6	7B	57
WAPRV058A	PRV	3,486	2	6	7C	57
WAPRV058B	PRV	3,486	6	6	7C	52
WAPRV066A	PRV	3,501	2	6	7D	47
WAPRV066B	PRV	3,501	6	6	7D	42
WAPRV079A	PRV	3,493	2	6	7D	56
WAPRV079B	PRV	3,493	6	6	7D	51

1.2.6 Pressure Zones

The City's distribution system currently operates with six primary (defined as those with storage facilities) pressure zones with numerous subzones served through PRVs or booster pump stations. Pressure zone boundaries are generally defined to maintain a desired range of service pressures based on ground topography and designated by overflow elevations of storage reservoirs or the discharge hydraulic grades of PRVs or booster pump facilities serving the area. **Table 1-6** provides details pertaining to the primary pressure zones with more extensive discussion for each zone provided below. Each pressure zone with the infrastructure it contains, and the system hydraulic grade line (HGL) configuration is illustrated in **Figure 1-3**. Additionally, **Figure 1-4** displays the pressure zone boundaries and pipe network by primary pressure zone.

Table 1–6 | Existing Primary Pressure Zones

Pressure Zone	Approximate Existing Service Elevation Range (feet)	Storage Reservoir Serving Zone	Controlling Overflow Elevation (feet)
1	3,967-4,167	Tower	4,244
2	3,828-4,017	College 1 and 2	4,120
3	3,675-3,969	Outback 2 & 3	4,011
4A	3,638-3,768	Overturf East & West, Westwood	3,872
4B	3,609-3,779	Rock Bluff & Pilot Butte 2	3,880
5	3,534-3,696	Awbrey & Pilot Butte 1 and 3	3,796

1.2.6.1 Pressure Zone 1

Pressure Zone 1 ranges in service elevation from approximately 3,967 to 4,167 feet. The HGL of the zone is set by the Tower Rock Reservoir. Tower Rock Reservoir has an overflow elevation of 4,244 feet and water supply is provided by the Awbrey Booster Pump Station. Several of the customers located in this service area at higher elevations have installed individual booster pump stations to increase in-home pressures to an adequate level.

1.2.6.2 Pressure Zone 2

Pressure Zone 2 ranges in service elevations from 3,828 to 4,017 feet. Supply into Zone 2 is from the College Booster Pump Station that pumps from Pressure Zone 3 and from several PRV connections from Pressure Zone 1. The HGL of the zone is established by College Reservoirs 1 and 2, with overflows at 4,120 feet.

1.2.6.3 Pressure Zone 3

Pressure Zone 3 serves customers with ground elevations roughly between 3,675 and 3,969 feet. The high elevation customers are primarily near the Outback Site and have service line booster pumps to increase pressures. The minimum HGL, set at the Outback 3 Reservoir from the Outback Site is limited by the suction pressures required on these service line boosters. Supply is provided primarily from the Outback 2 Reservoir through a flow control valve regulating surface water into the system and from the Outback 3 Reservoir through a PRV from the groundwater sources at Outback. Additional supply is provided from the Copperstone well located within Zone 3.

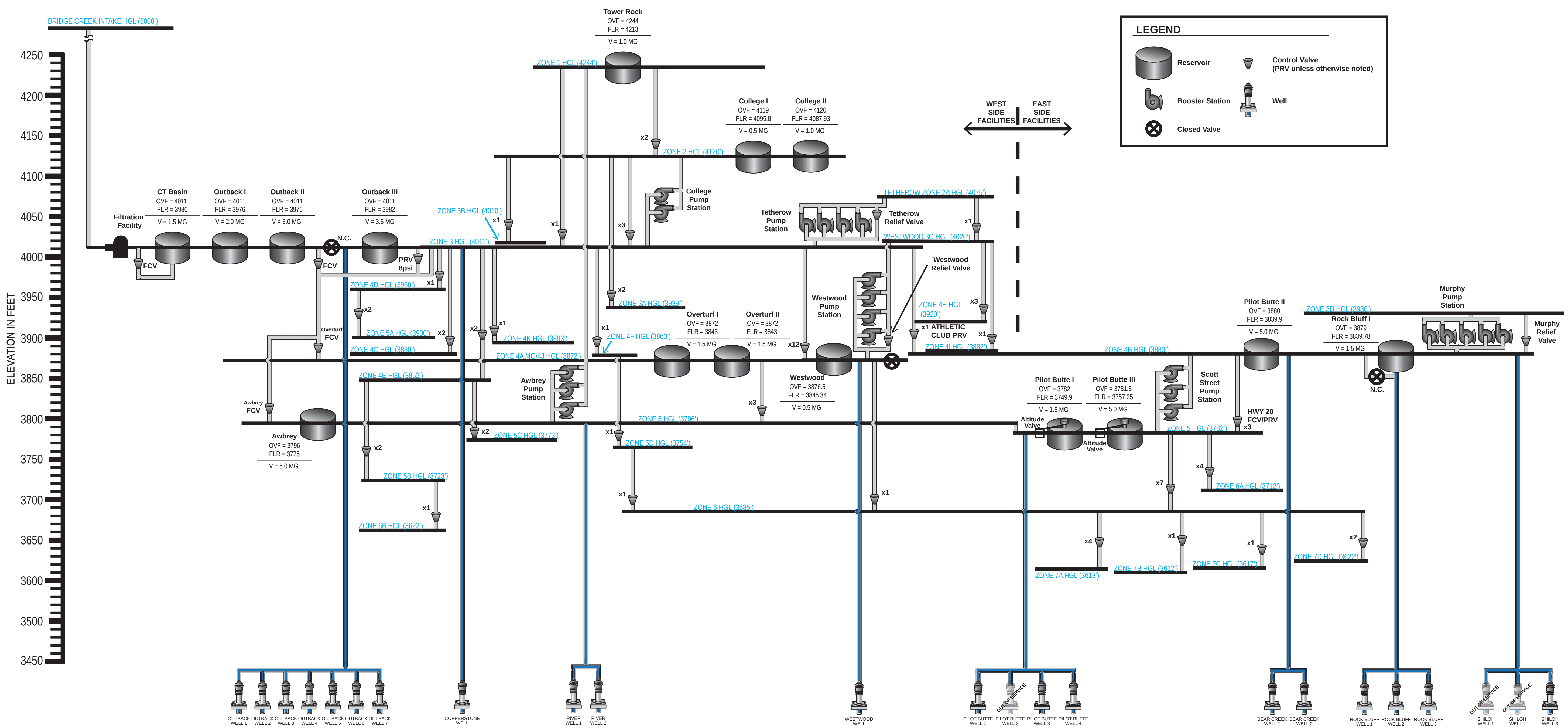
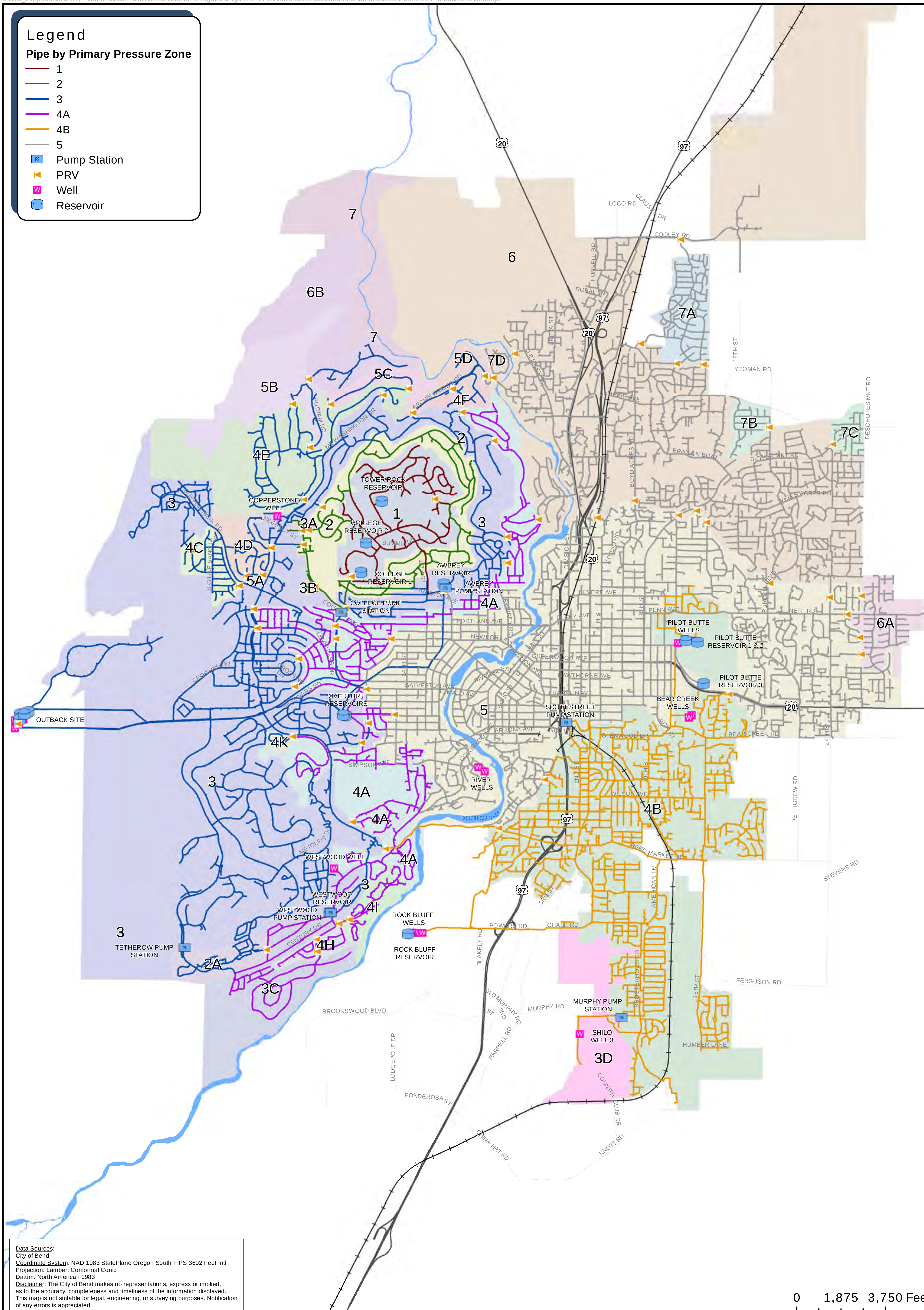


Figure 1-3
Hydraulic Profile

City of Bend
Integrated Water System Master Plan

murraysmith

I:\BOI_Projects\19\2484 - Bend IWSMP\GIS\MXD\Section 1 Figures\Figure 1-4 Pressure Zone Boundaries.mxd 9/13/2021 3:01:02 PM Michele.Neibergs



City of Bend
Integrated Water System Master Plan

Figure 1-4
Pressure Zone Boundaries

murraysmith

September 2021

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1.2.6.4 Pressure Zone 4A

Pressure Zone 4 is divided by the Deschutes River resulting in the area being comprised of two non-contiguous tracts, Zone 4A and Zone 4B, which operate at different HGLs. The two sections are connected via a 16-inch pipeline under the River, but during normal operations remain hydraulically isolated from each other via a closed valve. The area that lies on the west side of the River, Zone 4A operates at a hydraulic grade of 3,872 feet, set by the overflow elevations at the Overturf Reservoirs. The Westwood Reservoir also serves Zone 4A at a slightly higher HGL but is further away and much smaller than the Overturf Reservoirs so has less influence on the zone pressures. Supply to Zone 4A is primarily from a control valve from Zone 3, however the Westwood Well also provides a small amount of groundwater supply to the Zone. Zone 4A serves customers with ground elevations between roughly 3,638 and 3,768 feet.

1.2.6.5 Pressure Zone 4B

Pressure Zone 4B serves customers with ground elevations ranging from roughly 3,609 to 3,779 feet. The HGL of the Zone is set by the Rock Bluff and Pilot Butte 2 Reservoirs at a hydraulic grade of 3,880 feet. Water supply is provided primarily from the Shilo 3 Well, Rock Bluff and Bear Creek well sites, with a PRV connection from Zone 3 also available. Additionally, although not used during typical operations, supply may also be boosted from Pressure Zone 5 via the Scott Street Pump Station.

1.2.6.6 Pressure Zone 5

Pressure Zone 5 serves the largest number of customers in the system with ground elevations ranging from roughly 3,540 to 3,680 feet. The Zone 5 HGL is set by the Awbrey and Pilot Butte 1 and 3 Reservoirs. Similar to Zone 4A and 4B, Zone 5 serves the west and east sides of the Deschutes River, however, has more pipeline connectivity across the River serving the Zone. The Awbrey Reservoir is on the west side of the River and Pilot Butte 1 and 3 Reservoirs are on the east side. Overflow elevations of the reservoirs are 15 feet different with Awbrey overflow at 3,796 feet and Pilot Butte 1 and 3 at 3,782 and 3,781 feet, respectively. Water supply is provided primarily by the City's surface water supply and groundwater production wells located at the Outback Site through a flow control valve to the Awbrey Reservoir. Supply is also provided by the three Pilot Butte Wells and River Wells 1 and 2. PRV connections with Pressure Zone 4A and 4B provide additional water supply options for the Zone.

1.2.7 Distribution System

The City's distribution system is composed of approximately 440 miles of pipe (excluding 10 miles of raw water pipeline) comprised of multiple pipe materials installed over decades, with more than 98 percent installed since 1950. Most of the pipe is ductile iron (DI), the City's current material standard. There are cast iron (CI), galvanized iron, steel, and polyvinyl chloride (PVC) pipe materials in the system in lesser quantities. Pipeline diameters range from 2 to 36 inches. **Table 1-7** presents a summary of the length of distribution pipe in miles by diameters, approximate age, and material type. The piping summarized includes the distribution network piping that conveys treated water. The 9.5 miles of 30-inch and 36-inch raw water pipe is not included in the distribution pipe table below.

Table 1-7 | Distribution System Pipe (miles)

Installation Age	Material	6-inch and Less	8-inch	10-inch to 14-inch	16-inch to 18-inch	24-inch to 36-inch	Total
Before 1950	CI	2.64	0.90	1.54	0.88	0.00	5.97
	DI	0.66	0.14	0.26	0.26	0.00	1.32
	Other	0.30	0.00	0.35	0.12	0.00	0.77
1950-1959	CI	1.64	0.86	0.14	0.42	0.00	3.06
	DI	0.15	0.17	0.39	1.43	0.00	2.14
	Other	0.39	0.00	0.82	0.82	0.31	2.33
1960-1969	CI	3.46	1.26	1.79	0.00	0.00	6.51
	DI	0.73	0.15	1.09	0.01	0.00	1.97
	Other	0.00	0.00	0.00	0.00	0.00	0.00
1970-1979	CI	5.97	4.40	2.00	0.00	0.00	12.37
	DI	6.63	6.84	5.87	0.00	0.00	19.33
	Other	0.25	0.00	0.00	0.00	0.00	0.25
1980-1989	CI	0.05	0.30	0.00	0.00	0.00	0.35
	DI	2.07	10.47	9.50	1.57	0.00	23.61
	Other	0.21	0.68	0.27	0.11	0.00	1.27
1990-1999	CI	0.12	0.31	0.00	0.00	0.00	0.43
	DI	3.69	58.96	41.46	9.17	2.01	115.29
	Other	0.00	0.21	0.00	0.00	0.00	0.21
2000-2009	CI	0.00	0.13	0.00	0.00	0.00	0.13
	DI	1.18	78.93	18.09	13.07	4.80	116.08
	Other	0.01	0.06	0.00	0.00	0.00	0.07
2010-2019	DI	0.32	22.96	6.88	1.94	1.69	33.79
	Other	0.40	0.00	0.00	0.00	0.14	0.54
Unknown	CI	16.26	9.35	4.45	0.67	0.00	30.73
	DI	13.47	11.42	22.80	7.76	0.65	56.10
	Other	3.21	0.27	0.87	0.23	0.13	4.71
Total		**63.81**	**208.77**	**118.57**	**38.47**	**9.73**[1]	**439.35**

Note:

1. There is an additional 9.5 miles of 30-inch and 36-inch ductile iron raw water pipeline constructed in 2014 not included in this table.

1.3 Summary

The City is located east of the Cascade Mountains in Central Oregon with a population of approximately 90,000. The City's existing Urban Growth Boundary is served by three primary water suppliers, the City of Bend, Avion Water Company, and Roats Water System. The City also serves water to the Tetherow destination resort, the Westside Transect area including the Tree

Farm rural residential development and Awbrey Meadows, which are located outside the UGB. The study area for this master plan includes the area within the UGB served by the City and the three areas served outside the UGB.

The City has the capability to supply treated water to customers by utilizing surface water from the Bend Municipal Watershed and groundwater from the Deschutes Regional Aquifer. Both sources are known to have excellent water quality. Surface water is the primary source year-round while groundwater supply supplements peak season demands. The City's existing water system consists of a surface water intake facility, a water filtration facility, eight groundwater sites consisting of 20 active wells, 15 finished water storage reservoirs, 6 booster pump stations, approximately 440 miles of transmission and distribution mains, nearly 10 miles of raw water pipeline, and associated appurtenances including various valves, hydrants, and meters. The system includes six primary pressure zones with an additional twenty-three subzones.

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Section 2

Section 2

Population and Demand Forecast

2.1 Introduction

This section reviews the City of Bend (City) historical water use and develops growth projections and estimated water demand forecasts for the anticipated 10-year and 20-year planning periods. Employee (EMP) and housing unit (HU) projections across the City's water service area, developed during previous efforts, were used with water demand forecasts to estimate future water demand.

2.2 Historical Data

A summary of the historical and current system conditions is provided including connections and water use, service area population, water loss, and system production.

2.2.1 Service Connections and Water Use

Information on the water service connections by customer class is presented in **Table 2-1**. The City customer base is primarily residential, and the City maintains five customer classifications, with two residential classifications including single family and multifamily. There are also commercial, irrigation-only, and hydrant meter classifications. The City provides potable irrigation during peak season demands in addition to year round domestic demands. Multiple irrigation districts also serve customers within the City service area with non-potable irrigation water. This plan assumes similar irrigation service trends in the future as currently exist with irrigation for some areas served by the City and some areas served by irrigation districts or contracted entities. **Table 2-2** has the total water use billed to each customer class in millions of gallons (MG).

Table 2-1 | Service Connections by Customer Class

Customer Class[1]	2016	2017	2018
Single Family	20,649	20,658	21,017
Multi-Family	1,569	1,597	1,631
Commercial	2,124	2,141	2,169
Irrigation-only	359	359	371
Hydrant Meters[2]	61	56	57
Total[3]	**24,762**	**24,811**	**25,245**

Notes:
1. Irrigation is a component of each customer class.
2. Hydrant meters are specific hydrants designated for purposes such as construction, dust control, and other allowed uses. They are used multiple times by different users and are intended to measure hydrant use and prevent unauthorized hydrant use.
3. Number of connections varies throughout the year so the average, maximum, or current number may differ, and the values reported may differ slightly from information reported in other City documents.

Table 2-2 | Use by Customer Class (Million Gallons)

Customer Class	2012	2013	2014	2015	2016	2017	2018
Single Family	2,325	2,484	2,433	2,487	2,461	2,453	2,523
Multi-Family	1,316[1]	1,306[1]	452	475	495	521	531
Commercial	-	-	1,110	1,139	1,146	1,145	1,140
Irrigation-only	267	276	328	295	283	287	318
Hydrant Meters	10	18	31	43	28	35	26
Total	**3,919**	**4,182**	**4,353**	**4,439**	**4,413**	**4,441**	**4,537**

Note:
1. Prior to 2014, the Multi-Family and Commercial Classes were combined.

2.2.2 Service Area Population

The City's existing Urban Growth Boundary (UGB) and service area is served by three primary water suppliers, the City, Avion Water Company, and Roats Water System. The City currently estimates that they serve approximately 75 percent of the population within City limits. **Table 2-3** shows a breakdown of the City of Bend population versus those served by the City water system, with the difference served by private water systems.

Table 2-3 | City Population with City Water Service

	2012	2013	2014	2015	2016	2017	2018
City of Bend Population[1]	77,455	78,280	79,985	81,310	83,500	86,765	89,505
Population with City Water Service	58,703	59,341	59,744	60,673	62,091	64,905	67,187
Percent of City Population with City Water Service	76%	76%	75%	75%	74%	75%	75%

Note:
1. Population based on Portland State University Population Research Center (PRC) estimates

2.2.3 Water Production

Water production measures the total quantity of water drawn from the City's surface and groundwater supply sources. The amount of surface water production and well production varies on both a monthly and yearly basis. The City typically operates the system to utilize surface water supply first and then supplement as needed with groundwater. Water production from 2012 to 2018 is provided in **Table 2-4.** Monthly production by source for 2018 is shown in **Table 2-5** and **Figure 2-1**. The surface water supply infrastructure was undergoing maintenance from April through June of 2018 so was not being utilized as the primary supply source.

Table 2-4 | Production by Source Type (Million Gallons per Year)

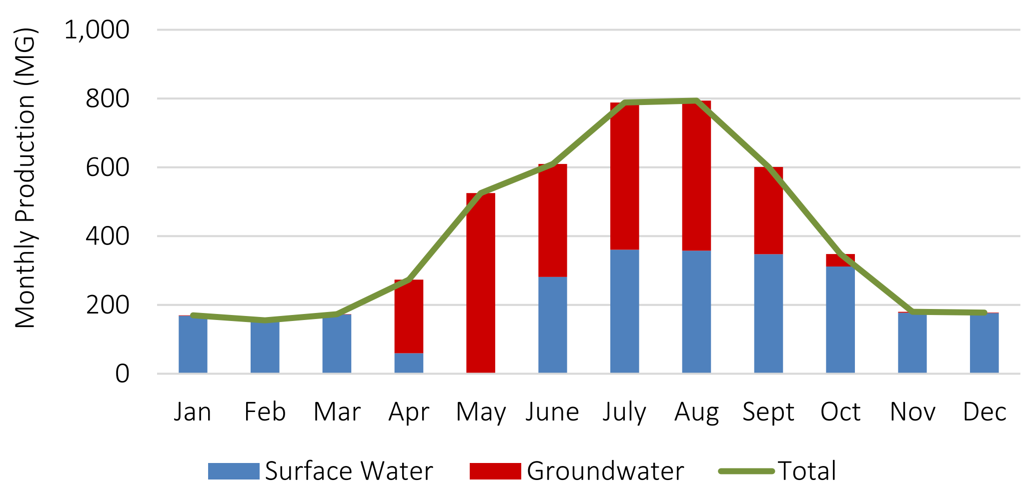
Source	2012	2013	2014	2015	2016	2017	2018
Surface Water	1,863	2,383	2,024	953	1,818	2,988	2,566
Groundwater	1,775	1,723	2,207	3,575	2,704	1,736	2,230
Total	**3,638**	**4,106**	**4,231**	**4,528**	**4,522**	**4,723**	**4,796**

Table 2-5 | 2018 Monthly Production by Source (Million Gallons)

Month	Groundwater	Surface Water	Total
January	1	168	170
February	2	154	155
March	1	172	173
April	214	60[1]	273
May	525	0[1]	525
June	328	282[1]	610
July	428	361	789
August	436	358	794
September	254	347	601
October	36	312	348
November	3	177	180
December	2	176	178
Total	**2,230**	**2,566**	**4,796**

Note:
1.Due to maintenance of the surface water treatment infrastructure from April to June, surface water was not the primary supply source (as it typically is) during these months.

Figure 2-1 | 2018 Monthly Production by Source[1]



Note:
1.Due to maintenance of the surface water treatment infrastructure from April to June, surface water was not the primary supply source (as it typically is) during these months.

Average day demand (ADD) is the annual demand divided by 365 days and is often expressed in units of million gallons per day (MGD). The maximum day demand (MDD) is the largest quantity of water delivered to the system over an actual 24-hour period during the year while peak hour demand (PHD) is equal to the system demand rate during the hour of highest use. **Table 2-6** shows the annual ADD and MDD for the period of 2012 to 2018 along with the peaking factor for each year and the average across the six-year period.

Table 2-6 | Historical Water Production

Year	ADD[1] (MGD)	MDD[1] (MGD)	MDD:ADD[1] Peaking Factor
2012	10.0	24.7	2.5
2013	11.2	21.3	1.9
2014	11.6	24.4	2.1
2015	12.4	26.5	2.1
2016	12.4	25.8	2.1
2017	12.9	28.0	2.2
2018	13.1	28.1	2.1
Average	**11.9**	**25.6**	**2.1**

Note:
1. The system changes over time and the ADD, MDD, and peaking factors reported can vary based on the degree of accuracy and the use of the data and may differ slightly from information reported in other City documents. For example, the City sold the Hole Ten well in 2016 so production values prior to 2016 may or may not include it depending on the reporting intent and use of the data.

2.2.3.1 Peak Hour Demand (PHD)

The City does not have historic PHD data available. However, the relatively recent installation of system-wide automated metering infrastructure (AMI) at all customer meters provides refined water use information including hourly data. This meter data provides information about the allocation of water use across each zone in the system as well as the time variation in water use. The City AMI data was evaluated to determine the demand allocation across each pressure zone and hourly peaking patterns based on six primary pressure zone groupings. Two weeks of AMI data from June 2018 was processed and scaled to match 2018 ADD production and was multiplied by the 2.1 peaking factor to get MDD. The MDD peaking factor was not evaluated zone by zone but could be done for additional future refinement of localized peaking factors. The PHD was calculated based on the AMI data peak hourly ratio for the six zone groups. The PHD to MDD peaking factor is higher in zones with mostly residential customers and highest in residential areas with large lot sizes where irrigation is greater. Zones with more commercial customers have less hourly variation in use, resulting in lower PHD to MDD peaking factors. The results are in **Table 2-7**.

Table 2-7|2018 Water Use and Peak Hour Demand (PHD) by Zone

Zone	2018 ADD (gpm)	2018 MDD (gpm)	2018 PHD (gpm)	PHD:MDD Peaking Factor	Service Connections[1]
1	272	582	1,563	2.68	423
2	286	611	1,673	2.74	521
2A	24	51	117	2.30	72
3	1,320	2,822	6,485	2.30	3,198
3A	8	18	49	2.74	20
3B	2	4	10	2.74	2
3C	158	337	775	2.30	388
3D	3	6	13	2.10	3
4A	570	1,220	2,692	2.21	1,738
4B	1,449	3,100	6,499	2.10	4,304
4C	91	194	446	2.30	295
4D	69	148	340	2.30	199
4E	159	341	783	2.30	335
4F	26	55	126	2.30	42
4H	45	97	224	2.30	156
4I	31	66	152	2.30	122
4K	23	50	115	2.30	52
5	2,602	5,565	9,627	1.73	7,162
5A	5	10	22	2.30	14
5B	12	25	57	2.30	24
5C	8	17	38	2.30	27
5D	33	70	161	2.30	54
6	1,528	3,267	6,443	1.97	4,453
6A	114	243	421	1.73	551
6B	27	59	135	2.30	40
7A	153	327	646	1.97	648
7B	58	125	246	1.97	220
7C	45	97	192	1.97	211
7D	6	13	30	2.30	40
System-wide	**9,127 (13.1 MGD)**	**19,519 (28.1 MGD)**	**40,080 (57.7 MGD)**	**2.05**	**25,314**

Note:
1.The number of active service connections in summer 2018. Slight differences in number of customers occur over the course of the year due to new and closed accounts, resulting in the minor difference in system-wide number of connections from Table 2-1.

2.2.4 Water Loss

The difference between the total water produced and metered consumption is called water loss. Since 2013 the City has used the American Water Works Association (AWWA) water audit methodology outlined in the AWWA M36 Manual. The City's water audits for 2013 through 2018 are in **Appendix 2A**. This method provides definitions and classifications for annual water production and consumption used to calculate water loss. The components of the water balance applicable to the City system are shown in **Table 2-8**.

Table 2-8 | Components of the AWWA Water Balance

<table>
<tr><td rowspan="4">System Input Volume
=
Water Supplied
=
Production
=
System Demand</td><td rowspan="2">Authorized Consumption</td><td>Billed Authorized Consumption</td><td>▪ Billed metered consumption
▪ Billed unmetered consumption</td><td>Revenue Water</td></tr>
<tr><td>Unbilled Authorized Consumption</td><td>▪ Unbilled metered consumption
▪ Unbilled unmetered consumption</td><td rowspan="3">Non-Revenue Water</td></tr>
<tr><td rowspan="2">Water Losses</td><td>Apparent Losses</td><td>▪ Customer metering inaccuracies
▪ Unauthorized consumption
▪ Systematic data handling errors</td></tr>
<tr><td>Real Losses</td><td>▪ Leakage on transmission and distribution mains
▪ Leakage and overflows at storage tanks
▪ Leakage on service connections up to a point of customer metering</td></tr>
</table>

AWWA. Manual of Water Supply Practices M36. Water Audits and Loss Control Programs, Fourth Edition, 2016.

Water loss can be the result of real or apparent losses. Apparent losses can be the result of things such as meter inaccuracy, theft, or reporting errors. Real loss is most likely due to system leaks, main breaks, or reservoir overflows. Water for uses such as firefighting, hydrant flushing, and street sweeping is authorized, but can be unbilled so the City attempts to account for this water use where possible. The City's water loss is calculated as the difference between measured production for the surface and groundwater supplies and the accounted for consumption, primarily the quantity of water measured through meters. The City's water loss is generally low as seen in the historical loss for the years 2012 through 2018 is in **Table 2-9**.

Table 2-9 | Water Loss

Year	Production[1] (MG)	Accounted for Water (MG)	Loss (MG)	Loss [2] (%)
2012	4,052	3,919	133	3.3
2013	4,317	4,248	69	1.6
2014	4,461	4,371	90	2.0
2015	4,746	4,455	291	6.1
2016	4,727	4,449	278	5.9
2017	4,746	4,453	294	6.2
2018	4,793	4,549	244	5.1
Average	**4,549**	**4,349**	**200**	**4.2**

Notes:
1. The historical production values used to calculate water loss are from the City's M36 Water Audits and include production from the Hole Ten wells, which were sold to Roats in 2016. The Hole Ten well production is included in the water loss calculations to avoid negative loss values compared to accounted for water but is not included in other production values throughout this section.
2. Third-party verification of the M36 Water Audit process in 2015 improved the City's data handling and reporting practices, which may be responsible for the somewhat higher loss starting in 2015.

2.2.5 Per Capita Demand

One measure of water use is per capita demand, which accounts for all uses, commercial, residential, and water loss for each person served. Because per capita demand includes all these types of use it exceeds the amount of water actually used by a typical individual. Per capita use can illustrate year-to-year trends however does not account for differences in customer mix, climate, rainfall, current economic conditions, or specifics such as hotel occupancy or number of commuters that may have an impact on system demand that does not reflect a direct relationship to population or efficiency of use. **Table 2-10** contains per capita calculations for 2012 to 2018. The estimated population served is based on the Portland State University Population Research Center (PRC) information and estimated percent of the City population with City water service as provided in **Table 2-3**. Per capita demand is measured in gallons per capita per day (gpcpd).

Table 2-10|Per Capita Demand

	2012	2013	2014	2015	2016	2017	2018
Service Area Population	58,703	59,341	59,744	60,673	62,091	64,905	67,187
Water Demand ADD (MGD)	10.0	11.2	11.6	12.4	12.4	12.9	13.1
Per Capita Demand (gpcpd)	170	189	194	204	199	199	195

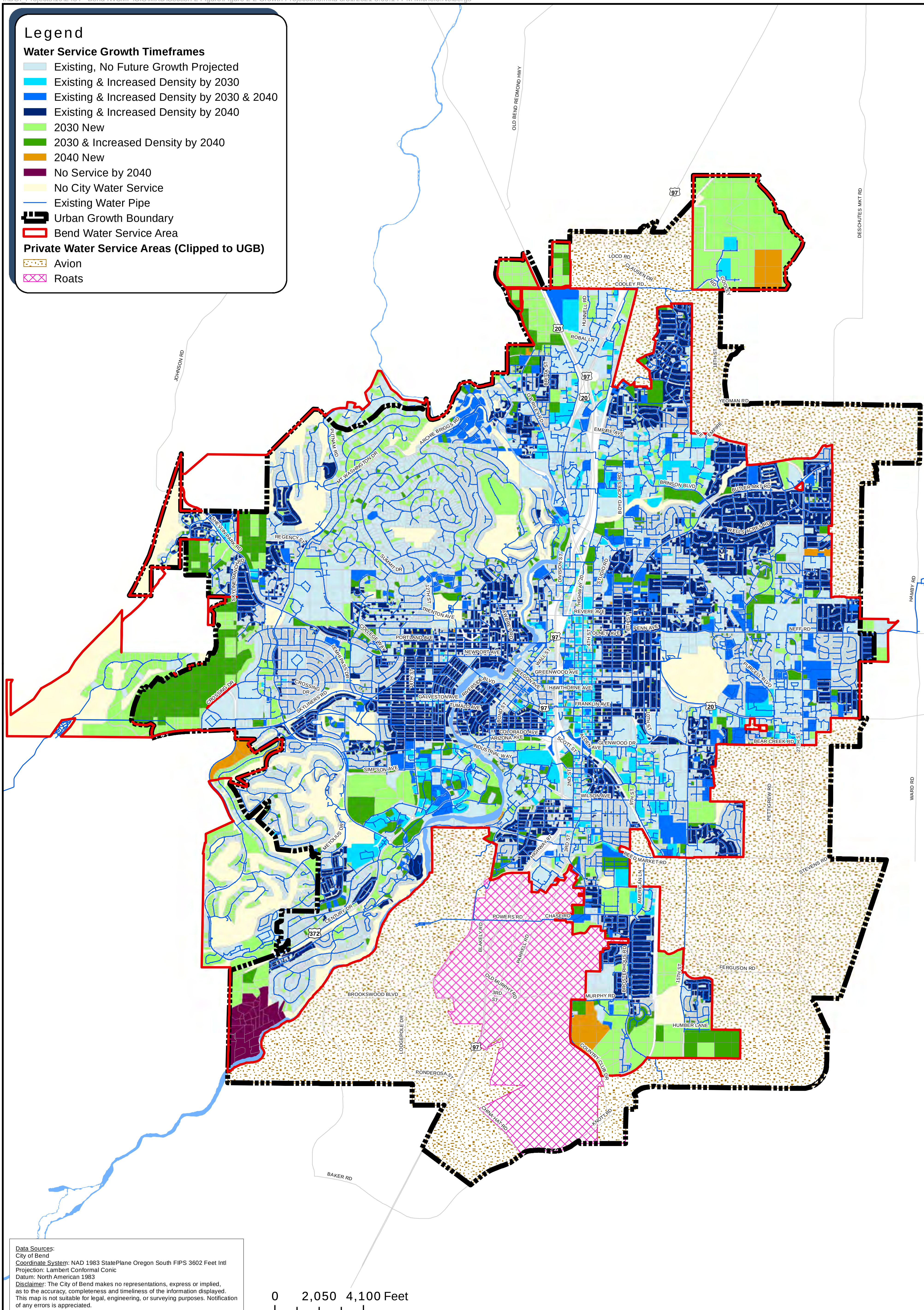
2.3 Future Demand Projections

Growth is a primary factor influencing future water demands. The location of existing and new customer connections affects storage, transmission, and distribution of future water supplies. Two future demand conditions were projected, a 10-year (2030) and 20-year (2040) horizon. The future demand projections require identifying the service areas for these horizons, along with the amount of demand associated with the 10-year and 20-year service areas.

2.3.1 Future Growth Areas

The City UGB and the City water service boundary, including the Tetherow, Westside Transect, and Awbrey Meadows developments that are located outside the UGB, along with the private water service areas within the UGB are illustrated in **Figure 2-2**. Growth is anticipated to occur through infill of existing areas and expansion to currently undeveloped areas. The figure indicates which areas have existing service and whether it is expected to increase in density due to infill along with areas projected for new service in the 2030 and 2040 horizons.

City planning data was used for existing and future employee (EMP) and housing unit (HU) projections across the City's water service area boundary. The future and projected number of employees and housing units was developed on a parcel basis by Angelo Planning Group during the City's 2016 Urban Growth Boundary Study and used in the City's 2018 Sewer Phasing Study.



Data Sources:
City of Bend
Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl
Projection: Lambert Conformal Conic
Datum: North American 1983
Disclaimer: The City of Bend makes no representations, either express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.

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City of Bend
Integrated Water System Master Plan

Figure 2-2
Growth Projections

These were used to determine the number of employees and housing units in the water service area boundary for existing, 2028, and 2040 conditions. To determine the 2030 projections from the 2028 planning data, the areas with 2028 EMP or HU data were scaled by the projected average annual growth rate in EMP or HU from 2028 to 2040.

2.3.2 Future Demands

The number of employees and housing units associated with the existing, 10-year, and 20-year horizons along with the average annual increase is shown in **Table 2-11**. The 2018 housing unit and employee values were also used with the 2018 consumption and production data to calculate an average water demand per employee and per housing unit. Average demand per housing unit was calculated from the 2018 single and multi-family residential consumption and employee demand was based on averaging the 2018 non-residential consumption. The resulting per unit values were factored to match 2018 production (accounting for water loss). The calculated average demand per employee and housing unit factors are in **Table 2-12**. The average demand factors were then used with the EMP and HU estimates to calculate demand for the 2030 and 2040 horizons and peaked to project MDD and PHD shown in **Table 2-13** and **Figure 2-3**. To conservatively plan for future requirements, the projections do not reflect potential decreases in demands that might occur due to expanded conservation program measures given the uncertainty of the magnitude and timing of conservation reductions. However, the impact of potential decreases in demand were considered during the system analysis and capital improvement plan. More extensive discussion and analysis regarding conservation are included in the Water Management and Conservation Plan (WMCP) completed in parallel with this iWSMP. The MDD projections by pressure zone are in **Table 2-14**.

Table 2-11 | Employee and Housing Units by Timeframe

Timeframe	Employees	Average Annual Increase	Housing Units	Average Annual Increase
2018	33,450	-	29,600	-
2030	47,533	3.0%	39,043	2.3%
2040	54,197	1.3%	47,422	2.0%

Table 2-12 | Employee and Housing Demand Factors

	2018 Count	2018 Consumption (gal/day)	2018 Production (gal/day)	Unit Demand Factors (gal/day)
Employees	33,450	4,064,608	4,293,892	128
Housing Units	29,600	8,365,706	8,837,614	299

Table 2-13|Demand Projections

Timeframe	ADD (MGD)	MDD (MGD)	PHD (MGD)	Average Annual ADD Increase
2018	13.1	28.1	57.7	
2030	17.8	38.0	78.0	2.5%
2040	21.1	45.2	92.7	1.7%

Figure 2-3|Demand Projections

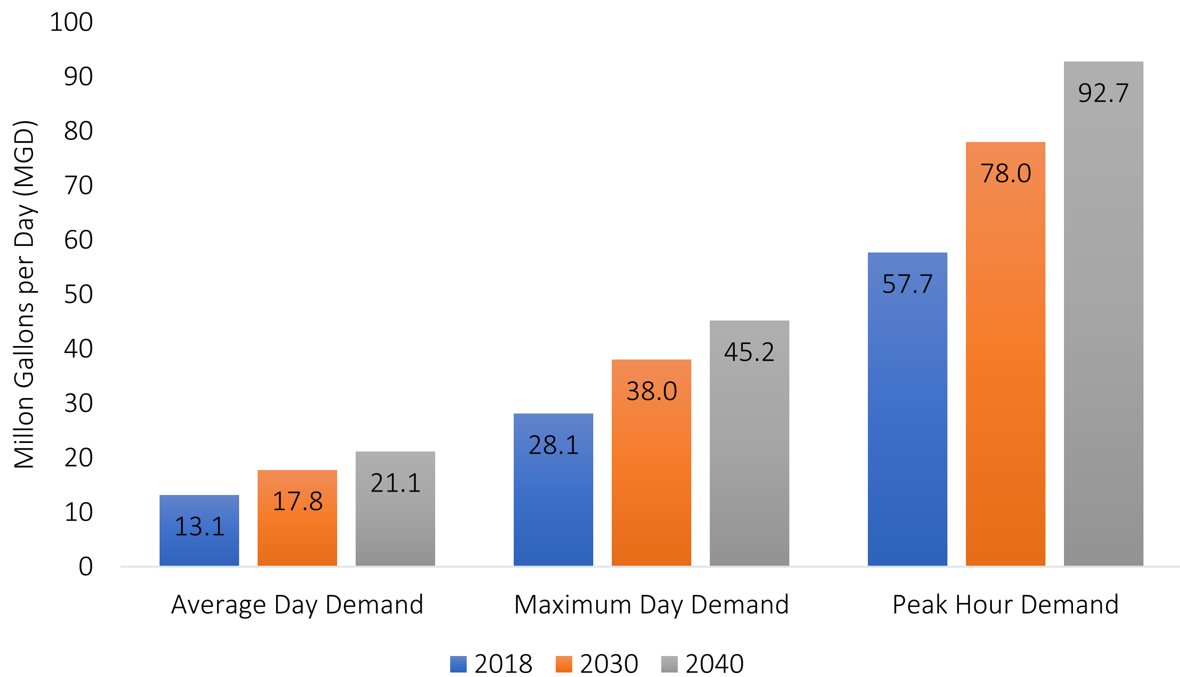

Table 2-14| Maximum Day Demand (MDD) Projections by Zone

Zone	2018 MDD (gpm)	2030 MDD (gpm)	2040 MDD (gpm)
1	582	658	691
2	611	681	715
2A	51	128	128
3	2,822	3,853	4,464
3A	18	24	28
3B	4	4	4
3C	337	415	436
3D	6	17	29
4A	1,220	1,666	2,246
4B	3,100	4,500	5,393
4C	194	255	290
4D	148	200	225
4E	341	395	415
4F	55	78	103
4H	97	113	113
4I	66	74	98
4K	50	50	50
5	5,565	6,705	8,335
5A	10	10	10
5B	25	28	29
5C	17	36	36
5D	70	117	170
6	3,267	5,460	6,375
6A	243	249	256
6B	59	64	64
7A	327	372	425
7B	125	127	129
7C	97	100	104
7D	13	13	14
System-wide	**19,519 (28.1 MGD)**	**26,391 (38.0 MGD)**	**31,375 (45.2 MGD)**

2.3.3 Demand Projection Methodology Comparison

For comparison purposes, the growth and demand projections in **Table 2-13** were compared with two other projection methodologies using the information in **Table 2-10**. One using historical average increases in production to project future production and the other using average per capita demand to project future demand. The historical information including per capita demands and average annual growth in production and service population are shown in **Table 2-15**. Projections were calculated using the annual average 5-year increase in production rate as well as the PRC future service area population projections and the 5-year average per capita demand to compare to the methodology using employee and housing unit projections. The 2030 and 2040 projections for the three methodologies are shown in **Table 2-16**. The resulting demands from each methodology are quite similar, varying less than four percent on an ADD basis. The housing unit and employee estimate selected for use in this Integrated Water System Master Plan is in the middle of the other two projection methods.

Table 2-15 | Historic Production and Population Change

Year	Service Population	Service Population Change (%)	Per Capita Demand (gpcpd)	Average Production (MGD)	Production Change (%)
2014	59,744	0.7	194	11.6	3.6
2015	60,673	1.6	204	12.4	6.9
2016	62,091	2.3	199	12.4	0.0
2017	64,905	4.5	199	12.9	4.0
2018	67,187	3.5	195	13.1	1.8
5-year Average	7,443	2.4	198	12.5	2.5

Table 2-16 | Demand Projection Comparison

Methodology	2030	2040
Service Population Estimate[1]	92,681	115,272
ADD from 5-year Average Per Capita	18.4 MGD	22.9 MGD
ADD from Employee and Housing Unit Estimates (Selected Method)	17.8 MGD	21.1 MGD
ADD from 5-year Production Change	17.7 MGD	22.7 MGD

Note:
1. Service population estimate based on 75 percent of the PRC population projection for the Bend UGB.

2.4 Summary

The City's historical customer accounts, service area population, water production, use, and loss were evaluated to determine trends in the system water requirements. Service area populations are estimated at 75 percent of the City population. The City is regularly improving its data collection and methodologies and as a result the historical data will continue to improve understanding of past and future system requirements. The future and projected number of employees and housing units, previously developed for the City on a parcel basis, was used to project growth in the water service area boundary. Unit demand factors based on 2018 consumption and production data were then applied to the employee and housing unit projections for each timeframe. This growth does not reflect potential declines due to less water use from increased conservation program measures. Projections reflect 20-year increases in average day demand requirements from 13.1 MGD to 21.1 MGD and maximum day demand from 28.1 MGD to 45.2 MGD and peak hour demand from 57.7 to 92.7 MGD. The City currently updates their plan every 10 years which gives the opportunity to track the population and demand trends and update projections. The projected demands for the next 20 years are used to evaluate the hydraulic capacity of the system and identify improvements. The actual timing of any improvements should be based primarily on when the system reaches certain demand thresholds versus specific predetermined timelines.

Section **3**

Section 3

Level of Service and Design Standards

3.1 Introduction

This section includes the planning and analysis criteria and assumptions used for the water system analysis. The City of Bend (City) has numerous objectives and considerations in achieving its mission to provide the right public services for its citizens. The City's water system is a critical component of achieving this mission by providing reliable, high quality water and service that meet regulatory standards and contribute to City policy objectives. The City's water system level of service (LOS) criteria and planning assumptions define the framework for analysis of the system including water rights, supply, storage, pumping facilities, and piping to meet existing and future requirements. Recommendations to provide water during emergency conditions including infrastructure redundancy and fire suppression capacity are incorporated into the system analysis. Consideration is also given more generally to City objectives such as financial and environmental stewardship, compliance with America's Water Infrastructure Act (AWIA), and energy efficiency. Additional consideration is also given to collaboration with the Deschutes National Forest including measurement and other compliance tasks such as maintaining and replacing fish screens, that are required as part of the United States Forest Service (USFS) Special Use Permit. The water demand forecasts developed in Section 2 are used in conjunction with the LOS criteria presented in this section for the analysis of the City water system presented in Section 4.

3.2 Level of Service Framework

The LOS criteria reflect regulatory requirements where applicable as well as City service goals. Oregon Administrative Rules (OARs) were used for specific criteria where applicable and industry standards and other regional state guidelines and best practices were considered where the OARs do not outline specific standards. Chapter 14 of City Code provides guidance and standards for outlining the use, operation, and service relating to the water system. The primary intent is to provide reliable, high quality water to City customers while maintaining reasonable rates that reflect the cost of service. The water system LOS standards also consider other City policies and programs such as conservation, climate change considerations, and synergy opportunities with other City departments such as capital projects from Transportation, Sewer, and Stormwater planning efforts.

3.3 Water Rights

The City's ability to serve reliable, high quality water at adequate capacities to meet customer demands starts with access to supply sources through water rights. The City's system relies on both surface water and groundwater rights to meet system requirements. The system benefits from the natural resiliency created by the diversification of its water rights portfolio to provide a dual source supply. To maintain reliable service the maximum rate of the City's water rights should be sufficient to allow the City to meet its maximum day demand. In addition, the annual volume of water use authorized by the City's water rights should be sufficient to meet annual demands.

Consideration should be given for the reliability of the water authorized by the water rights to conservatively anticipate drought, mitigation, natural disasters such as forest fires and more extreme weather patterns, regulatory changes, or other impacts that could reduce the actual water available under any given water right. The impact and options to reduce the impact on the system in the event of a disruption to either surface water or groundwater sources is important to maintaining reliable levels of service.

3.4 Supply

For typical operating conditions, the system supply, comprised of surface water treated at the Water Filtration Facility (WFF) and groundwater wells should be able to supply MDD under a firm capacity condition. To provide redundancy the firm capacity condition is defined as the largest capacity well or in the case of the WFF, one filter train, out of service in each pressure zone rather than the single largest supply out of service system wide.

There are many emergency conditions such as watershed wildfires, urban interface fires, surface or groundwater contamination, local earthquakes, population influx due to coastal earthquakes or other emergencies, or regional power failures that could reduce supply capacity or require supply modifications for long durations. During these long-term emergency conditions, the City's LOS is to provide average winter demand, approximately representing indoor water use, solely from either the surface water supply or groundwater supply.

The City is currently performing an initial Outback Siting Study (Siting Study) to further evaluate how recommended facilities such as pretreatment, new and rebuilt reservoirs, wells, and other water related facilities may be sited on existing and/or additional lands. These facilities will incorporate required federal security recommendations. The Siting Study also includes space considerations for potential locations for the siting of a hydropower generation building that works in conjunction with the addition of pretreatment and related facilities. Implementation of this hydropower option would only be considered if City Council chooses to proceed. A separate Hydropower Feasibility Study would need to be conducted first and was not a part of the iWSMP or Siting Study.

In the event of a wildfire or related water quality incident, pretreatment would allow the City to continue operating the WFF and provide resiliency to the overall system. Due to ongoing turbidity events from the 1979 Bridge Creek Fire, as well as risks from future fires, plans for pretreatment were part of the original WFF design. This Siting Study is an initial effort to understand land needs and potential hydraulic layout, all of which will be refined as part of a larger future Outback Facility

Plan that will finalize a location and construction of specific facilities recommended in the long-term plans for the site. The Outback Siting Study is in Appendix 3A.

Due to the lower cost of operations and lower power use of the surface water, which is supplied to the system by gravity, the City's goal is to maximize the use of that lower cost water under typical operating conditions.

3.5 Pumping Capacity

Areas served by pump stations should have some redundancy to meet average, peak, and emergency (such as fire flow) demand conditions. Pumping capacity requirements vary depending on how much storage is available to the area served by the pump station and the number of pumping facilities. For an open system, where gravity storage facilities serve the same area served by the pump station and provide peaking and fire suppression storage, it is recommended that total pumping capacity be equal or greater than MDD. Also, the firm capacity must be equal to or larger than ADD. Firm capacity is defined as a station's capacity with the largest pump out of service. In a closed system, where no gravity storage serves the area, the booster pump station must be able to provide peak hour demand (PHD) and MDD plus fire flow with the largest pump out of service.

3.6 Backup Power

During a short-term power outage, on-site automatic backup power should be available to meet average day demand (ADD) if two days of ADD is not available in standby or emergency storage. Additionally, pump stations serving areas without storage should have backup power.

3.7 Storage

Storage facilities are provided for four primary purposes: operational storage, equalization storage, emergency or standby storage, and fire storage. The total storage required is the sum of these elements. In addition, any storage unavailable for use due to providing substandard pressures or due to facility constraints, typically called dead storage should be taken into consideration in addition to the required storage components. A brief discussion of each element is provided below.

3.7.1 Operational Storage

Operational storage is the volume of water used from storage before supply sources turn on. It is used to prevent excess pump cycling, which could increase power use and lifecycle costs.

3.7.2 Equalization Storage

Equalization storage volume should be sufficient to meet normal system demands in excess of the maximum day demand and is generally considered as the difference between PHD and MDD (on a 24-hour duration basis). The equalization storage criterion is the volume required to meet demand in excess of supply capacity for 2.5 hours.

3.7.3 Emergency Storage

Emergency storage or standby storage is intended to provide water during emergencies such as pipeline failures, equipment failures, power outages or natural disasters. While any number of emergencies may occur over time, it is prudent to have enough storage to provide a minimum amount of water to meet demand while additional response can occur such as backup power turning on during a power outage or short-term supply or pipeline maintenance occurring.

The amount of emergency storage for a water system can be highly variable depending upon an assessment of risk and the desired degree of system reliability. OARs and other industry standards allow for localized decisions regarding the volume of emergency storage required. Provisions for emergency storage in other systems vary from none to a volume that would supply several days of MDD or higher. The benefit of large storage volumes for emergencies must be balanced with the cost of tank construction and water quality issues which are typically exacerbated by having large volumes of water in tanks that are not turned over regularly.

The City's dual supply sources from groundwater and surface water provide additional risk mitigation, reducing the potential for emergencies where only storage is available to supply the system since the vulnerability of each source along with the backup power requirements to address power emergencies, provide some redundancy in serving the system. As a result, in reviewing the range of industry practices and with consideration to the City's specific configuration, the LOS standard for emergency storage is to provide two days (48 hours) of ADD, reduced by the firm supply capacity with backup power. Even if adequate backup power is available, the standby storage should be a minimum of 200 gallons per Equivalent Residential Unit (ERU), which is approximately sixty percent of the average day use per ERU.

3.7.4 Fire Storage

While the distribution system provides water for domestic uses, it is also expected to provide for fire suppression. The amount of water recommended for fire suppression purposes is based on the size and duration of the anticipated fire which is typically associated with the local building type and size or the land use of a specific location. **Table 3-1** presents assumptions for minimum fire flow requirements by land use type. Fire storage should be available for the largest single fire requirement based on the land use in any zone the storage tank serves.

Table 3-1 | Fire Flow Requirement by Land Use

Land Use	Fire Flow Requirement (gpm)	Duration (hours)	Fire Storage Volume (gallons)
Residential	1,500	2	180,000
Commercial/Public	2,500	3	450,000
Central Business District	3,500	5	1,050,000

3.8 Distribution System

The distribution pipe network conveys water throughout the system to meet demands and fire flow requirements at adequate pressure and velocity. The pressure and velocity requirements vary based on the system demand conditions. A minimum 8-inch pipe distribution pipe and 16-inch transmission pipe diameter criteria is also required to meet the velocity and pressure requirements, particularly during fire flow conditions. Conformance to the pressure ranges may not always be possible or practical due to topographical relief, existing system configurations and economic considerations. In some areas, individual service line booster pumps or pressure reducing valves (PRVs) may be installed by the customer to help satisfy pressure needs. The distribution system criteria are in **Table 3-2**.

Table 3-2 | Pressure and Velocity Criteria

Attribute	Evaluation Criterion	Value
Service Pressure	Minimum during MDD plus fire flow	20 psi
	Minimum during PHD	30 psi
	Standard Range	40-100 psi
	Maximum	120 psi
Pipe	Maximum Velocity for ADD or MDD	5 feet per second
	Maximum Velocity for PHD	8 feet per second
	Maximum Velocity during Fire Flow	12 feet per second
	Minimum Distribution Pipe Diameter	8-inch
	Minimum Transmission Pipe Diameter	16-inch

3.9 Other Criteria

In addition to hydraulic criteria, some more general level of service considerations are used in evaluating the system as part of this Integrated Water System Master Plan (iWSMP). These inform the assumptions around the longevity of infrastructure, prioritization of infrastructure improvements, and case-by-case considerations for improvements that do not have a uniformly applicable level of service.

3.9.1 Life Cycle Assumptions

Maintaining infrastructure and planning for its natural lifecycle is important to providing ongoing levels of service with the existing system. Assessing how long water system infrastructure, including tanks, pumping facilities, wells or pipes will last while maintaining the adequate level of service requires many considerations and is best assessed periodically for each individual facility. However, for planning assumptions, general guidelines were set for evaluating the useful life of new infrastructure as well as the life cycle of conducting a full rehabilitation of existing infrastructure. These life cycle assumptions are needed to assess infrastructure improvement requirements. The assumed useful life of various infrastructure is listed in **Table 3-3**.

Table 3-3 | Life Cycle Assumptions

Facility	New Facility Life Cycle (years)	Maintenance of Existing Facility Life Cycle (years)
Storage Tank	75	56
Well or Pump Station	40	30
Pipeline	100	-

3.9.2 Redundancy

Redundant service provides flexibility in operations and allows continued service when one part of the system is unavailable. Redundancy for all infrastructure must be balanced with the cost to construct and maintain extra infrastructure. Many of the LOS criteria incorporate redundancy, such as having firm supply and pumping capacity requirements to account for ongoing service in the event a single piece of infrastructure, such as a pump, is offline. Additionally, as mentioned, the City's dual supply source provides some resilience in supplying at least typical indoor water demand—as measured by water used during the winter months—should either supply source be completely unavailable, such as during a severe watershed fire or groundwater contamination.

Redundancy should be evaluated to understand the number of customers which could be impacted if a single piece of infrastructure, from supply sources, PRVs, pipe connections, or isolation valves were inoperable. Although not set standards, this plan identified some measures for redundancy analysis as pressure zones served by only one PRV vault, single-feed pipes that serve over 50 gallons per minute (gpm) demand, and pipes that required more than four valves to isolate. However, the improvements required, or maintenance considerations will be evaluated more on a case-by-case basis depending on factors such as the cost or feasibility of adding redundancy and the number of customers or amount of demand impacted. As a result, a uniform level of service is not defined, but in each analysis and improvement redundancy is considered as a goal where feasible.

3.9.3 Standards and Specifications

Section 2-5 of the City standards and specifications outlines detailed information about water system components and appurtenances including some of the information in this iWSMP and much more specific information than is evaluated in this system-wide analysis.

3.10 Summary

The City's Level of Service criteria for the water system aim to provide reliable, high quality water and service that meet regulatory standards and support the City's numerous objectives and considerations. The Level of Service criteria and planning assumptions define the framework for analysis of the system including water rights, supply, storage, pumping facilities, and piping to meet existing and future requirements. The specifics are in **Table 3-4.** Even where specific criteria are not defined, guidelines for determining infrastructure life cycles for maintenance and improvements as well as considering infrastructure redundancy is important in determining system improvements. As individual criteria are used to evaluate the system, consideration is also given more generally to City objectives such as financial and environmental stewardship, compliance with America's Water Infrastructure Act (AWIA), and energy efficiency. Additional consideration is also given to collaboration with the Deschutes National Forest including measurement and other compliance tasks such as maintaining and replacing fish screens, that are required as part of the United States Forest Service Special Use Permit.

Table 3-4 | Level of Service Summary

Attribute	Evaluation Criterion	Value
Water Supply	Firm Supply Capacity	Greater than MDD assuming storage is adequate for equalization and fire suppression
	Emergency Power	At least two independent sources if adequate standby storage is not available
Storage	Total Storage Capacity	Sum of dead, equalization, fire, operational, and standby
	Dead Storage	Storage that is unavailable for use or that can provide only substandard quality, flows and pressures
	Equalization Storage	Difference of PHD and max supply capacity for 150 min
	Fire Suppression Storage	Largest fire flow in a zone for duration of that flow
	Operational Storage	The volume of water before sources turn on to prevent excess pump operation or cycling
	Standby Storage	48 hours of ADD minus firm supply capacity with backup power, with a minimum of 200 gallons per ERU
Pump Stations	Minimum No. of Pumps	2
	Firm capacity pumping to storage	ADD
	Total capacity pumping to storage	MDD
	Firm capacity pumping to system	MDD plus fire flow or PHD, whichever is greater
	Emergency Power	At least two independent sources adequate to serve ADD plus largest fire flow (where standby power and fire suppression storage are not adequate/available)
Service Pressure	Minimum MDD plus fire flow	20 psi
	Minimum PHD	30 psi
	Standard Range	40-100 psi
	Maximum	120 psi[1]
Distribution Piping[2]	Maximum Velocity for ADD or MDD	5 feet per second
	Maximum Velocity for PHD	8 feet per second
	Maximum Velocity during Fire Flow	12 feet per second
	Minimum Future Pipe Diameter	8-inch
Fire Suppression	Minimum Fire Flow Requirements[3]	Residential: 1,500 gpm for 2 hours Commercial/Public: 2,500 gpm for 3 hours Central Business District: 3,500 gpm for 5 hours

Notes:
1. For pressures above 80 psi, installation of individual pressure reducing valves is recommended for compliance with plumbing code.
2. Velocity criteria are primarily for designing pipe improvements and these criteria alone will not typically result in recommendations for existing system improvements.
3. For all fire flow evaluations, it is assumed that flow for only one fire at a time must be available.

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Section 4

Section 4

System Analysis

4.1 Introduction

This section describes the analysis of the City of Bend (City) water system. The system is evaluated using the level of service criteria, goals, and recommendations in Section 2 with a comprehensive approach incorporating condition, capacity, criticality, and operations analyses. The analysis reviews existing, 10-year and 20-year planning horizons to determine existing and future system surpluses and deficiencies. The deficiencies and recommendations inform the improvements identified in Section 6.

4.2 Comprehensive System Analysis Approach

The City has completed an extensive analysis of its water system that collected and looked at many data sources and established rigorous evaluation criteria. The City's existing water system as described in Section 1 was analyzed to meet both existing and future demands as well as typical and emergency operations. The approach for determining 10-year and 20-year future demand projections is in Section 2. The system is evaluated using the level of service (LOS) criteria in Section 3.

The City has made a significant investment in evaluating the system in a robust manner far exceeding the regulatory requirements in the Oregon Administrative Rules (OARs), which primarily address water quality and some capacity requirements. The water quality analysis is in Section 5. The analysis done for this Integrated Water System Master Plan (iWSMP) incorporates condition, capacity, criticality, and operations assessments, for all major facilities and the pipe network. The analysis incorporated numerous methodologies including Geographic Information System (GIS) data review, facility site evaluations, numerical analysis, traditional hydraulic modeling, and innovative optimization modeling that includes advanced algorithms to explore an extensive range of system modifications against complex decision-making considerations. Figure 4-1 illustrates the components and approach used in this iWSMP analysis.

The facility condition assessment was done through background GIS, construction drawing, and other data review as well as site visits and the results were also used in the optimization done through Optimizer Water Distribution System (WDS) software. The facility capacity assessment primarily utilizes a spreadsheet review that is then validated with the distribution system assessment. The distribution assessment and pipe and valve criticality assessments leverage steady state and extended period simulation (EPS) hydraulic modeling done through a variety of platforms including InfoWater, InfoWater Valve Criticality Modeling module, Optimizer WDS, and Optimizer Opticritical software. The operations analysis was done using an EPS simulation of existing conditions in InfoWater for the water age assessment and in Optimizer WDS for the existing operations assessment.

The value of this comprehensive analysis is to allow the City to accurately assess and continue to leverage the benefits of the historic investments that have been made to the system and the full extent of investments required moving forward. This will benefit existing customers and provide for future growth within the service area. The results of the analysis were used in the optimization process, which utilizes the Optimizer WDS software to determine optimal solutions to system deficiencies. Optimization uses genetic algorithms to run millions of EPS hydraulic model simulations to balance the best hydraulic performance at the overall lowest life cycle and capital cost. The optimization results inform the Capital Improvement Plan (CIP) and operational program recommendations and prioritization outlined in **Section 6**.

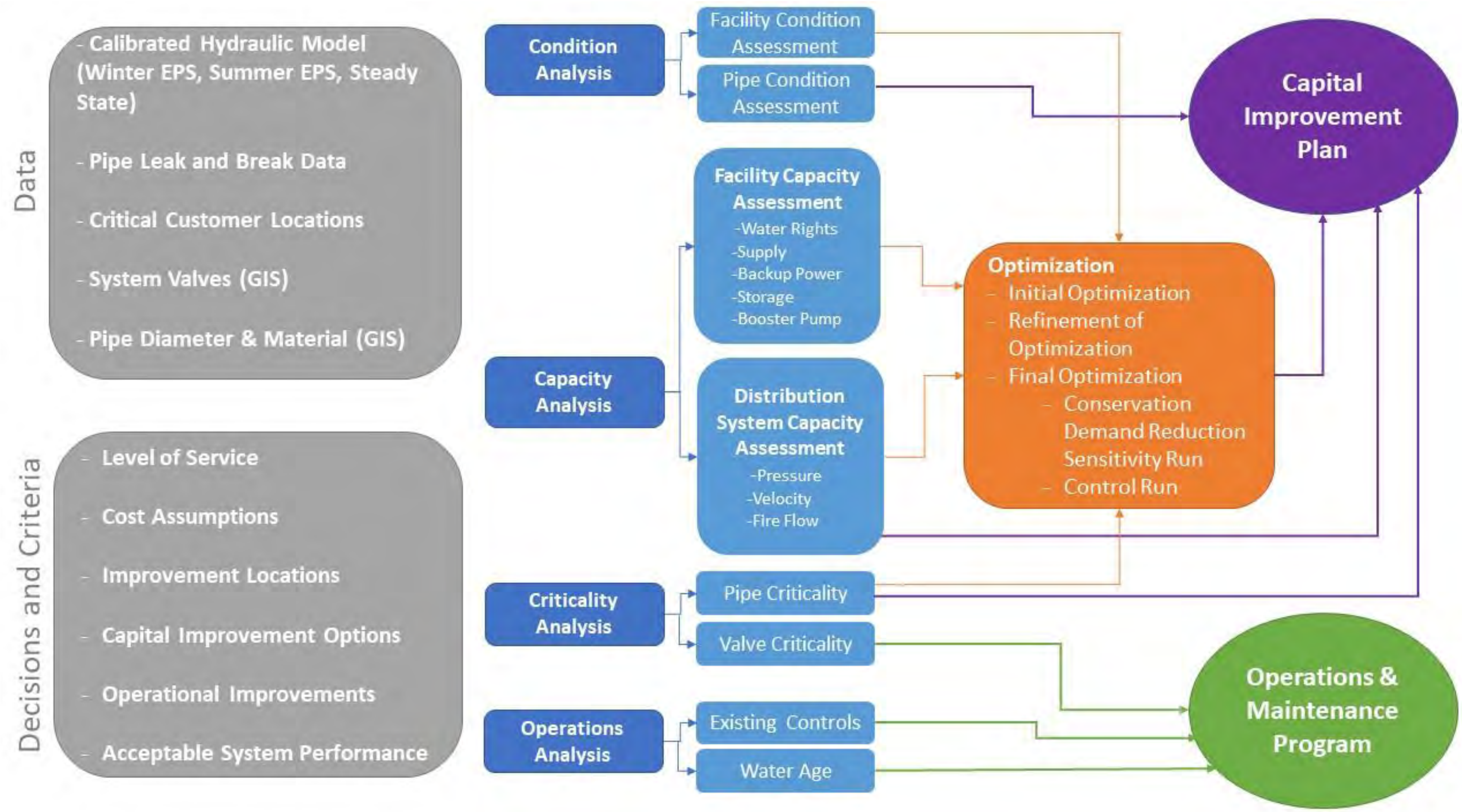
4.3 Condition Analysis

An analysis of the existing system infrastructure was done to evaluate the facility and pipe condition. This is the City's first master planning effort to address the condition of all existing facilities and piping on a programmatic level.

The condition analysis identifies current deficiencies at each facility and helps set priorities and develop an approach to address deferred facility maintenance and extend their useful life. The facility condition assessment recommended improvements are used in the Optimization Analysis to evaluate the ability of existing facilities to meet existing and future requirements and determine the cost and benefit of improvements at existing facilities compared to constructing new facilities.

A recommendation was developed to prioritize which pipes should be replaced first as part of a comprehensive pipe replacement program. Ultimately the City will need to determine what level of funding will be made available to determine the rate of ongoing pipe replacement.

Figure 4-1 | Comprehensive System Analysis Components



4.3.1 Facility Condition Assessment

To provide an evaluation of the necessary investment in the existing system, a condition assessment of the City's active wells, storage facilities, and booster pump stations was performed. Facilities were assessed through a review of background data (e.g., operational narratives, power consumption records, construction drawings, property ownership, parcel size and zoning, etc.) and onsite visits. The onsite examination assessed physical and operating conditions (e.g., buildings, tanks, valves, pumps, motors, electrical equipment, safety elements, site access, security, etc.). An estimate of the value of the facility based on its existing assets was completed. The condition of each facility was assessed for over a dozen categories including things such as access, mechanical, electrical, fire protection and more as detailed in the complete Infrastructure Condition Assessment Report. Each element was assessed on five general criteria: sanitary, safety, structural, level of service, and security.

Based on the assessment, each facility was ranked, and improvements were identified that are required to maintain current facilities and extend their useful life. Facilities have a mix of elements, each containing a range of conditions from excellent to very poor, however, to assess the overall condition of a facility, a Facility Condition Index was applied with possible overall ratings of Excellent, Good, Fair, Poor, and Very Poor. The index is based on the ratio of overall deferred or backlog maintenance to the estimated cost of replacing the facility.

Figure 4-2 shows the Facility Condition Index rating for each facility. The detailed maintenance and improvement recommendations and their associated costs are identified for each facility in the Infrastructure Condition Assessment Report. The recommended improvements are intended to restore all components of the facilities to Good condition.

4.3.2 Pipe Condition Assessment

Pipes have a certain useful life and to maintain system performance should be lined or replaced prior to failure. Many variables affect the lifespan of a particular pipe including material, liner material (if applicable), age, soil conditions, water quality and installation methods to name a few. The City, like many utilities, is developing an understanding of how long their pipe will last and where they should focus their replacement efforts.

Having a condition-based replacement program is essential to keep system piping in working order and within appropriate life cycle expectations. The City's investment in pipe replacement will need to increase over time and this analysis provides some proposed prioritization for how that might occur. No in-situ pipe condition analysis was completed so the future pipe replacement itself will serve as a critical data source for refining the program and informing the adequacy of the proposed investment levels, which should be reassessed as part of each subsequent water master planning effort.

Currently the City has been replacing approximately 1 mile of pipe per year as part of the condition-based replacement program (additional replacement occurs as part of the CIP). Much of their historical replacements have been focused on specific breaks, undersized piping, or materials they know to be substandard. Based on its current 440 miles of existing pipe that corresponds to approximately a 400-year life cycle. The City's goal is to increase the funding to allow for approximately 2 miles of pipe per year to be replaced, reducing to a 200-year replacement rate.

The City's pipe GIS data (2018) was used to assign each pipe in the system a replacement rating based on material, diameter, valve frequency, and break history. A higher rating indicates worse pipe condition. Certain types of materials, such as steel, cast iron, or galvanized iron are older and more prone to leaks and no longer meet the City's material standards. These materials were more heavily weighted, contributing to a higher rating. Ductile Iron pipe was given a 0 rating since it is the City's current standard for pipe material. Additionally, small diameter pipe that no longer meet City standards received higher ratings.

Replacement ratings used for material and diameter are shown in **Table 4-1**. Small diameter steel pipe received the highest material and diameter rating of 3.5. The criteria assigned to break and leak history at specific pipes and the number of valves required to isolate the pipe also contributed to the overall condition rating. The ratings for these criteria are in **Table 4-2**. The assessment to determine the number of valves required to isolate each pipe is outlined in the Criticality Analysis later in this section.

Table 4-1 | Rating for Material and Diameter

Material	Pipe Diameter (inches)		
	1"-6"	8"-14"	16"-36"
Cast Iron	3	2	2.5
Galvanized Iron	2.5	1.5	2
PVC	2	1	1.5
Steel	3.5	1	1.5
Other	0.5	0	0

Table 4-2 | Rating for Break, Leak and Valve Isolation

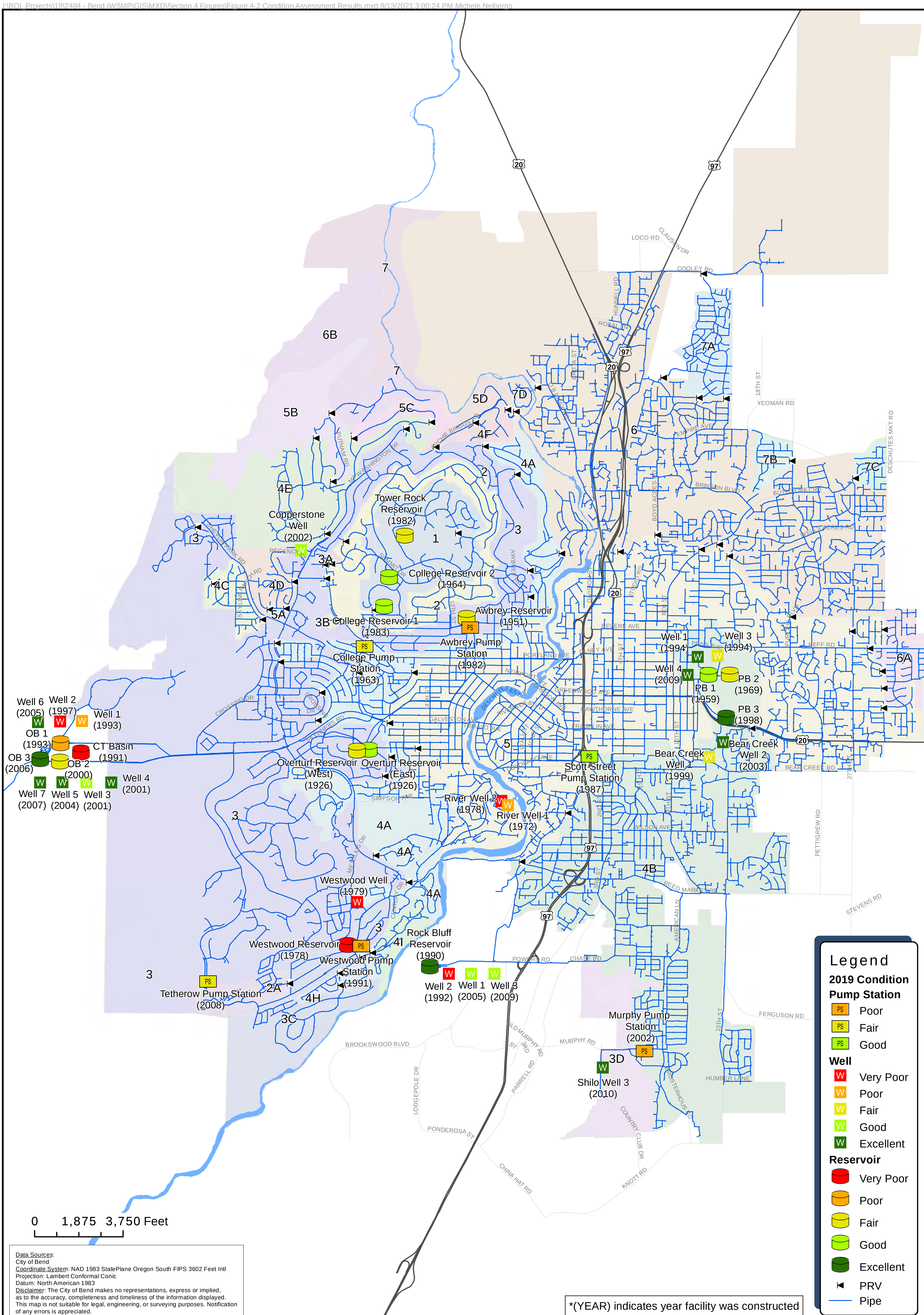
Criteria	Count	Rating
Break/Leak History	1+	2
Number of Valves Closed to Isolate Pipe	1 - 4	0
	5 - 6	3
	6 - 7	4

Based on the criteria the breakdown of replacement rating by length in miles and diameter groups is shown in **Table 4-3**. **Figure 4-3** illustrates pipe replacement ratings across the system. Based on a condition replacement program of approximately two miles of pipe per year (200-year replacement rate), ratings of 5.5 to 7.5 could be addressed in one year. Over the 20-year horizon ratings of three and higher could be replaced, allowing for some initial build-up time to increase funding for the program. Ultimately pipes that are identified for improvements due to hydraulic deficiencies including criticality, fire flow, and capacity will not be listed as part of the pipe replacement program, however, do contribute to the overall replacement rate and life-cycle goal of the City's program. As an example, some of the localized fire flow improvements are due to undersized piping. As such fire flow CIP projects are identified individually and not included in the general pipe replacement program. Prioritization of pipes in the replacement program and coordination with other CIP projects is discussed in **Section 6**.

Table 4-3 | Pipe Replacement Length by Rating (miles)

Rating	Pipe Diameter (inches)			Total Miles	Cumulative Total Miles
	1" - 6"	8"-14"	16"-36"		
7.5	0.00	0.00	0.03	0.03	0.03
7	0.07	0.00	0.00	0.07	0.1
6.5	0.30	0.00	0.13	0.43	0.53
6	0.22	0.33	0.00	0.55	1.08
5.5	0.33	0.00	0.56	0.89	1.97
5	0.34	1.40	0.00	1.74	3.71
4.5	0.29	0.00	0.23	0.52	4.23
4	0.00	0.81	0.29	1.10	5.33
3.5	1.29	0.00	0.00	1.29	6.62
3	21.93	2.40	0.96	25.29	31.91
2.5	1.58	0.00	0.76	2.34	34.25
2	0.40	18.90	0.01	19.31	53.56
1.5	0.00	0.00	8.61	8.61	62.17
1	0.00	1.20	0.00	1.20	63.37
0.5	29.64	0.00	0.00	29.64	93.01
0	0.01	296.05	45.65	341.70	434.72
Total[1]	**56.38**	**321.10**	**57.24**	**434.72**	

Note:
1. Pipes identified for capacity improvements are not included in the pipe replacement totals.



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City of Bend
Integrated Water System Master Plan

Figure 4-2
Condition Assessment Results

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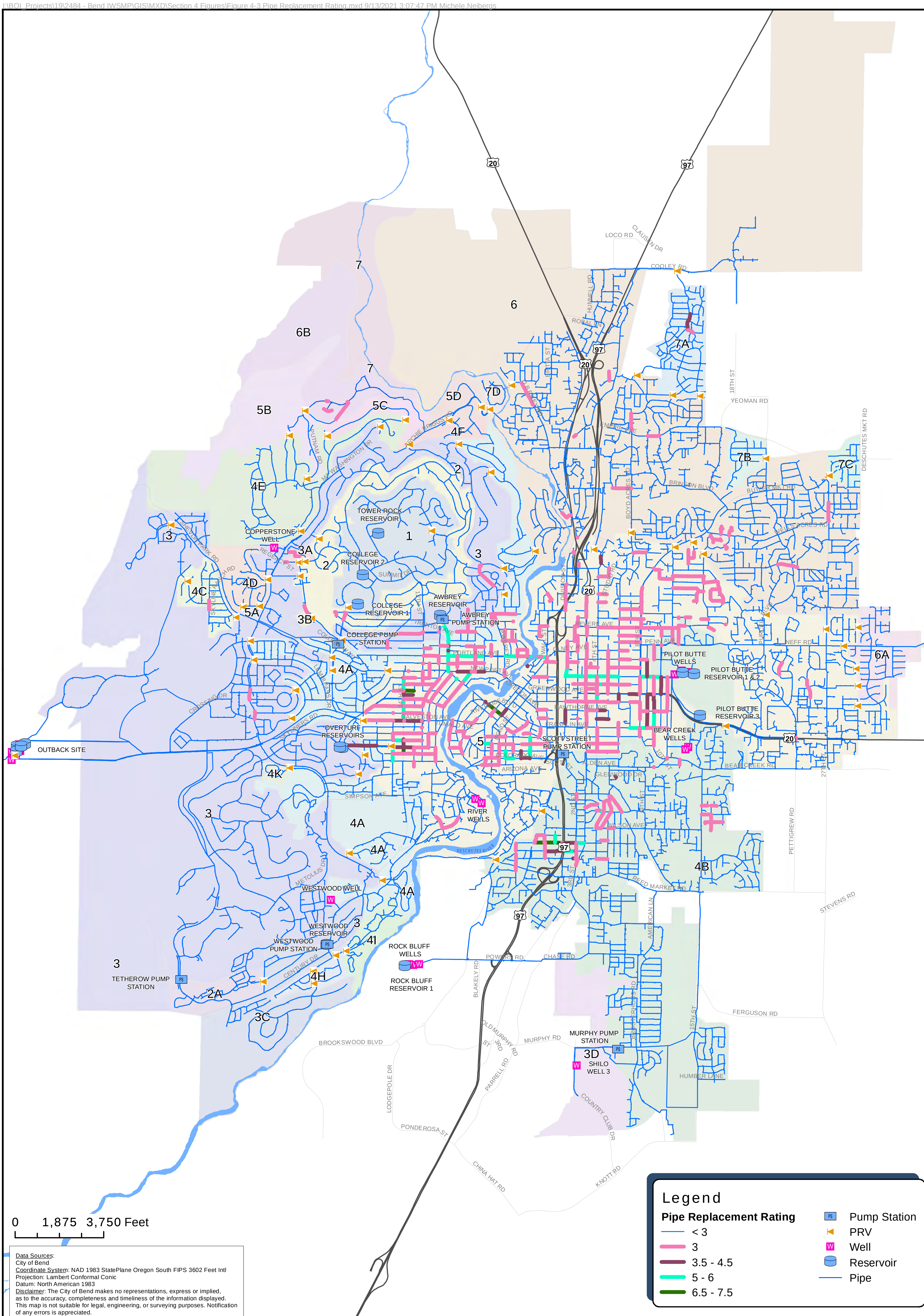

murraysmith	City of Bend Integrated Water System Master Plan	Figure 4-3 Pipe Replacement Rating

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4.4 Capacity Analysis

Many of the specific LOS criteria in **Section 3** address the hydraulic capacity requirements of the system. These are intended to evaluate the capacity of the system components including water rights, supply, storage, pumping, and pipe to reliably provide water to City customers under a variety of demand, emergency, or operational conditions.

The capacity analysis includes several numerical comparisons of facility capacities relative to demand conditions, based on unique requirements for different system assets consistent with the LOS criteria. A hydraulic model is used to evaluate the overall interaction of the system components, particularly the pipe network capacity to convey water from wells, storage, and booster pump stations to customers distributed throughout the system.

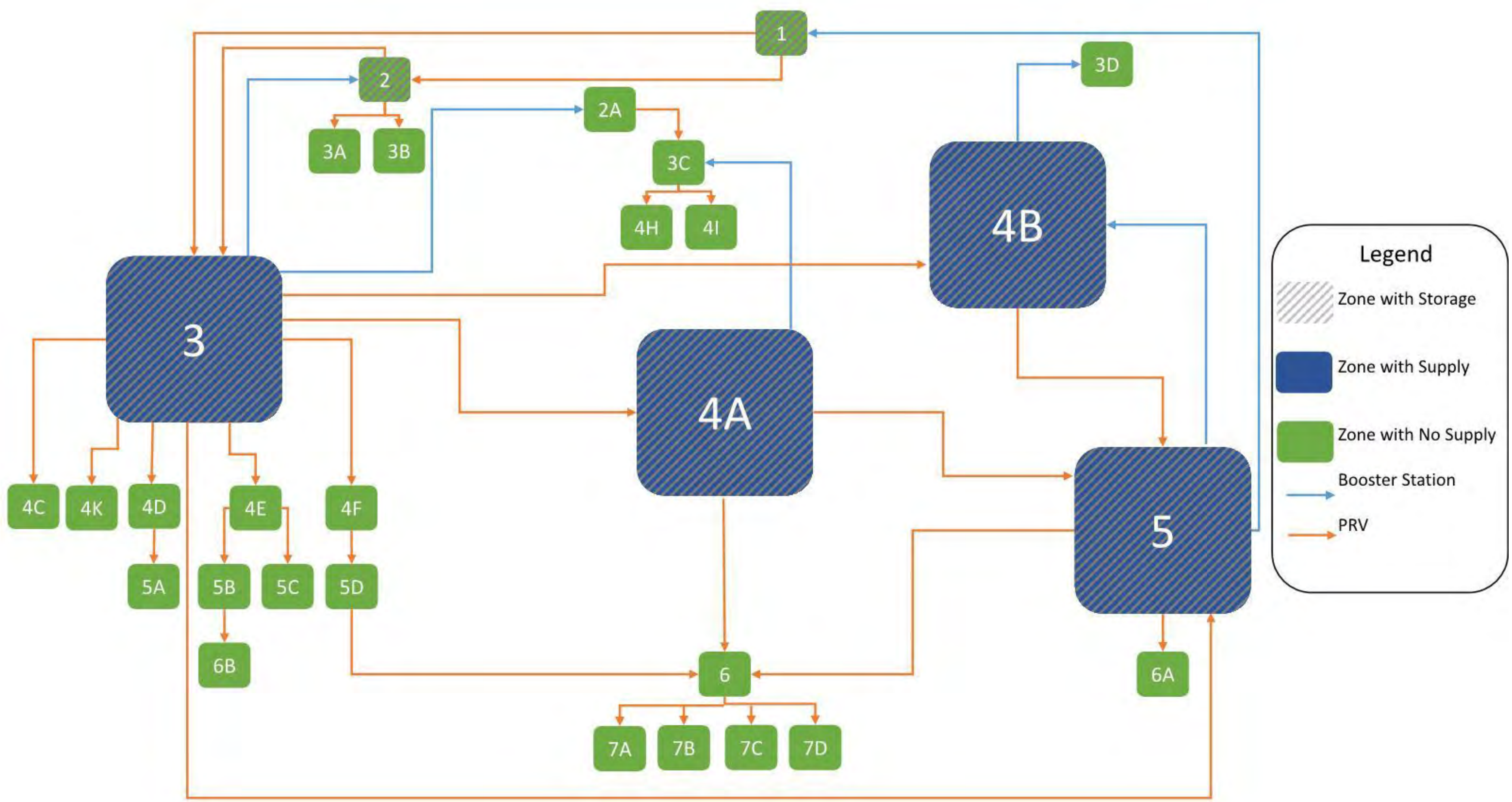
The facility and distribution system capacity assessment results are used in the Optimization Analysis described later in this section to determine recommended improvements to address deficiencies in meeting the LOS criteria.

4.4.1 Facility Capacity Assessment

The facility capacity assessment compares existing and projected demand requirements to the City's existing water rights (surface water and groundwater), supply capacity at the Water Filtration Facility (WFF) and wells, storage reservoir, and pump station capacity. To support the City's LOS goals for redundancy and meet regulatory requirements where applicable, the analysis generally includes conservative assumptions regarding system capacity, such as assuming the largest supply source is out of service in each zone. Additionally, it uses the City's current limiting surface water right (limited by special permits and City ordinance), rather than the City's total historic water rights portfolio. The analysis incorporates these considerations as well as the LOS requirements to illustrate the adequacy of existing facilities to meet future demand conditions and indicate where improvements are necessary.

Many of the facilities are designed to serve the pressure zone they are in, as well as other subzones. **Figure 4-4** shows the interconnectivity of the system with regards to supply and storage and the pressure reducing valve (PRV) and booster pump station connections that can convey the supply and storage to other zones and subzones. The analysis considers supply groups based on where water can be served, and storage groups based on which subzones each zone with storage can serve. Additional detail about each facility, its respective capacity and interconnectivity are in **Figure 1-3** and in **Section 1**.

Figure 4-4 | Pressure Zone Supply and Storage Group Connectivity



4.4.1.1 Water Rights Analysis

Table 4-4 presents the City's water rights for both groundwater and surface water sources as compared to the maximum day demand (MDD) over the 10-year and 20-year planning horizons. The specific capacity and limitations on the City's water rights are discussed in **Section 1**.

As indicated in **Table 4-4**, the City's surface water and groundwater rights are sufficient to provide the City's maximum day demand through 2040.

Table 4-4 | Water Rights Analysis

Water Source	Water Right (gpm)	Total Water Right (gpm)	MDD (gpm)			Surplus/Deficiency (gpm)		
			2018	2030	2040	2018	2030	2040
Surface	8,169	38,798	19,519	26,391	31,375	19,279	12,407	7,423
Groundwater	30,629							

More extensive discussion and review of the City's water rights requirements are included in the Water Management and Conservation Plan (WMCP) completed in parallel with this iWSMP. The WMCP analysis considers additional restrictions on the City's surface water supply, fluctuations in demand throughout the day, and the City's water right needs beyond the 2040 horizon covered in this iWSMP.

4.4.1.2 Supply Analysis

For the supply analysis, a spreadsheet calculation of the balance of available supply relative to demand was done. Zones with groundwater or surface water supply sources and the subzones without supply that they serve were grouped together into supply groups. The supply groups for this analysis are shown in **Table 4-5** and reflected in **Figure 4-4**. The system must be able to provide MDD in each zone with firm capacity, or the largest supply out of service. The City uses a combination of surface water and groundwater to supply the system. For Zone 3, the firm capacity is calculated as one membrane filtration train out of service at the WFF. For every other zone with supply the firm capacity assumes the largest well in the zone is out of service.

The City operates the system to maximize use of the surface supply when feasible and uses groundwater supply only to meet demands above the maximum available surface water supply or to meet localized demand requirements. During existing peak demand periods, the City fully utilizes its available surface water rights. The surface water is used as the first supply since it is less expensive to use than the groundwater wells which require pumping. This also allows more consistent flows through the WFF, which provides greater operational stability. The potential for hydropower generation could also be maximized with use of the surface water supply and contribute to the City's goals to reduce fossil fuel use but requires additional study and would require City Council approval. The surface water supply is more vulnerable to a watershed water quality disruption, such as a wildfire, and additional pretreatment at the facility would increase the resilience and ability to depend on maximum use of this supply. The wells are more easily operated to meet fluctuations in demand above the base supply from the WFF.

The City's capacity from existing wells and the WFF to meet existing and future demands by zone and system-wide is in **Table 4-6**. Though there are some zones showing a current deficit, the overall excess system-wide supply can help meet demands via valve connections to zones with excess supply. By 2030, system-wide supply deficiencies exist. Since no additional surface water rights are available, additional well supply will be required to meet future MDD.

Table 4-5 | Supply Groups

Primary Supply Group	Zones Supplied
3	3, 2, 2A, 3A, 3B, 3C, 4C, 4D, 4E, 4F, 4H, 4I, 4K, 5A, 5B, 5C, 5D, 6B
5	5, 1, 6, 6A, 7A, 7B, 7C, 7D
4A	4A
4B	4B, 3D

Table 4-6 | Supply Analysis

Zone Group	Total Capacity (gpm)	Firm Capacity (gpm)	MDD (gpm)			Surplus/Deficit (gpm)		
			2018	2030	2040	2018	2030	2040
3	16,519	14,950[1]	4,974	6,524	7,377	9,976	8,426	7,573
4A	700	0	1,220	1,666	2,246	(1,220)	(1,666)	(2,246)
4B	5,700	4,500	3,106	4,517	5,421	1,394	(17)	(921)
5	6,500	4,600	10,220	13,684	16,330	(5,620)	(9,084)	(11,730)
System-wide	29,419	**24,050**	**19,519**	**26,391**	**31,375**	**4,531**	**(2,341)**	**(7,325)**

Note:
1. Firm capacity for zone group 3 is based on one of the three active membrane filtration trains out of service at the WFF.

The City also has a level of service requirement to supply average winter demands using solely the groundwater or solely the surface water sources. Based on the ability to move supply water across all zones, particularly to meet the lower winter demand, the analysis was done system wide. **Table 4-7** summarizes the City's capacity to achieve that objective. There is adequate supply from either the groundwater or surface water sources alone to meet winter demand.

Table 4-7 | Winter Demand Supply Analysis

Supply	Total Capacity (gpm)	Firm Capacity (gpm)	Average Winter Daily Demand[2] (gpm)			Surplus/Deficit (gpm)		
			2018	2030	2040	2018	2030	2040
Groundwater	21,250	17,450	3,386	4,578	5,443	14,064	12,872	12,007
Surface Water	8,169	6,600[1]				3,214	2,022	1,157

Notes:
1. Firm capacity for zone group 3 is based on one of the three active membrane filtration trains out of service at the WFF.
2. Average Winter Demand based on the 2018 ratio of average day demand (ADD) to Winter Demand of 37 percent.

4.4.1.3 Backup Power Analysis

To provide resilience and reliable water delivery during an emergency, in the event of a power outage, the system should have adequate backup power to meet average day demand (ADD) through on-site backup power or two days of ADD in standby storage. **Table 4-8** and **Table 4-9** present an analysis of the City's backup power capacity for water supply sources and booster pumping stations, respectively. The City's primary supply, the WFF has backup power to operate during a power outage. The Westwood and Scott Street Pump Stations do not have backup power. They are redundant facilities to zones that can be served by wells or pump stations with backup power; as a result, they are not included in the analysis.

As shown in **Table 4-8**, most supply sources lack backup power, and three of four zone groups only have one supply source with backup power, resulting in a deficiency. However, there is considerable excess capacity in Zone Group 3, which can be used to offset deficits in most of the system. By 2040, the backup power analysis indicates a system-wide deficit. The backup power requirement can be met by adding generators to new supply wells.

As shown in **Table 4-9**, the College Pump Station and Murphy Pump Station have current and future deficits. The Murphy Pump Station is already equipped with a backup power supply; it simply has insufficient pumping capacity to meet the fire flow requirement. The City is currently designing and planning to construct a higher capacity replacement of the Murphy Pump Station that can operate with the existing generator so it will have adequate standby capacity at the completion of the improvement. Zone 2, served by the College Pump Station can be supplied from Zone 1 through PRV connections allowing the excess backup power capacity in Zone 1 to serve the deficiency in Zone 2. No improvements are necessary to meet the emergency power requirements.

Table 4-8 | Backup Power Analysis of Supply Sources by Zone Group

Zone Group	Facility	Backup Power Available	Total Capacity (gpm)	Backup Firm Capacity (gpm)	Fire Flow (gpm)	ADD (gpm)			Surplus/Deficit (gpm)		
						2018	2030	2040	2018	2030	2040
3	WFF[1]	Yes	8,169	6,600	Met through storage	2,326	3,051	3,450	8,293	7,568	7,169
	Copperstone Well	No	950	0							
	Outback Well 1	No	800	0							
	Outback Well 2	No	950	0							
	Outback Well 3	No	1,050	0							
	Outback Well 4	Yes	1,150	1,150							
	Outback Well 5	No	1,050	0							
	Outback Well 6	No	1,100	0							
	Outback Well 7	Yes	1,300	1,300							
4A	Westwood Well	Yes	700	0	Met through storage	570	779	1,050	130	(79)	(350)
4B	Bear Creek Well 1	No	1,050	0	Met through storage	1,452	2,112	2,535	(352)	(1,012)	(1,435)
	Bear Creek Well 2	Yes	1,100	0							
	Rock Bluff Well 1	No	750	0							
	Rock Bluff Well 2	No	800	0							
	Rock Bluff Well 3	No	800	0							
	Shilo Well 3	No	1,200	0`							
5	Pilot Butte Well 1	No	750	0	Met through storage	4,779	6,399	7,636	(3,629)	(5,249)	(6,486)
	Pilot Butte Well 3	No	900	0							
	Pilot Butte Well 4	Yes	1,150	0							
	River Well 1	No	1,800	0							
	River Well 2	No	1,900	0							
System-wide			**29,419**	**9,050**		**9,127**	**12,340**	**14,671**	**4,442**	**1,229**	**(1,102)**

Notes:
1. WFF firm capacity is based on one of the three active membrane filtration trains out of service.

Table 4-9 | Backup Power Analysis of Booster Pumping Stations by Zone

Zone	Facility	Backup Power Available	Total Capacity (gpm)	Backup Firm Capacity (gpm)	Fire Flow (gpm)	ADD (gpm)			Surplus/Deficit (gpm)		
						2018	2030	2040	2018	2030	2040
1	Awbrey Pump Station	Yes	3,600	3,600	Met through storage	272	307	323	3,328	3,293	3,277
2	College Pump Station	No	2,200	0	Met through storage	286	318	335	(286)	(318)	(335)
2A, 4H, 4I	Tetherow Pump Station	Yes	3,800	3,800	2,500	100	147	158	1,200	1,153	1,142
2A, 4H, 4I, 3C	Tetherow Pump Station	Yes	3800	3800	2,500	258	341	362	1,042	959	938
3D	Murphy Pump Station	Yes	1,500	1,500	2,500	3	8	13	(1,003)	(1,008)	(1,013)

4.4.1.4 Storage Analysis

Storage in the system is intended to serve four purposes: operational, equalization, fire suppression, and standby storage (if adequate standby power is not provided). The total distribution storage required is the sum of the four components plus dead storage. Dead storage is the volume of water not available for system use due to operational constraints or that provides substandard customer pressures.

The system has 15 tanks as described in **Section 1**. For the analysis, zones with storage were grouped together with the subzones that they serve through PRVs or pump stations, as outlined in **Table 4-10** and illustrated in **Figure 4-4**. Fire suppression storage was determined assuming the single highest fire flow requirement base on land use across the zones the storage serves which is also indicated in **Table 4-10**.

Table 4-10|Storage Groups and Fire Flow Requirements

Storage Group	Zones Served	Highest Fire Flow Requirement (gpm)	Duration (hours)
1	1	1,500	2
2	2, 3A, 3B	2,500	3
3	3, 4D, 4C, 4K, 4F, 2A, 3C, 4H, 4I, 4E,5B, 5D, 6B,5C,5A	2,500	3
4A	4A	2,500	3
4B	4B, 3D	2,500	3
5	5, 6A, 6, 7A, 7B, 7C, 7D	3,500	5

Dead storage was calculated as all unavailable water in tanks to maintain levels for various purposes including to provide 20 pounds per square inch (psi) to the highest customer in the zone, provide adequate contact time at the WFF to meet regulatory requirements, or provide adequate suction pressure for service line booster pumps or pump stations. Tower Rock dead storage is based on providing minimum pressure to high elevation customers. Outback 2 dead storage is the level required to maintain adequate contact time in the Contact Time (CT) Basin. Outback 3 dead storage is the level required to maintain adequate suction pressure at the individual service line boosters in the nearby Tree Farm Development and Awbrey Reservoir's dead storage level is based on maintaining a minimum level to provide adequate suction pressure for the Awbrey Pump Station. The dead storage components could potentially be addressed through operational or other system modifications and are used in this analysis to determine any additional existing or future storage volumes required.

Operational storage was determined based on summer tank operations as the difference between pump on and off settings. Equalization storage was calculated as the difference between the peak hour demand (PHD) and total supply capacity for 150 minutes. Standby storage represents 2 days of the difference between average day demand (ADD) and firm supply capacity with backup power. Standby storage can also be reduced to a minimum of 200 gallons per equivalent residential unit (ERU) if adequate backup power exists at supply sources to meet at least ADD. Reducing the volume of standby storage can also help with operations and improving water age so balancing the available storage during an emergency with the unused storage that can negatively impact water age and quality is an important operational consideration.

The storage analysis in million gallons (MG) is shown with the full standby storage requirement in Table 4-11 and with the minimum standby storage (assuming 200 gallons per ERU) requirement in Table 4-12. The maximum available volume for each tank is based on the high operational level of each tank and is generally set below the maximum tank level to avoid tank overflows.

The system has significant existing storage deficiencies with the larger standby storage requirement, however, by using the standby power criteria to reduce the standby storage requirement, the existing system has adequate storage system-wide. Although some zone groups have deficiencies, they can leverage surplus storage from high zones through valve connections. The ability to move storage across the system from surplus to deficient zone groups was validated using the hydraulic model analysis. By 2030 there are system-wide storage deficiencies that will require approximately 2.25 MG of additional storage and another 3.5 MG by 2040 for a minimum additional storage requirement of 5.75 MG. The additional storage is needed in Zone 3, Zone 5, and Zone 4B.

Table 4-11 | Storage Analysis with Larger Standby Storage Requirement

Storage Group	Tank	Max Operated Volume (MG)	Dead/Unavailable (MG)	Storage Requirements (MG)											Surplus/Deficit (MG)		
				Fire	Operational	Equalization			Standby			Total					
						2018	2030	2040	2018	2030	2040	2018	2030	2040	2018	2030	2040
1	Tower Rock	0.90	0.01[1]	0.18	0.06	0.15	0.17	0.17	0.24	0.27	0.28	0.63	0.68	0.70	0.26	0.21	0.19
2	College 1, College 2	1.44	0.00	0.45	0.22	0.17	0.18	0.20	0.85	0.95	1.01	1.69	1.81	1.87	(0.25)	(0.37)	(0.43)
3	Outback 2, Outback 3	6.51	3.08[2]	0.45	0.38	0.24	0.75	1.03	1.78	2.38	2.71	2.85	3.96	4.58	0.58	(0.53)	(1.15)
4A	Overturf East & West, Westwood	3.27	0.00	0.45	0.83	0.30	0.45	0.64	1.64	2.24	3.02	3.22	3.97	4.94	0.05	(0.70)	(1.67)
4B	Pilot Butte 2, Rock Bluff	2.45	0.00	0.45	0.25	0.12	0.57	0.85	4.18	6.08	7.30	5.01	7.35	8.85	(2.56)	(4.90)	(6.40)
5	Awbrey, Pilot Butte 1, Pilot Butte 3	10.10	1.46[3]	1.05	2.01	1.67	2.63	3.34	12.98	17.54	21.06	17.70	23.23	27.46	(9.07)	(14.59)	(18.83)
System-wide		**24.67**	**4.55**	**3.03**	**3.76**	**2.64**	**4.74**	**6.23**	**21.67**	**29.47**	**35.39**	**31.10**	**41.00**	**48.41**	**(10.98)**	**(20.88)**	**(28.29)**

Notes:
1. Dead Storage based on high elevation customers maintaining 20 psi.
2. Dead storage at Outback 2 based on maintaining 21 feet of storage in the CT Basin for contact time. Dead storage in Outback 2 based on maintaining 10.5 feet of storage to provide adequate suction pressure at Tree Farm service line booster pumps.
3. Dead Storage based on maintaining 6 feet of storage for adequate Awbrey Pump Station suction pressure.

Table 4-12 | Storage Analysis with Minimum Standby Storage Requirement

Storage Group	Tank	Max Operated Volume (MG)	Dead/Unavailable (MG)	Storage Requirements (MG)											Surplus/Deficit (MG)		
				Fire	Operational	Equalization			Standby			Total					
						2018	2030	2040	2018	2030	2040	2018	2030	2040	2018	2030	2040
1	Tower Rock	0.90	0.01[1]	0.18	0.06	0.15	0.17	0.17	0.24	0.27	0.28	0.63	0.68	0.70	0.26	0.21	0.19
2	College 1, College 2	1.44	0.00	0.45	0.22	0.17	0.18	0.20	0.26	0.29	0.31	1.10	1.15	1.17	0.34	0.29	0.27
3	Outback 2, Outback 3	6.51	3.08[2]	0.45	0.38	0.24	0.75	1.03	1.78	2.38	2.71	2.85	3.96	4.58	0.58	(0.53)	(1.15)
4A	Overturf East & West, Westwood	3.27	0.00	0.45	0.83	0.30	0.45	0.64	0.50	0.68	0.92	2.08	2.41	2.84	1.19	0.86	0.43
4B	Pilot Butte 2, Rock Bluff	2.45	0.00	0.45	0.25	0.12	0.57	0.85	1.27	1.85	2.22	2.10	3.12	3.77	0.35	(0.67)	(1.32)
5	Awbrey, Pilot Butte 1, Pilot Butte 3	10.10	1.46[3]	1.05	2.01	1.67	2.63	3.34	3.94	5.33	6.40	8.67	11.02	12.80	(0.03)	(2.38)	(4.17)
System-wide		**24.67**	**4.55**	**3.03**	**3.76**	**2.64**	**4.74**	**6.23**	**7.99**	**10.80**	**12.84**	**17.42**	**22.33**	**25.86**	**2.70**	**(2.21)**	**(5.74)**

Notes:
1. Dead Storage based on high elevation customers maintaining 20 psi.
2. Dead storage at Outback 2 based on maintaining 21 feet of storage in the CT Basin for contact time. Dead storage in Outback 2 based on maintaining 10.5 feet of storage to provide adequate suction pressure at Tree Farm service line booster pumps.
3. Dead Storage based on maintaining 6 feet of storage for adequate Awbrey Pump Station suction pressure.

4.4.1.5 Booster Pump Station Analysis

There are six booster stations in the existing system. The criteria for booster stations depends on whether the zone served has gravity storage (open system) or not (closed system). In an open system, assuming the storage is adequate for fire suppression and equalization, the booster pump station total capacity must be equal to or larger than MDD for the zones it serves. Also, the firm capacity must be equal to or larger than ADD. In a closed system, the booster pump station must be able to provide PHD with the largest pump out of service and MDD plus fire flow with the largest "routinely used" pump out of service.

The MDD and ADD analyses of the pump stations serving zones with storage are in **Table 4-13** and **Table 4-14 respectively.** The Awbrey Pump Station and College Pump Station have sufficient capacity to meet the MDD and ADD requirements of their respective open zones through the 20-year planning period. The Scott Street Pump Station serves as a backup supply to Zone 4B and is not intended to meet system demands. As a result, it is not included in the analysis.

Table 4-13|Open System MDD Analysis

Zones Served	Booster Station	Total Capacity (gpm)	MDD (gpm)			Surplus/Deficit (gpm)		
			2018	2030	2040	2018	2030	2040
1	Awbrey	3,600	582	658	691	3,018	2,942	2,909
2, 3A, 3B	College	2,200	632	708	747	1,568	1,492	1,453

Table 4-14|Open System ADD Analysis

Zones Served	Booster Station	Total Capacity (gpm)	Firm Capacity (gpm)	ADD (gpm)			Surplus/Deficit (gpm)		
				2018	2030	2040	2018	2030	2040
1	Awbrey	3,600	2,400	272	307	323	2,128	2,093	2,077
2, 3A, 3B	College	2,200	1,100	296	331	349	804	769	751

The analysis of the pump stations serving zones without storage is in **Table 4-15** and **Table 4-16**. The Tetherow Pump Station directly serves Zone 2A and can serve Zones 3C, 4H, and 4I through a PRV connection. Those zones can also be served by the Westwood Pump Station. These three zones could be served by either pump station or a combination of the two operating together. Although the Westwood Pump Station does not have adequate capacity, the Tetherow Pump Station can serve all four zones. The Tetherow Pump Station has a minimal deficiency by 2040 that does not merit additional pump capacity since the pumping capacity will be a bit higher than shown under fire flow conditions when the pump is operating farther out on its curve and pressure criteria are lower than typical operating requirements. In addition to the spreadsheet analysis, the Tetherow Pump Station capacity was validated through the hydraulic model and determined not to require improvements. As shown in **Table 4-16**, the Murphy Pump Station has insufficient capacity to meet the MDD plus fire flow demand requirements for Zone 3D. The City is currently designing and planning to construct a higher capacity replacement of the Murphy Pump Station that will address the deficiency.

Table 4-15 | Closed System PHD Analysis

Zones Served	Booster Station	Total Capacity (gpm)	Firm Capacity (gpm)	PHD (gpm)			Surplus/Deficit (gpm)		
				2018	2030	2040	2018	2030	2040
2A	Tetherow	3,920	3,220	117	294	294	3,103	2,926	2,926
2A, 3C, 4H, 4I[1]	Tetherow	3,920	3,220	1,269	1,674	1,780	1,951	1,546	1,440
3C, 4H, 4I[1]	Westwood	2,275	1,375	1,151	1,380	1,486	224	(5)	(111)
3D	Murphy	1,500	1,200	13	35	60	1,187	1,165	1,140

Note:
1. Zones 3C, 4H, and 4I can be served by the Westwood Pump Station directly or the Tetherow Pumps Station via a PRV connection.

Table 4-16 | Closed System MDD+Fire Flow Analysis

Zones Served	Booster Station	Total Capacity (gpm)	Firm Capacity (gpm)	Fire Flow (gpm)	MDD (gpm)			Surplus/Deficit (gpm)		
					2018	2030	2040	2018	2030	2040
2A	Tetherow	3,920	3,220	2,500	51	128	128	669	592	592
2A, 3C, 4H, 4I[1]	Tetherow	3,920	3,220	2,500	552	728	774	168	(8)	(54)
3C, 4H, 4I[1]	Westwood	2,275	1,375	1,500	501	601	647	(626)	(726)	(772)
3D	Murphy	1,500	1,200	2,500	6	17	29	(1,306)	(1,317)	(1,329)

Note:
1. Zones 3C, 4H, and 4I can be served by the Westwood Pump Station directly or the Tetherow Pumps Station via a PRV connection.

4.4.2 Distribution System Capacity Assessment

Distribution system performance was assessed using the City's hydraulic model to evaluate the service pressure and velocity criteria summarized in **Section 3**. Pressures should not fall below 30 psi under PHD conditions and 20 psi under MDD plus fire flow conditions. Where feasible operating pressures should remain between 40 and 80 psi with a maximum of 120 psi. Pipe flow velocity criteria were also used during the distribution system analysis to indicate potential areas of undersized piping. Distribution piping was assessed based on a maximum velocity of 5 feet per second (fps) under ADD and MDD conditions and 8 fps under PHD conditions. Typically, velocity criteria alone will not drive an improvement, but are used to determine capacity constraints and inform improvements to address overall system capacity limitations.

4.4.2.1 Hydraulic Model

The City's existing hydraulic model in InfoWater software by Innovyze was updated and calibrated under both steady state and EPS conditions in 2018, as documented in the City's Calibration memo in **Appendix 4A**. The calibrated model was used to evaluate the performance of the distribution system under existing and future demand conditions to identify deficiencies and evaluate the adequacy of improvements.

4.4.2.1.1 Modeling Conditions

Distribution system analysis was initially performed using the steady state model scenarios for existing, 10-year, and 20-year conditions for ADD, MDD, PHD and MDD plus fire flow conditions to identify deficiencies. The Optimization Analysis described later in this section was completed using a 2040 EPS scenario. Operational Analysis described later in this section were done using the model existing MDD and winter demand condition EPS scenarios.

4.4.2.1.2 Demand

Existing demand was allocated in the model during the 2018 calibration based on the location of meters using AMI data, which was updated to match 2018 production. The AMI data was also evaluated to determine hourly use patterns for winter and summer periods for Zones 1, 2, 3, 4A, 4B, 5, and 6. The AMI peaking factors by zone were used to determine a representative PHD peaking factor relative to MDD for each primary zone.

Future water demands were calculated based on unit values associated with the number of employees and housing units projected in identified growth areas. The projected demands are outlined in Section 2.

4.4.2.1.3 Fire Flow

Fire flow requirements are based on land use type as per the City of Bend Standards and Specifications. For residential areas, the fire flow requirement is 1,500 gpm. Commercial and publicly owned properties have a requirement of 2,500 gpm. The Central Business District area has a requirement of 3,500 gpm.

4.4.2.2 Distribution System Results

A steady state system analysis was performed to assess the ability of the City's current distribution system to provide water for existing and projected future demands and fire suppression.

4.4.2.2.1 Existing Condition Analyses

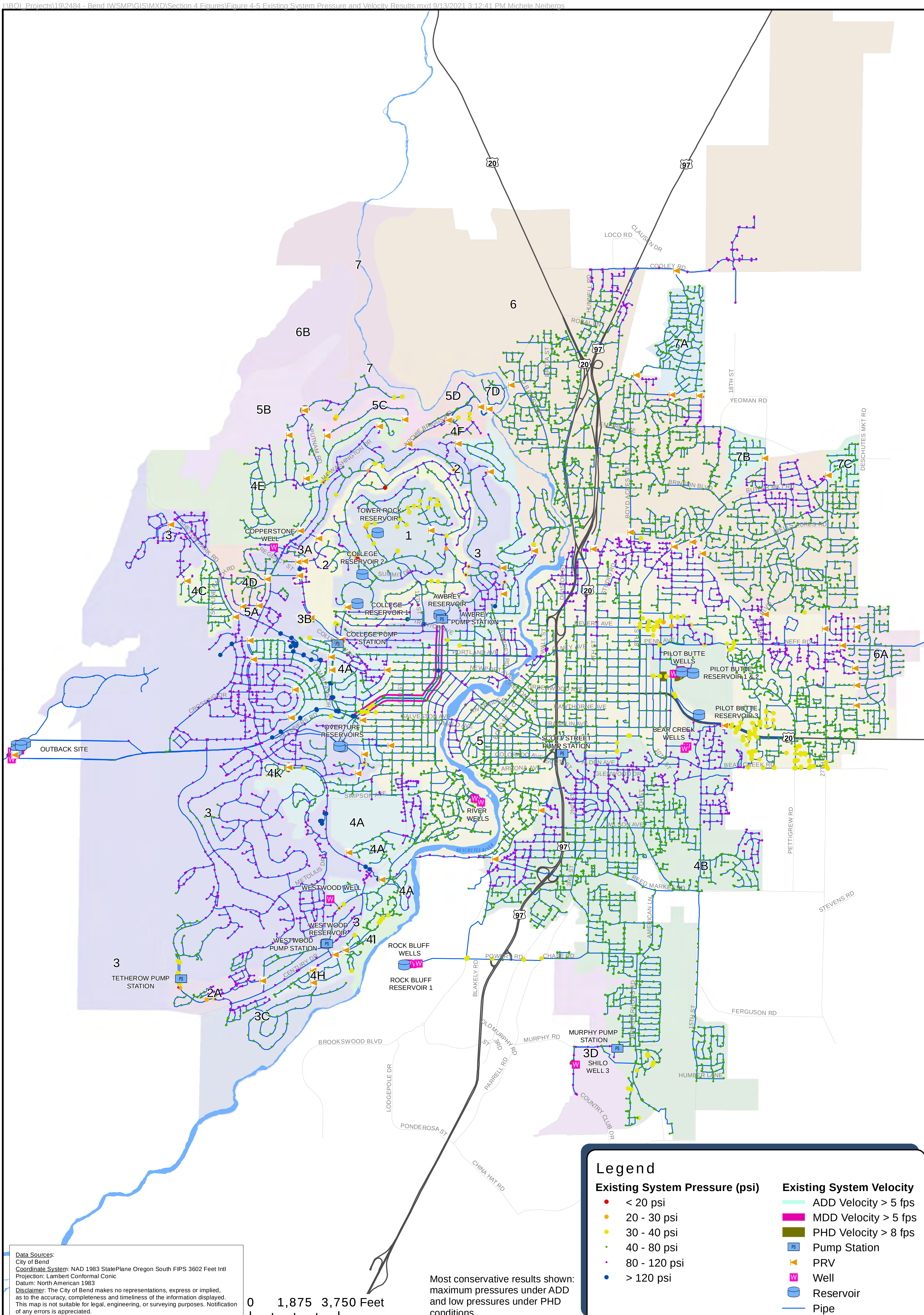
The system was modeled under existing ADD, MDD and PHD conditions. Under each scenario there are areas of pressures below 40 psi and above 120 psi across the system. In part this is due to a wide range in elevation throughout the system. In addition, some low pressures are a result of head loss due to conveying water from the Outback Facility to the rest of the system. It should be noted that areas of low pressure exist in the Tree Farm development, however this was a known condition when the area was developed. Service line booster pumps provide adequate service pressure and 20 psi minimum pressure during fire flows to customers. The booster pumps were not modeled as part of this analysis, however requirements to provide a minimum suction pressure of 7 psi was evaluated for each of the service line boosters. In addition, in all demand scenarios there are areas of high pressure above 120 psi. In these areas it is recommended that customers install PRVs on their service lines consistent with plumbing code requirements. The range of system pressures for ADD and PHD conditions are shown in Figure 4-5. Low pressures generally occur during PHD due to higher head loss and the high pressures during ADD.

Under existing ADD and MDD scenarios, a few areas exceed velocity requirements. Most of these are very small segments of facility site piping at Outback or other facilities. The most significant velocity exceedance of up to 8 fps during MDD occurs in the Awbrey transmission line that conveys flow from Outback to the Awbrey Reservoir. High velocities in the Awbrey transmission line are of particular concern because the pipe is seventy years old and the primary corridor to convey water from the Outback Facility to meet the demands on the east side of the system in Zone 5 and Zone 6. Existing velocity exceedances are shown in Figure 4-5.

Under the MDD plus fire flow scenario, there are areas in the system that cannot adequately meet fire flow requirements. The deficiencies and flow available at each hydrant are shown in Figure 4-6. The deficiencies are primarily due to small diameter and/or dead-end pipe. Improvements to address fire flow deficiencies were primarily evaluated using the steady state InfoWater model and are identified in Section 6.

4.4.2.2.2 Future Scenario Analyses

Future scenarios were run with future demand projections and existing system infrastructure to identify all future system deficiencies. As expected, due to significant increases in demand and future deficiencies in supply and storage, there are many areas in the system that have pressures below 30 psi and velocities that exceed 8 fps if the existing system infrastructure were to serve 2040 PHD. These deficiencies are useful to illustrate potential areas for improvement that were used in the Optimization Analysis that ultimately determined what supply and pipe improvements were needed to meet future system requirements. Future system deficiencies are shown in Figure 4-7.



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City of Bend
Integrated Water System Master Plan

Figure 4-5
Existing System Pressure & Velocity Results

Exhibit 26

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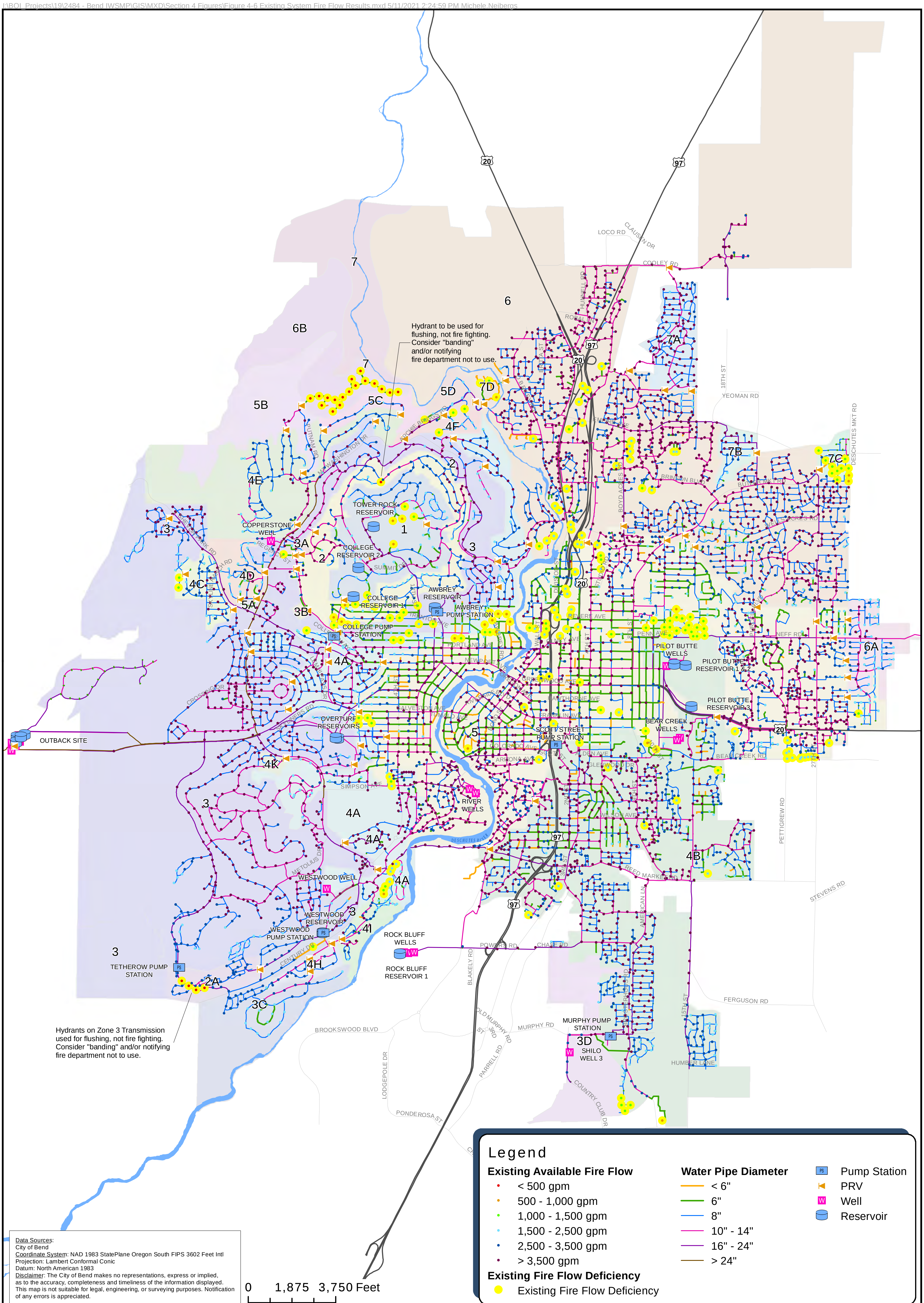
19-2484

I:\BOI_Projects\19\2484 - Bend IWSMP\GIS\MXD\Section 4 Figures\Figure 4-6 Existing System Fire Flow Results.mxd 5/11/2021 2:24:59 PM Michele.Neibergs



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City of Bend
Integrated Water System Master Plan

Figure 4-6
Existing System
Fire Flow Results

Exhibit 26

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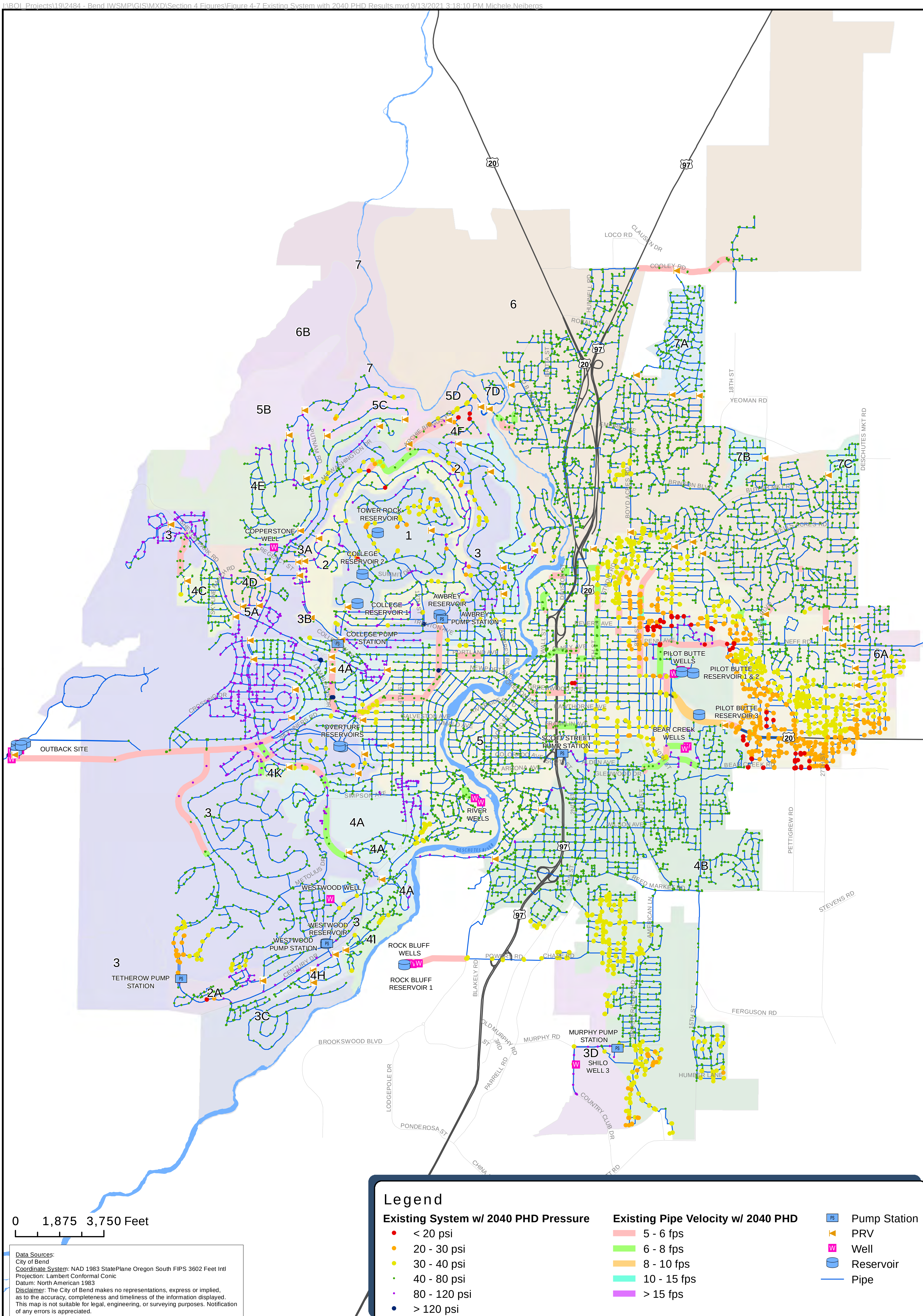
September 2021

19-2484

I:\BOI_Projects\19\2484 - Bend IWSMP\GIS\MXD\Section 4 Figures\Figure 4-7 Existing System with 2040 PHD Results.mxd 9/13/2021 3:18:10 PM Michele.Neiberos



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City of Bend
Integrated Water System Master Plan

Figure 4-7
Existing System with 2040 PHD Results

September 2021

19-2484

4.5 Criticality Analysis

In addition to a hydraulic capacity assessment, a review of the consequence of failure of supply, pipe, and valve assets was conducted. This criticality or consequence of failure analysis provides a more detailed look at the redundancy and resiliency of the system to an unplanned interruption in service due to asset failure or other emergency condition. This criticality analysis is in addition to the America's Water Infrastructure Act (AWIA) Risk and Resilience Assessment that the City recently completed.

A review of the supply critically was completed, and the hydraulic model was used to identify critical system pipes and valves that would result in significant demand impacts, low pressures, or disruptions in service if a pipe or valve failed. The pipe criticality assessment indicates how much demand (also related to number of customers) is impacted if a pipe breaks and the valve criticality analysis determines the number of valves required to isolate a pipe. These analyses were completed using the 2018 MDD EPS scenario imported into the Optimatics software Opticritical. The valve criticality evaluation that determines the number of valves required to isolate an area if a valve breaks was done in the InfoWater Valve Criticality Modeling extension using the 2018 steady state model.

The pipe criticality results were used to identify improvements to increase redundancy in areas where a single pipe break could isolate a significant amount of demand. The valve criticality assessment was used with other criteria to determine ratings and prioritization for the pipe condition assessment. The valve break assessment provides data for the City to identify where valve installations should be made and prioritizes valve exercising during operation and maintenance programs.

4.5.1 Supply Criticality Assessment

The capacity assessment of the supply sources, previously described, has some resiliency included since the analysis assumes firm capacity, or the largest supply source, in each supply zone, is out of service. However, given the large, and preferential use of the surface water supply, a high-level discussion with City staff was conducted concerning the potential for supply disruption or failure at the WFF, beyond the single membrane filtration train being out of service assumed in the capacity assessment. The anticipated largest disruption or reduction in capacity at the WFF was determined to be the result of a water quality issue, such as a wildfire, that would impact sediment loads in the influent water. A pretreatment facility is the most feasible option to address this potential vulnerability and was included as part of the original WFF design but was deferred during the WFF upgrades. An initial study to evaluate the feasibility and planning level costs of such a facility is being conducted as part of this iWSMP, with a more detailed Outback Facility Plan to follow. **Appendix 3A** includes the details of the Outback Siting Study.

4.5.2 Pipe Criticality Assessment

A pipe is considered critical if when broken and exposed to atmospheric pressure it cuts off supply to a significant demand or number of customers, to critical customers or causes pressures to drop below 20 psi. The Opticritical hydraulic model was used to iteratively break each pipe to determine if hydraulic LOS criteria were violated. The analysis identifies areas fed by a single pipeline. The City provided locations of large and/or critical customers and these were also considered in the evaluation. The analysis was run under 2018 MDD, and critical areas were identified as those that do not have redundant piping and impact more than 50 gpm of demand. The 50 gpm threshold is the equivalent of approximately 100 single-family connections on a MDD basis.

In addition, two transmission pipe corridors that convey significant supply throughout the system were identified as critical to system operations. These include the Outback and Awbrey transmission pipes. Although each facility pipe is critical to the system in different respects, many areas have redundant feeds through other well supplies or PRVs or serve a smaller portion of the system. However, these two transmission lines convey a large portion of the system supply, are critical to maximizing surface water use, and cannot be rerouted through other corridors. The critical pipes are shown in **Figure 4-8**. Improvements are included in **Section 6** to provide redundancy for each of these critical pipes.

4.5.3 Valve Criticality Assessment

The valve criticality analysis was completed using the City's GIS valve layer by associating isolation valves in the system with the nearest pipe. The Opticritical model was then used to simulate the number of valves required to isolate each pipe after a break. The larger the number of valves required, the more time and effort is required to isolate the area and the potential for a greater number of customers to be impacted by the isolation. The relative number of valves required to close a pipe were used in rating pipes for replacement in the pipe condition assessment.

Another analysis was completed to determine how many valves are needed to isolate an area if a valve was broken. These results can be used to prioritize valve exercising and adding additional isolation valves as part of operation and maintenance programs.

The number of valves to isolate a pipe and to isolate a broken valve are shown in **Figure 4-9**.

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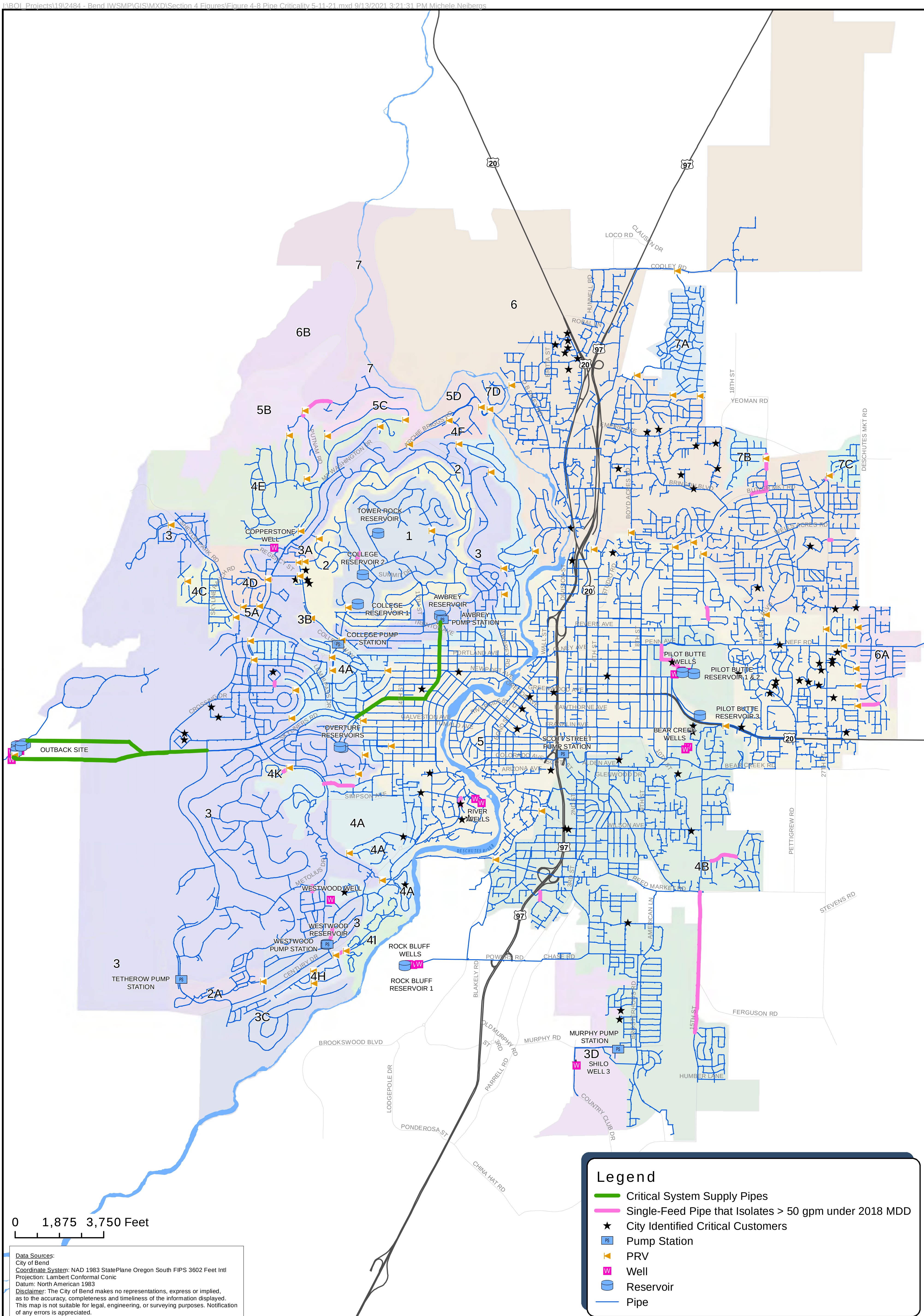

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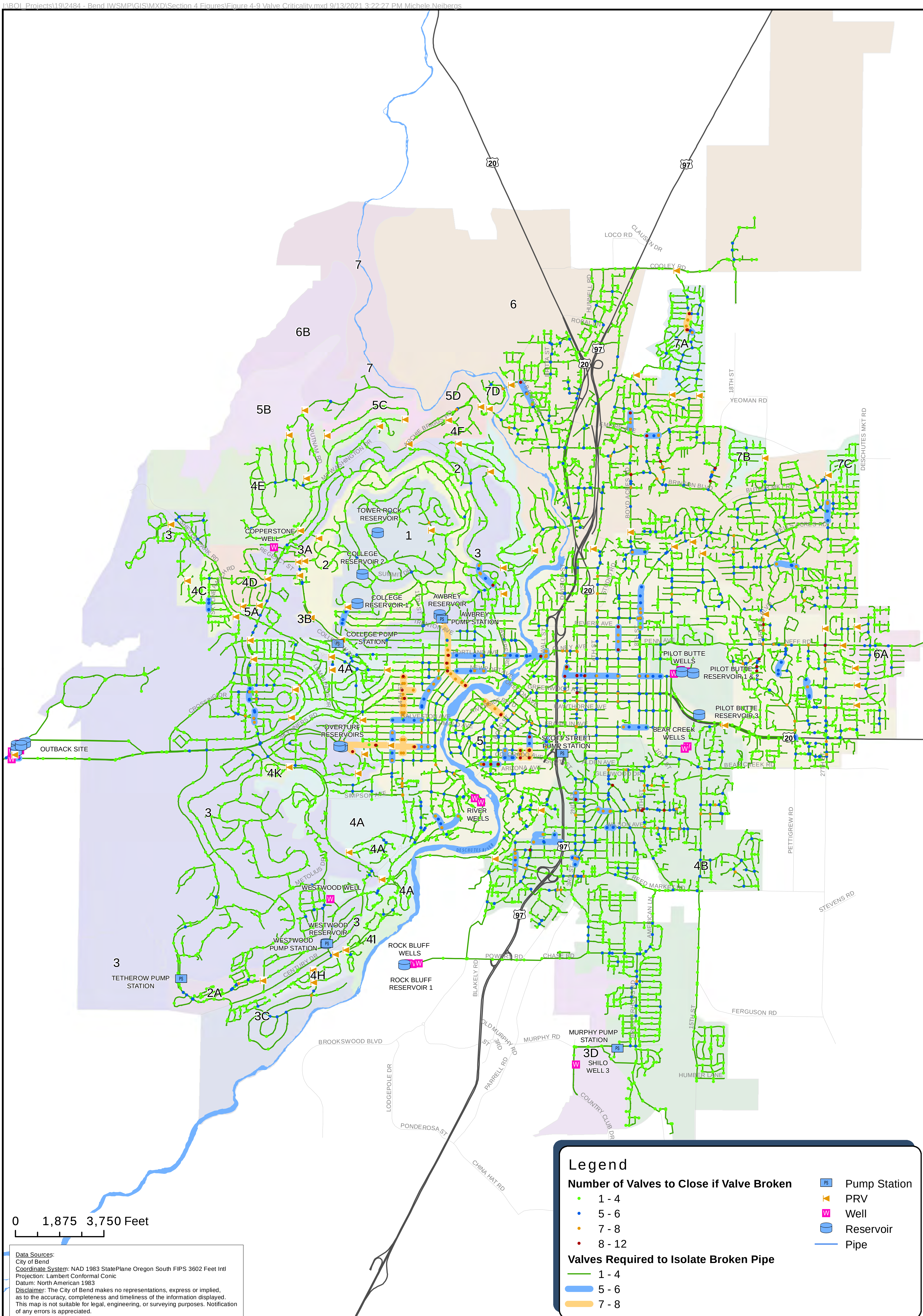

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Figure 4-9
Valve Criticality

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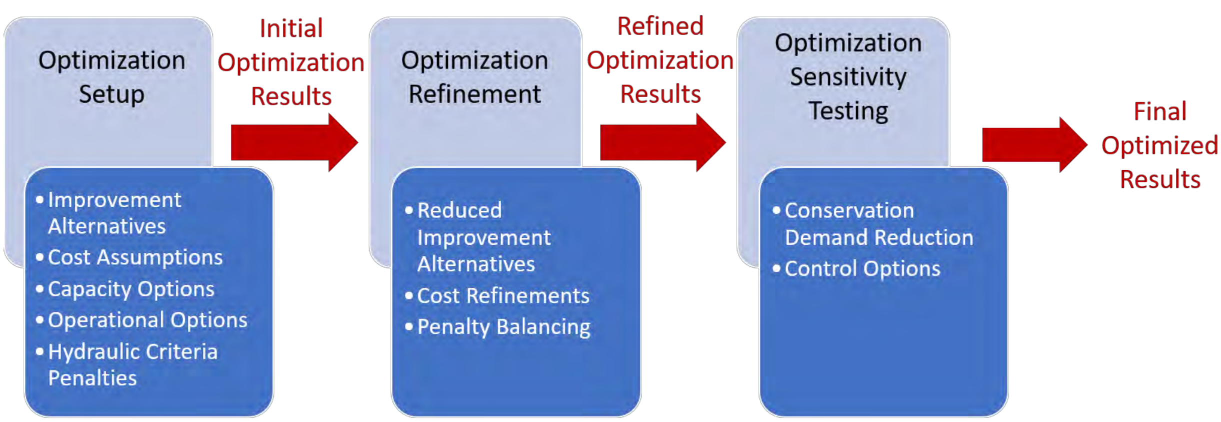
4.6 Optimization Analysis

To evaluate options for addressing the deficiencies previously identified in this section including facility and pipe capacity, criticality, and condition deficiencies, a formal optimization process was utilized, similar to the process the City conducted in the 2009-2010 master planning effort. A complex software, Optimizer WDS (Optimizer), was utilized. The software uses a genetic algorithm running the EPANet hydraulic model using cloud computing to find the best hydraulic performance at the lowest overall life cycle and capital costs. Optimizer utilizes EPS hydraulic model simulations to evaluate hundreds of thousands of asset combinations comparing improvement life cycle cost and hydraulic performance objectives to determine a range of optimized solutions. Just prior to this planning effort, City staff received some training in the software to increase their familiarity with and understanding of the software. Optimization reduces bias in the evaluation process by allowing for the identification of hundreds of improvement options instead of a few that are typically evaluated using traditional hydraulic modeling methods. The optimization primarily focused on 2040 MDD conditions and optimized solutions were refined to identify the system CIP, which is outlined in **Section 6**. Optimizer was also used to evaluate existing system operations, with more detail in the Operations Analysis discussion. The optimization process components are in **Figure 4-10**.

Figure 4-10 | Optimization Process



4.6.1 Optimization Setup

Numerous steps are required to build the optimization model and formulation in the Optimizer platform. The decisions that Optimizer is given to select a solution comprise the formulation for the scenario being analyzed. The required setup includes adding improvement alternatives, assigning life cycle and capital costs to each improvement, providing a range of capacity and operational decisions to each alternative, and setting hydraulic criteria penalties.

4.6.1.1 Hydraulic Model Import

The optimization software operates using an EPANet hydraulic platform. Optimizer was used to evaluate the 2040 MDD scenario to determine system improvements to meet 2040 conditions and for the existing MDD scenario to determine optimized controls for operating the current system. The InfoWater 2040 MDD and 2018 MDD EPS scenarios utilized as part of the Distribution System Assessment were setup with some of the baseline decisions, such as improvement alternative locations and basic operational ranges and then exported to EPANet compatible files for use in the 2040 improvements and existing controls Optimizer analyses.

4.6.1.2 Improvement Alternatives

To evaluate solutions a broad array of potential system improvements was identified. The location of deficiencies determined during previous system analyses, review of the previous optimization effort and input from City staff were used to identify potentially viable project site locations. The alternative options in **Figure 4-11** were determined during a workshop with City Engineering & Infrastructure Planning, Utility, and Water Resources Department staff as well as team members from GSI, Clearwater Engineering, and Murraysmith. These are the full suite of locations that were considered for improvements during the initial optimization process.

The new facility improvement options included additional wells, gravity storage, or pump stations with some being constructed at existing facility sites and some at new sites. New pumped ground storage and PRVs were also included in the alternatives. Increasing the size of existing piping and new pipe alignments were added as options.

4.6.1.3 Cost Assumptions

Optimizer uses costs associated with operating and making improvements to infrastructure to find lower cost solutions that can also minimize hydraulic criteria penalties. The improvement costs are based on life cycle costs that incorporate capital and operation costs. Operation and maintenance costs were developed based on the average 2018 City budget allocation and include expenses such as repairs, chemicals, electricity, and generators. Capital costs include components required for new construction, design, and administrative expenses and in the case of existing facilities are based on the recommended improvements from the Facility Condition Assessment.

The capital and operating costs were assessed over the useful life of each asset and converted to an equivalent uniform annual cost (EUAC) accounting for assumptions for inflation and the discount rate. The EUAC allows a more equitable comparison of each improvement in the Optimization by accounting for infrastructure costs associated with different useful lifespans. Further detail about how costs were generated and applied is provided in **Appendix 6A**, **Appendix 6B**, and **Appendix 6C** and the resulting costs for the CIP are in **Section 6**.

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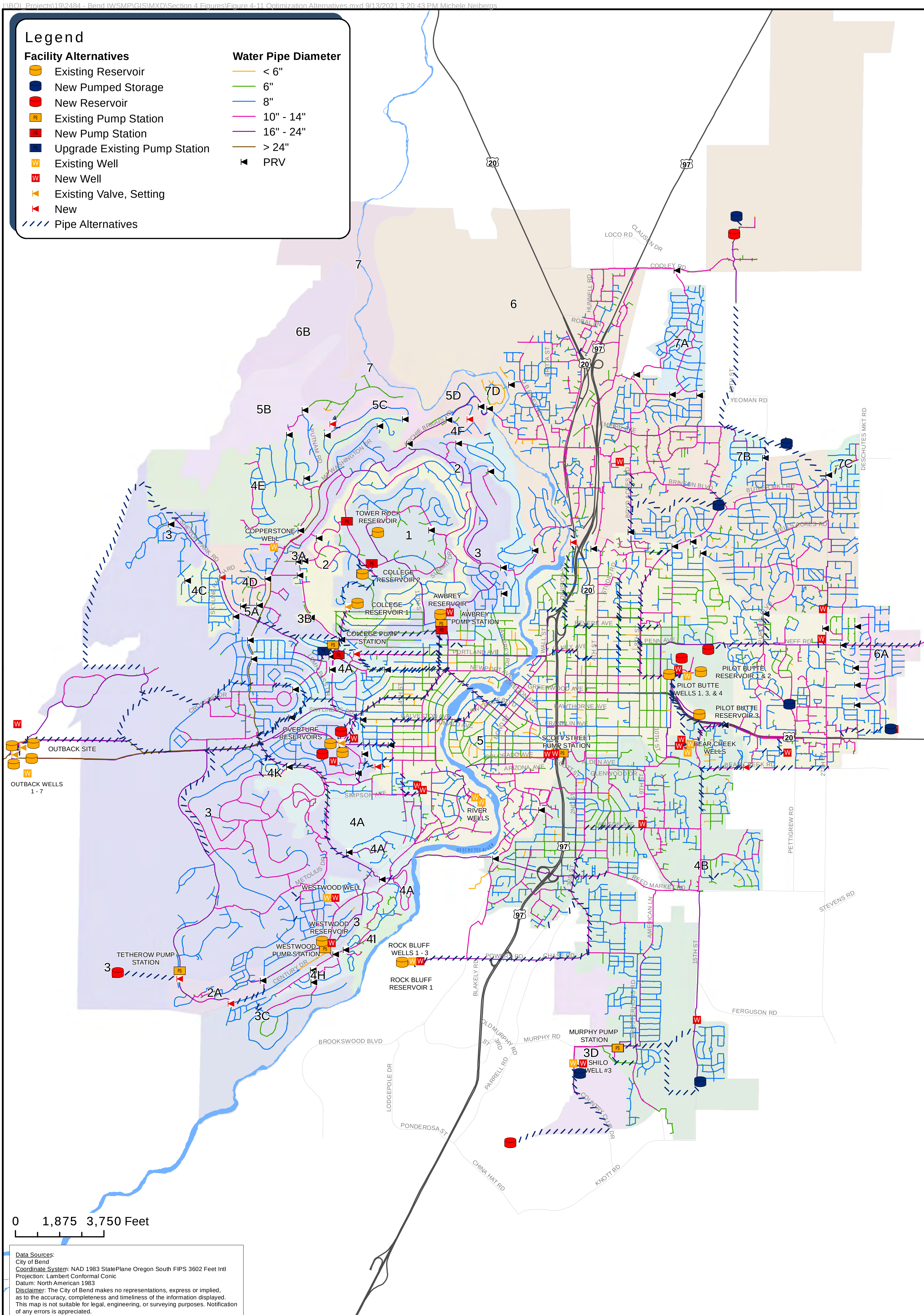

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Figure 4-11
Optimization Alternatives

September 2021

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4.6.1.4 Capacity and Operational Options

For each type of improvement, the range of options used in the Optimizer formulation are summarized in Table 4-17. For each improvement there is the option to be "selected" to convey water in the system and incur the associated life cycle cost. For existing "selected" facilities, the cost is based on improvements identified in the condition assessment; or if the facility is not selected it could be decommissioned. College Pump Station was the only existing facility with an option to increase capacity. For new well, storage, booster pump station, pipe, and PRVs, the life cycle cost of the new infrastructure was applied to those that were selected. Existing pipes could either be replaced with a larger diameter pipe and incur a capital cost or left in service as is at no additional cost. For selected facilities, a range of operational decisions were also considered by Optimizer including booster pump controls and settings for PRV or flow control valves (FCV).

4.6.1.5 Hydraulic Criteria Penalties

Optimizer seeks to minimize the life cycle cost associated with improvements while also minimizing the hydraulic penalties associated with hydraulic performance criteria. Although there are no actual costs associated with not meeting the hydraulic performance criteria, the penalties are assigned relative dollar values in Optimizer to compare with the actual cost associated with facility or pipe improvements. By assigning relative dollar values to the hydraulic penalties, Optimizer is able to compare potential project costs to the "costs" of not addressing hydraulic deficiencies. The magnitude of penalty costs requires some iterative trial and error and seek to balance the severity of the criteria violation with the improvements required to address it. For example, low pressure penalties that violate regulatory requirements and impact water quality health and safety standards are given much higher penalties than velocity criteria. While high velocities are important, they do not typically lead to water quality health and safety concerns. However, given the criticality of some facilities, such as the Awbrey transmission main, the velocity criteria violation on that pipe was penalized more heavily than a standard distribution pipe since the impact of a failure, which could be accelerated with long-term velocity exceedance. The type of penalties associated with hydraulic criteria and which type of facilities they were specifically applied to are in Table 4-18. The penalties align with not meeting level of service criteria that apply to the respective infrastructure. For supply, which includes wells and the WFF, a penalty was applied if the maximum day demand was not met by supply. Additionally, a penalty was applied for using groundwater over surface water to meet the level of service aiming to maximize surface water. Storage reservoirs are assigned penalties to ensure levels and volumes are maintained within level of service requirements. To meet pressure and velocity level of service, penalties are assigned for hydraulic solutions outside of the level of service ranges. The penalties are used in Optimizer to balance the cost of infrastructure improvements while still aiming to meet system level of service criteria.

Table 4-17 | Optimizer Capacity and Operational Options

Infrastructure Type	Status	Options	Number of Facilities
Well	Existing	▪ Selected/Not Selected ▪ Range of On/Off Level Control Settings	20
	New	▪ Selected/Not Selected ▪ Range of capacities representing between 1 - 3 wells per location ▪ Range of On/Off Level Control Settings	25
Gravity Reservoir	Existing	▪ Selected/Not Selected ▪ Range of volumes (HGL fixed)	15
	New	▪ Selected/Not Selected ▪ Range of volumes (HGL fixed)	7
Pumped Reservoir	New	▪ Selected/Not Selected ▪ Range of volumes ▪ Range of pump station discharge pressure settings	7 (3 with Associated and Dependent Well Option)
Pump Station	Existing	▪ Selected/Not Selected ▪ Range of On/Off Level or Discharge Pressure Control Settings ▪ 1 Option to Increase Capacity	6
	New	▪ Selected/Not Selected ▪ Range in capacity ▪ Range of On/Off Level or Discharge Pressure Control Settings	4
PRV and FCV	Existing	▪ Selected/Not Selected ▪ Range of flow or pressure settings	4 Key System Valves (Outback Surface Water FCV, Outback Groundwater PRV, Awbrey FCV, Overturf FCV) and numerous PRV settings
	New	▪ Selected/Not Selected ▪ Range of pressure settings	9
Pipe	Existing	▪ Range of Diameters	11.5 Miles
	New	▪ Selected/Not Selected ▪ Range of Diameters	29.3 Miles

Table 4-18 | Optimizer Hydraulic Criteria Penalties

Criteria	Infrastructure	Penalty
Supply	Well and WFF	▪ Not Meeting Minimum System-wide Flow ▪ Operating Cost Associated with Pumping and/or Treating
Storage	Reservoirs	▪ Outside Range of Minimum & Maximum Level ▪ Not Meeting Minimum Return Level ▪ Not Meeting Minimum Zone Volume
Pressure	Service Meters (Model Junctions)	▪ Outside Range of Minimum & Maximum Pressure
Velocity	Pipe	▪ Above Maximum

4.6.2 2040 Optimization

The Optimizer model was run for a 2040 MDD EPS scenario, which included diurnal patterns to simulate 2040 PHD. Millions of individual solutions were run and analyzed, through several major iterations of the analysis, each one resulting in a workshop with City staff to discuss the results. At each workshop, the City and consultant team would "reality check" the results and provide input on what should be investigated further or refined in subsequent runs. Much of the discussion focused on the type and location of the infrastructure being selected and why. Three major optimization iterations were used to determine an optimized solution of capital improvement and operational settings to serve existing and future demands while minimizing hydraulic deficiencies.

Because optimization evaluates millions of combinations of system improvements, the result is not a single, optimized solution, but rather a range of solutions since somewhat different infrastructure could result in similar hydraulic conditions. For example, to improve velocity conditions in a pipe, one solution could be to upsize the pipe diameter, and another could be to send less flow through the pipe by using different supply sources that convey water through other pipes. Each of these choices could result in reasonable hydraulic penalty solutions, but with a different combination of infrastructure improvements.

Figure 4-12 illustrates the pareto curve output from Optimizer that is used to investigate the trends across solutions. Each dot on the curve represents a unique solution comprised of specific infrastructure improvements and their associated life cycle and hydraulic penalty costs. As discussed previously what makes the optimization process unique is its goal of reducing the cost of both in parallel. In general, large gains are made initially as the random starting scenario is modified, and adequate improvements are made in the system to address large hydraulic penalties, causing the penalty cost to drop at much greater rates than the associated infrastructure cost. The genetic algorithm used in the optimization process chooses the best "offspring" or solution set from each run and uses it as the solution set for the next run. The optimization continues to run until both life cycle costs, and penalty costs are minimized, or the maximum number of trial iterations are exhausted. Solutions from the initial bend in the curve, the area just before the curve flattens, and a few solutions in the flattened part of the curve are evaluated for similarities and differences to determine trends in the solutions. Within each of these areas, the specific solutions chosen for evaluation is more nuanced.

Figure 4-13 shows a more detailed section of the pareto curve to illustrate which are more optimal solutions within each review and the tradeoff between system improvements and hydraulic penalties. Where the pareto graph shows a more significant drop in penalty cost for a smaller increase in infrastructure cost, the solution is likely better than the prior solution. Similarly, a solution that has a large increase in infrastructure cost, but minimal decrease in hydraulic penalty costs is likely not a preferred solution.

The optimization requires an iterative process of investigating the trends across several locations and solutions within the pareto. This helps reduce the number of alternatives in future simulations and focus on continually more optimized solutions. Similarly, since no solution eliminates all hydraulic penalties, investigating trends in areas where hydraulic issues persist helps reduce penalties that likely have no feasible solution and focus on penalties that are significantly impacted by the infrastructure selected solution. Each of these iterations results in a more optimized solution but requires a revisit of the optimization setup outlined above to continue to refine the process and results.

Figure 4-12 | Pareto Curve

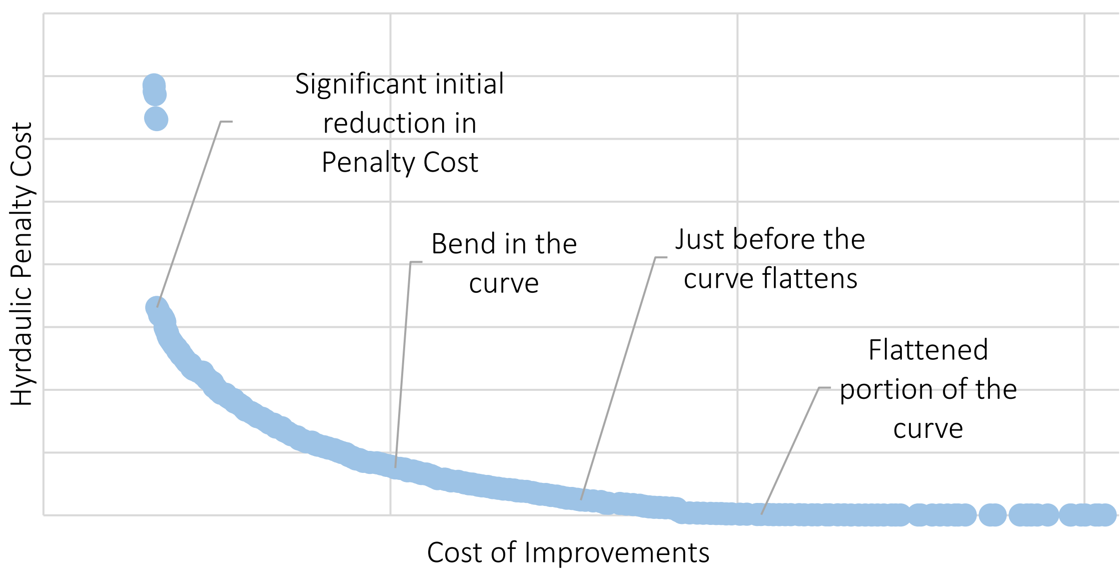
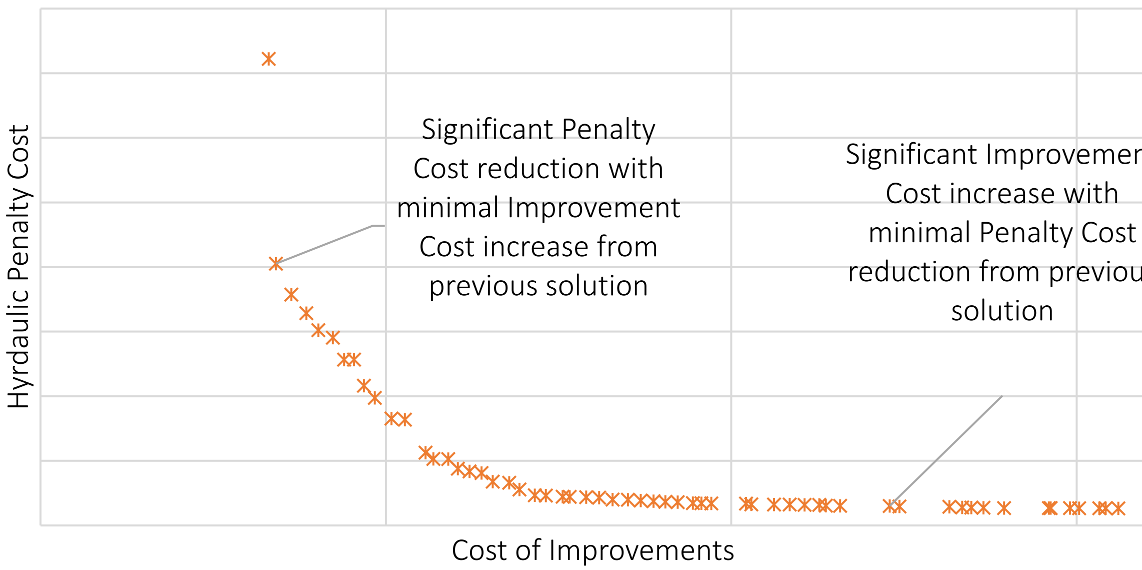


Figure 4-13|Flattened Pareto Curve Solutions



4.6.2.1 Initial Optimization Results

The optimization was initially run with three types of scenarios to narrow the impact of some key decisions and further focus the optimization setup. These three scenarios differed between either what alternative improvements were made available during or what hydraulic penalties were applied. The three scenarios included 1) All available improvement alternatives and options; 2) Well locations not at existing facility sites being excluded as alternatives; 3) A maximum required standby storage penalty applied based on the storage analysis difference between the standby storage and minimum standby storage analyses. These scenarios were selected to illustrate the impact of some basic assumptions that could influence the direction the optimization algorithms took. By illustrating the trends across the scenarios, it helped narrow the number of alternatives and decisions, but focus on more feasible, optimized solutions.

The initial three optimization scenarios illustrated trends that led to decision modifications for the refinement optimization. These decisions included:

- Remove the pumped storage alternatives that were consistently not selected as cost-effective improvements.
- Include all other improvement alternatives, including wells at new sites, since outside of the pumped storage, nearly all other improvement options were showing in trends across viable solutions.
- Given the constructability challenges, further evaluate the benefit of any facility improvements on Pilot Butte – beyond required investment in the existing facilities.

- Reduce the standby storage penalty to reflect the minimum requirement.
- Update tank penalty levels to not be lower than fifty percent of the tank volume.
- Reduce penalties to the minimum allowable pressure for areas where trends showed no viable solution to keep pressures in the reasonable range.
- Incorporate potential cost modifications for land acquisition and synergy cost reductions for pipe projects that could be constructed as part of roadway projects.

4.6.2.2 Optimization Refinement

The refinement optimization incorporated decisions made from the initial optimization and involved several additional smaller refinements such as including additional velocity penalties to the Awbrey transmission main given its criticality to the system. The refinement phase also did individual testing of numerous pareto solutions to determine the tradeoffs between different selected alternatives, the sizing of selected improvements, and the magnitude and location of hydraulic penalties. Ultimately, only solutions that met the minimum supply and storage requirement penalties—determined during the Facility Capacity Assessment—were used for ongoing refinement. Pipe improvements were refined by grouping pipe projects within corridors to similar diameters to reflect constructability since the optimization would periodically select the minimal required diameter by pipe segment, resulting in smaller pipe diameters for short runs within larger diameter pipe improvement projects. Lastly, numerous similar solutions were used to “seed” some final optimization runs to eliminate the initial random selection of the software and more immediately focus the algorithms on viable solutions. Each of these refinements and checks involved numerous optimization simulations and reviews to continue to refine the selected solution.

4.6.2.3 Optimization Results

After doing numerous refinements of the results and reviewing incremental solutions with City staff, the selected solution includes over nine miles of pipe projects including upsizing existing pipe and constructing new pipe alignments. These are in addition to some improvements identified as part of the fire flow and criticality analysis. The solution indicates some existing facilities are not necessary by 2040 to meet the level of service criteria if the other improvements are constructed. Those existing facilities could be decommissioned or used only for standby or backup purposes including the Outback CT Basin, Overturf Reservoirs, Westwood Pump Station, Westwood Well, Westwood Reservoir, and the Scott Street Pump Station. The City may elect to continue operation of some of these facilities but minimize the investment in deferred and ongoing maintenance. The recommended 2040 solution includes six new pressure reducing valves (PRVs), seven new wells and 14 MG of new storage (8 MG additional storage if existing reservoirs are decommissioned). Detailed information on each of the improvements, the associated cost, and prioritization of the CIP are in **Section 6**.

4.6.2.4 Optimization Sensitivity Results

Once a nearly final solution was selected from the initial and refinement processes, it was run through several additional optimization simulations to determine whether the sensitivity of the improvements identified were due to a reduction in demand or operational modifications in controls.

4.6.2.4.1 Conservation Program Demand Reduction

As part of the update to the City's WMCP completed concurrently with this iWSMP, an additional analysis was included to determine the water conservation potential of the City's system. A water savings and cost effectiveness analysis were completed, including use of the Maddaus Water Management Demand Side Management Least Cost Planning Decision Support System (DSS Model). The DSS model evaluated numerous conservation measures that could reduce indoor or outdoor water use. The measures were combined into conservation programs to estimate the cost of implementing specific measures and the associated reduction in demand. After several iterations with City staff, a recommended program of conservation measures was selected for implementation. If the recommended measures from the analysis are implemented over the next 20-years, the projected system-wide MDD is estimated to be reduced by 5.1 million gallons per day (MGD). The demand reductions were applied system-wide and the resulting demand projections are in **Table 4-19**.

Table 4-19|Demand Projections with Conservation

Timeframe	MDD with Conservation (MGD)	MDD without Conservation (MGD)	Projected Decrease Due to Conservation (MGD)
2030	35.0	38.0	3.0
2040	40.1	45.2	5.1

The reduced demand projections for the selected conservation program were then used in this iWSMP analysis to determine any reduction in future system deficiencies and associated reductions in the required system infrastructure improvements identified during the optimization. The impact on the supply and storage deficiencies without conservation demand reductions (from **Table 4-6** and **Table 4-12**) and with demand reductions are in **Table 4-20**.

Table 4-20|Supply and Storage Analysis with Conservation Demand Projections

Timeframe	Supply Deficiency		Storage Deficiency	
	Without Conservation (gpm)	With Conservation (gpm)	Without Conservation (MG)	With Conservation (MG)
2030	(2,341)	(222)	(2.21)	(1.31)
2040	(7,325)	(3,797)	(5.74)	(2.72)

4.6.2.4.2 Conservation Demand Sensitivity Results

After selecting a recommended optimization solution of improvements, an additional "sensitivity" analysis was considered to determine which improvements could be eliminated due to a reduction in demand from the conservation program projections and modeling work done in the WMCP update. More extensive discussion and analysis regarding conservation are WMCP. The analysis followed the same process as the original optimization, but the 2040 MDD analyzed reflected the 5.1 MGD projected reduction. The results indicated that three supply wells and approximately 4 MG of storage improvements could be unnecessary if demands were at the lower projections. The costs for implementing the conservation program and associated reduction in improvement costs due to conservation demand reductions are discussed in **Section 6** and used to inform the prioritization of the improvements.

4.6.2.4.3 Operations Sensitivity Results

Another sensitivity check completed on the final optimized solution was the significance of changes to control settings across the selected facilities. Although the specific operations of the system will vary significantly across a 20-year timeframe, the optimization was run with varying control decisions to determine whether operational modifications had a significant impact on the infrastructure requirements. Some pipe improvements were reduced based on modifying the operational settings so that supply was balanced across certain facilities and velocity or pressure penalties were not unnecessarily created by over or under relying on certain facilities to meet demand before additional supply was introduced through control modifications.

4.7 Operations Analysis

The existing system has many supply options for meeting demands and pump, valve, and pipe corridor options for conveying water throughout the system. The City has numerous objectives to balance when it operates the system; focusing on delivering high quality water to its customers that includes meeting the hydraulic level of service criteria, observing water right requirements and limitations, maximizing the use of the less expensive gravity fed surface water supply source, balancing the use and wear across facilities, and minimizing costs. The Operation Analysis focused on reviewing system control operations and water age to determine potential operational improvements.

4.7.1 Existing Conditions Controls Assessment

The controls at each facility influence how water moves and what sources are required to meet demand. The optimization of the controls was intended to determine individual facility control settings as part of a system-wide control scheme that maximizes use of surface water supply and reduces hydraulic penalties. Optimizer was used to evaluate the existing MDD scenario to determine optimized controls for current system operations. The InfoWater 2018 MDD EPS scenario established as part of the Distribution System Assessment was exported to an EPANet compatible file for use in the existing controls Optimizer analysis. The hydraulic deficiency penalties and many of the control options used in the 2040 Optimization formulation were leveraged to optimize the control settings for the existing MDD conditions.

The City's Operations staff are effectively balancing the many objectives in its current operations, so no extensive modifications are recommended, however, the model is also setup for use to determine the impact of future operational modifications to the system. The resulting recommended control modifications are in **Appendix 4B**.

4.7.2 Water Age Assessment

Water age was evaluated for existing conditions using the winter demand and operation conditions in the InfoWater winter EPS scenario developed during the 2018 model calibration. Water age refers to the amount of time water is in the distribution system prior to being used by the customer. The age is influenced by factors such as pipe diameter, system connectivity, facility operations and demand. Water age is not specifically regulated so there are not set limits, however water that remains in the system for extended periods of time can result in low chlorine residuals and the build-up of disinfection byproducts along with secondary water quality issues such as unpleasant taste, color, or odor. The City is looking to reduce the water age in the system, where possible, to improve these attributes.

Water age is typically a concern during low demand winter conditions, particularly where water may sit in a storage tank for longer periods before being turned over. The City's low demand during winter months and use of surface water supply, which unlike the well supply is not as directly controlled by numerous tank levels throughout the system, results in high water age in many of the tanks. In some areas it is possible to change system operations to turn over water more frequently. These changes could include turning off facilities, changing pump station control settings, increasing settings at zone PRVs, or closing isolation valves to require water to travel through an alternate system corridor. In other cases, it is difficult to change operations to improve water age. Examples of these areas include dead-ends and small, single-feed PRV zones. For these areas, flushing is recommended to increase turnover.

The InfoWater model was run for 30 days with winter demand and control settings. **Figure 4-14** shows the relative water age, classified as low, medium, and high, for each pipe and tank in the system with existing operations, as well as after some recommended changes to operations. Zone 1 and 2, as well as the Pilot Butte Reservoirs specifically, improve with the recommended changes.

Zone 1 is supplied by the Awbrey Pump Station and the Tower Rock Reservoir. There is a small amount of demand in the Zone during winter conditions and limited connectivity to the rest of the system. To improve water age, a potential operational change could be to shut off the College Pump Station and raise the PRV settings on valves that feed from Zone 1 to Zone 2 and from Zone 2 to Zone 3. Although it will require additional energy costs to pump water to Zone 1 and then reduce it, by making these operational changes water is forced to cycle through Zone 1 and be conveyed to Zone 2 and Zone 3, which also reduces the water age in the Tower Rock Reservoir. It is important to note that the PRV settings should not be set so high as to drain Awbrey, Tower Rock, College 1, and College 2 Reservoirs substantially.

Zone 5 is hydraulically split into an east and west portion connected by piping that crosses the Deschutes River. Awbrey Reservoir primarily serves the west side of Zone 5 and Pilot Butte 1 and Pilot Butte 3 Reservoirs serve the east. Due to Awbrey's proximity to surface water supply from Outback, higher hydraulic grade line (HGL), and suction supply to the Awbrey Pump Station, the Awbrey Reservoir does not have high water age because it turns over much more frequently than the Pilot Butte Reservoirs. Pilot Butte 2, which serves Zone 4B, does not turn over often due to the low winter demand in Zone 4B and its location relative to surface water supply. To improve the tanks on the east side of the system the pressure setting was reduced at the Athletic Club PRV (WAPRV038B), which conveys flow from Zone 3 to 4B, to increase the flow from the Pilot Butte 2 Reservoir to meet Zone 4B demand prior to the Athletic Club Valve opening. This results in Pilot Butte 2 Reservoir draining and filling more frequently reducing the water age in the tank. Additionally, changes could be made at Wilson and Bond PRV (WAPRV039B) to increase flow from Zone 4B to Zone 5. This improves water age in Zone 5 near the PRV and in Pilot Butte 2 Reservoir.

Another operational change identified was having Scott Street Pump Station run. Scott Street pumps from Zone 5 to 4B. With the pump station on, water is cycled from Zone 5 to 4B which improves the age of water in the Zone 5 Pilot Butte Reservoirs. As a result of changing the primary supply path from Athletic Club PRV that is from Zone 3, more water moves from the west side of Zone 5 to the east, causing the Awbrey Reservoir to drain more rapidly. To minimize this, it is recommended that the setting at the Awbrey FCV be increased.

Figure 4-15 through Figure 4-17 show the tanks with improved turnover and decreased water age because of the outlined operational changes.

It should be noted that the change in water age in certain areas with the operational modifications does not impact the total demand in the system. Therefore, when the operational change causes a flow path to change, the quality in another area may be impacted as less water moves through that area. As a result, it is recommended that operational changes vary throughout the winter to ensure water is moving through different flow paths. As an example, the City could operate the system as they currently do during the first half of the winter and then make the recommended changes shown on Figure 4-14 for the second half. Additionally, the City could consider prioritizing automation at these valve locations where it does not currently exist to make operational changes easier to implement and change more frequently.

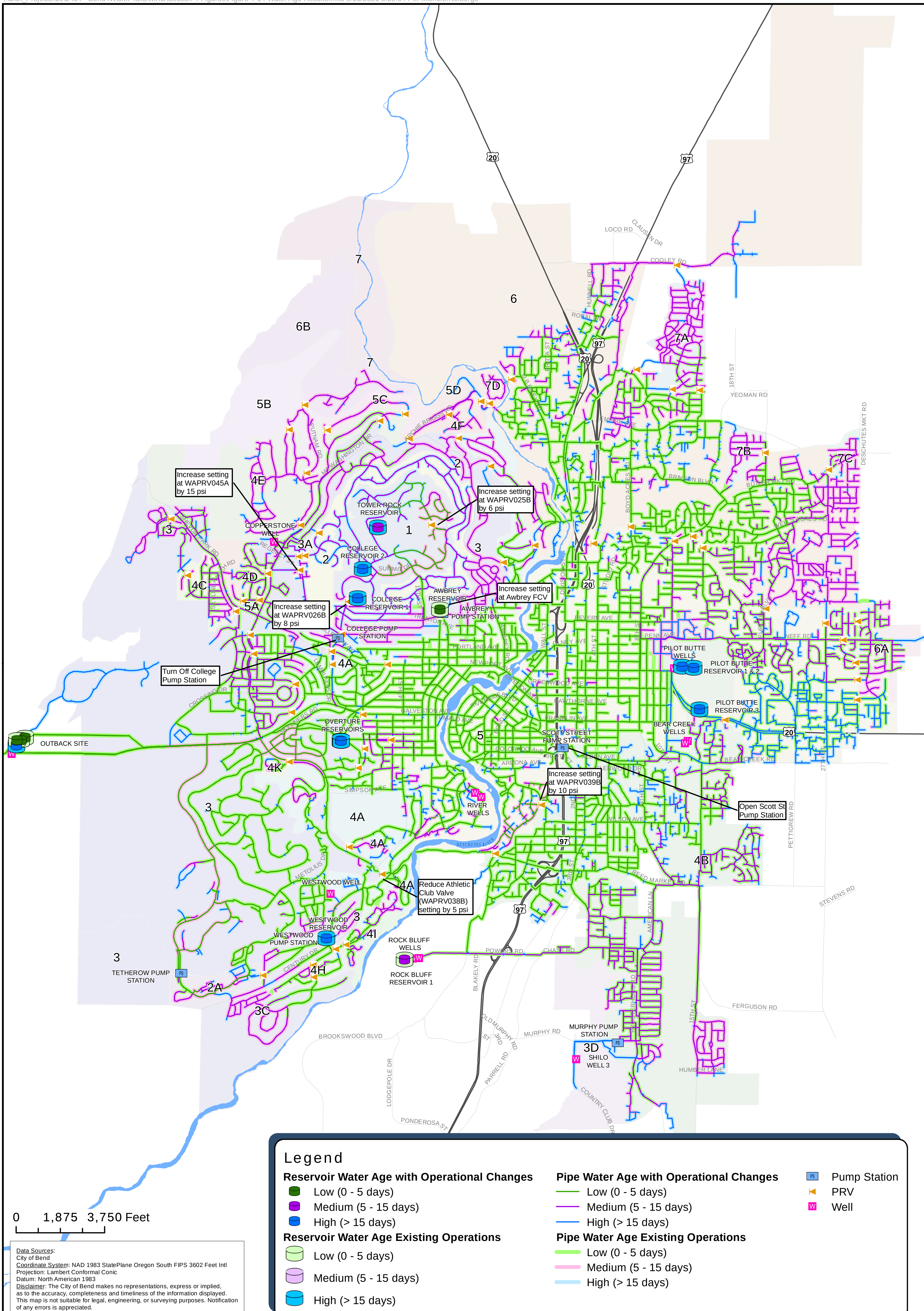


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Figure 4-14
Water Age Results

Figure 4-15 | Pilot Butte 1 & Pilot Butte 3 Water Age

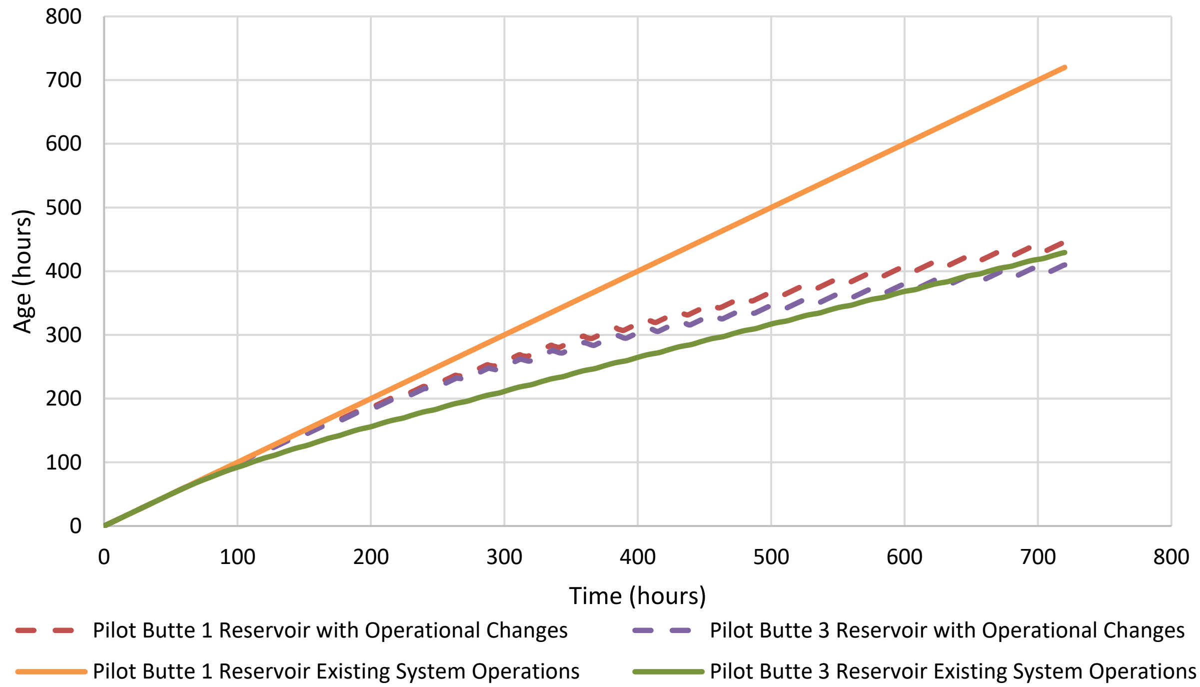


Figure 4-16 | Pilot Butte 2 Water Age

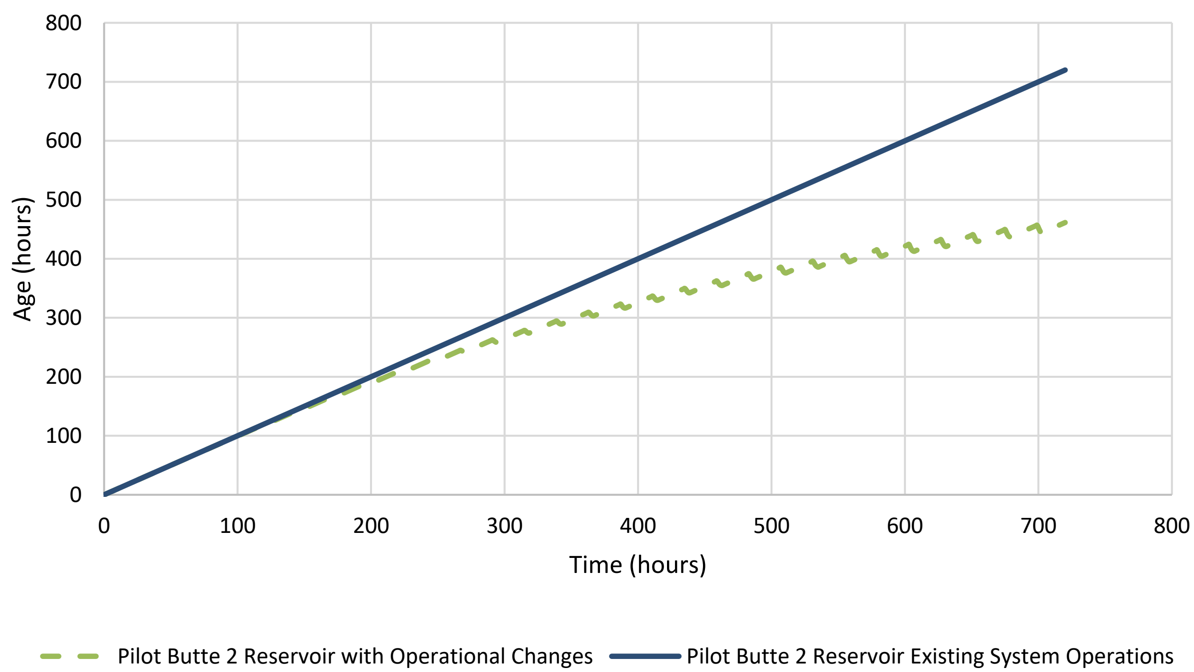
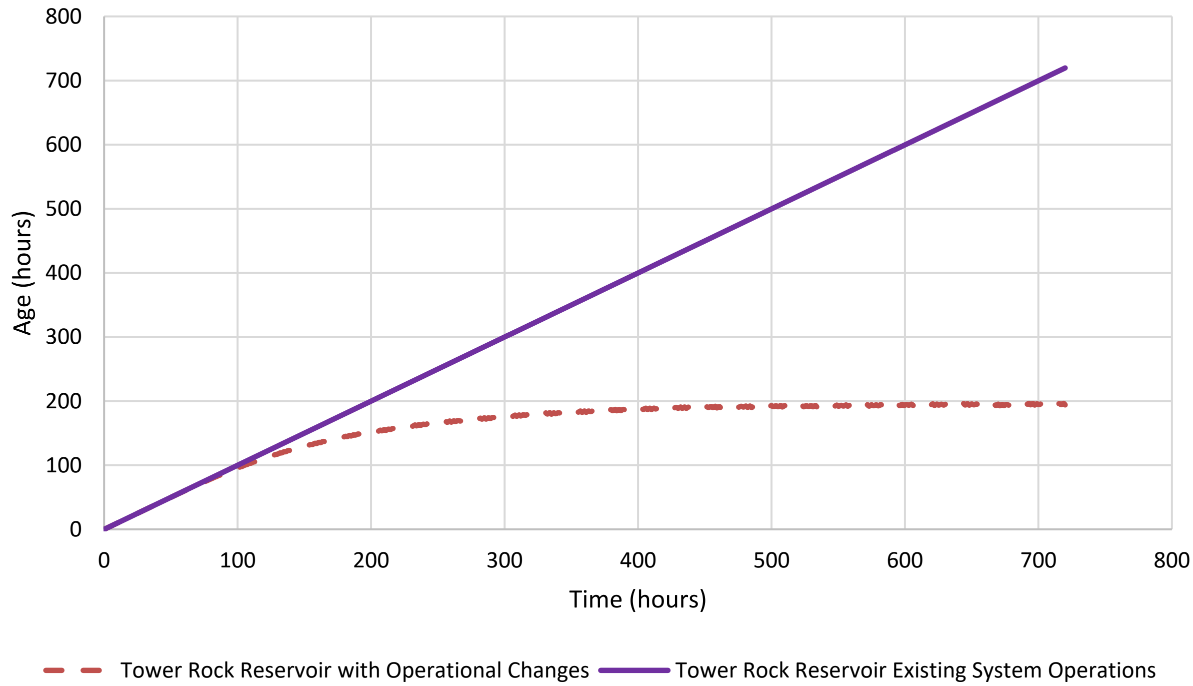


Figure 4-17|Tower Rock Water Age



4.8 Summary

The comprehensive system analysis of the City's water system included assessments of current infrastructure conditions, existing and future system capacity, asset criticality, and existing operations. Extensive hydraulic modeling and optimization were utilized, in addition to standard qualitative and quantitative assessments of the system. Overall, the City has a robust system that provides many ways to convey water. In addition, the value of having both surface and groundwater sources cannot be overstated from a resiliency standpoint. However, significant investment is needed to address deferred maintenance on the existing pipe and facilities to provide adequate fire flow and increase redundancy to continue service in the event of a critical asset failure. A summary of the results of each component of the system analysis is included below. Detailed information on each of the improvements recommended from the analysis, the associated cost, and prioritization are in **Section 6**.

4.8.1 Condition Analysis Summary

The condition analysis focused on the existing system infrastructure to identify what improvements are required at each facility to extend its useful life and comply with current standards as well as develop a long-term pipe replacement program. Condition analysis and improvements are important to ensure investment in the existing infrastructure to maintain its performance and extend its useful life.

The City has over 440 miles of pipe and 20 active wells, 6 booster pump stations, and 15 storage facilities, in addition to the Water Filtration Facility and dozens of control valve vaults. These assets range in age, but the oldest facilities are approaching 100 years. The City conducts regular and proactive maintenance of the system. However, as the infrastructure ages and safety, structural, and security standards change over time, the maintenance required to repair and replace the existing infrastructure increases. Additionally, as the pipe network ages the City will need to increase the replacement rate and target undersized and substandard pipe to avoid pipe failures and maintain consistent service.

4.8.2 Capacity Analysis Summary

The capacity analysis identifies how much additional supply, storage volume, or pipe upsizing is required to meet Level of Service criteria for existing and future demand conditions. In addition to maintaining the existing pipe and facilities, the system also requires investment in pipe to address existing fire flow, velocity, and pressure deficiencies, as well as future improvements to provide capacity for growth. No new well or storage facilities are needed to meet existing system capacity requirements, however, by the 10-year horizon, additional well supply with backup power and storage will be needed and further wells and storage to meet 20-year projected demands. Facilities are needed to meet demand thresholds and if demands are lower than those projected (i.e., due to reductions from the conservation program) the number of new facilities will be reduced. The City has adequate water rights to meet 20-year demand projections but will need existing groundwater rights to be available at all facilities across the system to have operational flexibility and optimally utilize its wells.

4.8.3 Criticality Analysis Summary

The criticality analysis focused on identifying critical infrastructure without redundancy or secondary service options that could significantly disrupt system operations and impact a substantial amount of demand or customers if it were out of service. The criticality analysis focused on determining which assets would have a significant impact or consequence if they were unavailable to serve the system due to failure, reduced capacity, or other unanticipated issues.

Most areas of the system have redundancy, where two or more system elements (i.e., looped pipe, multiple PRV vaults, etc.) can provide water to the area and could continue to serve customers for a period if one component of the system was offline. So, although every asset in the system adds value and is important for long-term system performance, identifying the areas without multiple service options is critical to build a more resilient system that can maintain service in the event part of the system was offline.

The WFF capacity is critical to providing reliable supply to the system. The construction of a pretreatment facility is recommended in the near-term as a solution to provide resilience for a wildfire or other water quality event that might cause high total dissolved solids and/or sediment loads. If one of these described events were to occur without pretreatment the capacity of the WFF could be reduced or nearly eliminated . As previously mentioned, the Outback Siting Study

(**Appendix 3A**) evaluates how recommended facilities such as pretreatment, new and rebuilt reservoirs, wells, and other water related facilities may be sited on existing and/or additional lands at the Outback Facility, which will be further refined as part of an Outback Facility Plan. Pipe improvements are recommended to address areas where single pipe breaks could result in a significant disruption to service, including the Awbrey and Outback transmission mains. Valve criticality can be used to inform ongoing maintenance programs to target locations to exercise existing valves and add new valves to the system to reduce how large an area must be isolated from service during maintenance.

4.8.4 Optimization Analysis Summary

The optimization analysis uses advanced hydraulic modeling techniques to evaluate and determine optimal improvements and modifications to the system to balance the cost of improvements with the improvements to Level of Service. The optimization analysis included extensive setup of improvement alternatives, ranges of operational decisions, and establishing costs for system improvements and hydraulic penalties. The analysis included numerous refinements and evaluations of the sensitivity of the solution to various parameters, resulting in millions of combinations of improvement options. The optimization process reduced the many inputs and iterations to a single recommended solution to meet 2040 projected demands. This solution includes over twenty miles of pipe projects, seven new wells, six new pressure reducing valves (PRVs), and 14 MG of new storage. In addition, four existing storage reservoirs, one well, and one pump stations can be considered for decommissioning or used in standby or backup status with reduced investment in deferred and ongoing maintenance. As the City continues to expand its Conservation Program it should continually assess the impact on demands and the potential reduction in required facility improvements. In addition to the existing Conservation Program, newly proposed conservation measures in the WMCP could eliminate the need for three of the new wells and 4 MG of the additional storage.

4.8.5 Operations Analysis Summary

The operations analysis focuses on the operational settings used at the existing infrastructure. The analysis indicates that the City is successfully leveraging its existing facility operations to maximize surface water use and meet hydraulic requirements. Water age will continue to be an issue in portions of the system during low demand conditions and will improve as demand increases due to growth but can also be improved through operational modifications during low demand periods to circulate water in different ways throughout the system. Operational modifications to address water age should be balanced with increased energy costs due to pumping and reduced water cycling and operations costs associated with making operational changes, as well as any water quality concerns associated with reversing flow in pipes.

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Section 5

Section 5

Water Quality and Regulations

5.1 Introduction

This chapter contains an analysis of the City's water quality and compliance with relevant regulations.

5.2 Water Quality Review and Regulatory Compliance

Both state and federal agencies regulate public drinking water systems. For the federal government, the U.S. Environmental Protection Agency (EPA) establishes standards for water quality, monitoring requirements, and procedures for enforcement to comply with the Safe Drinking Water Act (SDWA). Oregon, as a primacy state, has been given the primary authority for implementing EPA's rules within the state. The state agency which administers most of EPA's drinking water rules is the Oregon Health Authority (OHA), Drinking Water Services (DWS). DWS rules for water quality standards and monitoring are adopted from EPA. DWS is required to adopt rules at least as stringent as federal rules. To date, DWS has elected not to implement more stringent water quality or monitoring requirements. The State program is outlined in Oregon Administrative Rules (OAR) and is comprised of monitoring the water supply for specified chemical and physical contaminants. By State law (OAR 333-061-0036), the City is required to maintain an ongoing water quality testing and monitoring program. The OHA requires that the source water supplies be monitored for primary and secondary contaminants. Primary drinking water standards establish absolute concentration limits called Maximum Contaminant Levels (MCL) and Maximum Contaminant Level Goal (MCLG). MCLs are enforceable standards, while MCLGs are non-enforceable public health goals.

In some areas not directly related to water quality, DWS rules cover a broader scope than EPA rules. These areas include general construction standards, cross connection control, backflow installation standards, and other water system operation and maintenance standards. The complete rules governing DWS in the State of Oregon are contained in OAR Chapter 333, Division 61, Public Water Systems.

5.2.1 City Sources

The City provides water to a population of approximately 67,000 people in six primary pressure zones that have storage reservoirs, via approximately 25,500 connections. The City supply sources include surface water from the Bend Municipal Watershed (BMW) and groundwater from the Deschutes Regional Aquifer pumped from 20 active City groundwater wells at eight sites. The eight groundwater sites are considered well fields by the state and sampling is only required at any one of the wells for each site.

5.2.2 Regulations

Since being introduced in 1974, the SDWA has been amended twice, once in 1986 and then again in 1996. The intent of these amendments is to strengthen the 1974 SDWA, primarily in setting regulations to ensure that public water supplies are safe. The EPA was mandated by Congress to establish rules and regulations relating to the SDWA and subsequent Amendments. The OHA administers the SDWA Regulations in Oregon through the 1981 Oregon Revised Statute that has been periodically amended after the original passage. OAR 333-061 outlines the requirements. The regulations that apply to the City's water system are in **Table 5-1**.

Table 5-1 | Drinking Water Rules

Regulation	Type	Rule
Primary Drinking Water Regulations (NPDWR)	Chemical Contaminants	Chemical Contaminant (IOC, SOC, VOC)
		Radionuclides
		Arsenic
		Lead and Copper
	Microbial Contaminants	Groundwater
		Disinfectant and Disinfection Byproducts
		Total Coliform & Revised Total Coliform
	Right-to-Know	Consumer Confidence Report
		Public Notification
Secondary Drinking Water Regulations (NSDWR)	Aesthetic	Aluminum, Chloride, Color, Copper, Foaming Agents, Iron, Manganese, pH[1], Sulfate, Threshold Odor Number, Total Dissolved Solids, Zinc
	Cosmetic	Fluoride, Silver
	Technical	Aluminum, Chloride, Copper, Corrosivity, Iron, Manganese, pH[1], Total Dissolved Solids, Zinc
Contaminant Candidate List	NA	NA
Surface Water Treatment Rule (SWTR)	NA	NA

Note:
1. pH = Potential Hydrogen

5.2.2.1 Chemical Contaminant Rules

Chemical contaminants have been regulated in phases, which are referred to as the Chemical Contaminant Rules. The chemicals regulated fall into three categories: Inorganic Contaminants (IOCs), Synthetic Organic Contaminants (SOCs), and Volatile Organic Contaminants (VOCs). The Contaminant Rules regulate over 65 chemicals and establish recommended MCLGs and enforceable MCLs for each contaminant. The number of samples and monitoring frequency is based on numerous factors and can be reduced for some contaminants based on historic sampling levels. The Standardized Monitoring Framework is used to standardize, simplify, and consolidate drinking water monitoring requirements across the contaminant groups. The monitoring framework is divided into 9-year compliance cycles which are further divided into three 3-year compliance periods.

5.2.2.1.1 Impact of the Chemical Contaminant Rules on the City

The City is in compliance with all applicable Chemical Contaminant Rules. Table 5-2 below shows the City's current sampling schedule for each of the chemical contaminants. The asbestos testing requirement is every 9 years, but currently the City is not required to test for asbestos because no asbestos cement pipe has been identified in the system.

Table 5-2 | Chemical Contaminant Rule Testing Frequency

Contaminant Category	Source	Testing Frequency	Number of Samples	Notes
Inorganic Contaminants	All	9 Years	1/site	OHA Granted Monitoring Reduction
Synthetic Organic Contaminants	All	3 Years	2/site	2 Consecutive QT Samples Required
Volatile Organic Contaminants	Surface Water	Annually	1/site	
	Groundwater	3 years	1/site	
Nitrate	All	Annually	1/site	
Nitrite	All	9 years	1/site	OHA Granted Monitoring Reduction

5.2.2.2 Radionuclide Rule

The Radionuclides Rule (RR) sets MCLGs at zero for all radionuclides because they are known cancer-causing contaminants. The MCLs are for combined radium-226 and radium-228, gross alpha particle radioactivity, beta photon emitter radioactivity, and uranium. The current MCL standards are combined radium of 5.0 picocurie per liter (pCi/L), gross alpha of 15.0 pCi/L (not including radon and uranium) and uranium of 30.0 microgram per liter (µg/L). The MCL of beta photon emitters is 4 millirems (a traditional unit of radiation dose equivalent) per year.

5.2.2.2.1 Impact of the Radionuclide Rule on the City

The City is in compliance with the provisions set forth in the Radionuclide Rule. **Table 5-3** details the City's current sampling schedule for radionuclides.

Table 5-3 | Radionuclide Testing Frequency

Radionuclide Category	Source	Testing Frequency	Number of Samples
Radium 226/228	Bridge Creek, Rock Bluff Wells, Outback Wells, Westwood Well	9 Years	1/site
	River Wells, Pilot Butte Wells, Bear Creek Wells, Copperstone Well, Shiloh Wells	6 Years	
Gross Alpha Particle Radioactivity	All	9 Years	1/site
Uranium	All	9 Years	1/site

5.2.2.3 Arsenic Rule

The Arsenic Rule MCL is 0.01 milligrams per liter (mg/L). The MCLG for arsenic is zero because it is a known cancer-causing contaminant. If any arsenic concentration exceeds half of the MCL (0.005 mg/L), it must be reported in the annual Consumer Confidence Report (CCR). The rule applies to all community and non-transient, non-community water systems. All water systems that exceed the MCL of 10 parts per billion are required to come into compliance within 5 years after publication of the final rule.

5.2.2.3.1 Impact of Arsenic Rule on the City

The City is currently in compliance with all provisions set forth in the Arsenic Rule and collects one sample every 9 years for each site**.** No samples to date have exceeded the MCL.

5.2.2.4 Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR) was implemented in 1989 to reduce the potential for pathogenic contamination in drinking water. The rule has been updated multiple times, with the last rule implemented in 2006. It applies to all public water systems that use surface water or groundwater under the direct influence of surface water (GWUDI). The SWTR addresses:

- Criteria under which filtration is required
- Performance criteria for filtration
- Disinfection requirements for both filtered and unfiltered systems
- Monitoring requirements for all surface water supplies

The SWTR started by requiring that source waters be treated to achieve a minimum 3-log (99.9 percent) removal and/or inactivation of Giardia cysts and a 4-log (99.99 percent) removal and/or inactivation of enteric viruses. A 2-log (99 percent) removal of cryptosporidium has also been added to the rule.

5.2.2.4.1 Impact of Surface Water Treatment Rule on the City

The City constructed a membrane filtration system in 2016 and utilizes coagulation and hydrogen potential (pH) adjustment facilities for particulate removal. They have also installed a chlorination system for disinfection of surface water and conducted a tracer study in 2016 to determine contact time requirements. The City is currently in compliance with the SWTR rules.

5.2.2.5 Revised Total Coliform Rule

The Revised Total Coliform Rule (RTCR) was published in 2013, with minor corrections in 2014, and is a revision to the Total Coliform Rule (TCR). The TCR establishes a zero MCL for total coliform (TC), which can be an indicator of disease-causing pathogens. The RTCR establishes testing procedures should a sampling location test positive for TC, including requiring that E. coli testing be done for any positive TC sample.

The required number of samples taken each month depends on the population served by the water system. **Table 5-4** provides a summary of the sampling requirements for various populations served. Per these requirements, the City must collect at least 70 samples each month.

Table 5-4|Total Coliform Sampling Requirements

Population Served	Minimum Number of Samples per Month
41,001 to 50,000	50
50,001 to 59,000	60
59,001 to 70,000	**70**
70,001 to 83,000	80

General Note: The City's current service population is noted in **Bold** in the table.

5.2.2.5.1 Impact of TCR and RTCR on the City

The City is currently in compliance with all provisions set forth in the RTCR. The City currently collects at least 70 monthly samples for total coliform analysis from approximately 40 sites in the distribution system. When the City's population served exceeds 70,000, which is projected to occur in the next few years, the number of required monthly samples will increase from 70 to 80.

5.2.2.6 Lead and Copper Rule

The Lead and Copper Rule (LCR), establishes action levels of 0.015 mg/L for lead and 1.3 mg/L for copper based on the 90th percentile of samples. An AL exceedance is not a violation but can trigger other requirements including additional service and source monitoring, corrosion control treatment, public education, or lead service line replacement. The major difference between this regulation and most others is that the water is to be monitored at the customer's tap instead of the treatment plant discharge point. Lead and copper must be monitored at the customer's tap every 6 months at the highest risk locations. Systems can qualify for reduced monitoring if samples are below the AL for multiple consecutive years. The City system is on reduced monitoring of every 3 years.

If the action levels are exceeded for either lead or copper, the water system must collect source water samples and submit all data to the state with a treatment recommendation to reduce concentrations below the action level. In addition, the water system must also provide a public education program to its customers within 60 days of the action level exceedance. The public education program must be continued as long as the water system exceeds the lead action levels.

All water systems that exceed the lead or copper action levels are also required to conduct a corrosion control study. Corrosion control studies must compare the effectiveness of pH and alkalinity adjustment, calcium adjustment, and addition of a phosphate- or silica-based corrosion inhibitor. Large and medium systems are also required to monitor many other water quality parameters at the entry point to the distribution system and customer taps.

5.2.2.6.1 Impact of LCR on the City

The City water system is in full compliance with the provisions set forth in the LCR. The City currently must test 30 samples every 3 years. The City must send the LCR results to the customers sampled within 30 days of receiving the results and make OHA aware of the customer notification within 90 days of submitting the results to customers.

5.2.2.7 Disinfectants and Disinfection Byproducts Rule

Stage 1 of the Disinfectants/Disinfection Byproducts Rule (Stage 1 DBPR) applies to all water systems that treat with a chemical disinfectant, such as chlorine, for either primary or residual treatment. The rule establishes MCLGs and MCLs for total trihalomethanes, haloacetic acids, chlorite, and bromate. Bromate testing is only required for systems that use ozone, which the City does not. It also establishes maximum residual disinfectant level goals (MRDLGs) and maximum residual disinfectant levels (MRDLs) for three chemical disinfectants: chlorine, chloramines, and chlorine dioxide (OAR 333-061-0036(4)(i)). The Stage 1 DBPR Rule also attempts to reduce general Disinfection Byproducts (DBP) formation by requiring specific levels of total organic carbon (TOC) removal by enhanced coagulation.

The Stage 2 Disinfectants/Disinfection Byproduct Rule (Stage 2 DBPR) builds on the Stage 1 DBPR by requiring different monitoring and reducing some MCLs for Disinfection Byproducts. The Stage 2 DBPR requires the use of locational running annual averages (LRAA) to determine compliance with the MCLs for Total Trihalomethanes (TTHMs) and Five Haloacetic Acids (HAA5). This differs from the running annual average approach outlined in Stage 1 DBPR, where compliance was determined by calculating the running annual average of samples from all monitoring locations across the system. Stage 2 monitoring is intended to identify and add testing locations that are more likely to exhibit higher DBPs than a random system sampling. The MCLs for the DBPR are shown in Table 5-5.

Table 5-5 | DBPR Limits

Contaminant	MCL (mg/L)
Total Trihalomethanes (TTHM)	0.080 LRAA
Chloroform	0.07
Bromodichloromethane	0
Dibromochloromethane	0.06
Bromoform	0
Five Haloacetic Acids (HAA5)	0.060 LRAA
Monochloroacetic acid	0.07
Dichloroacetic acid	0
Trichloroacetic acid	0.02
Bromoacetic acid	-
Dibromoacetic acid	-
Bromate	0.010
Chlorite	1.0
Chlorine/Chloramines	4.0

Note:
1. All systems must monitor during month of highest DBP concentrations.
2. Systems on quarterly monitoring must take dual sample sets every 90 days at each monitoring location.

5.2.2.7.1 Impact of the D/DBP Rule on the City

The City is in compliance with all Disinfectant/ Disinfection Byproduct (D/DBP) Rules and currently collects two samples every three months. Samples are collected from the raw surface water source and from other sites agreed upon with OHA.

5.2.2.8 Groundwater Rule

The final Groundwater Rule was published in November 2006 and took effect in Oregon in December 2009. The Groundwater Rule seeks to reduce the risk of illness caused by microbial contamination and includes treatment technique requirements, compliance monitoring, and source water monitoring. Treatment technique requirements include providing treatment that reliably achieves 4-log treatment of viruses and correcting all significant deficiencies. Compliance monitoring is composed of testing for minimum disinfectant residual concentrations. Source water monitoring adds fecal indicator bacterial testing of the water source, as well as regulatory steps, should a source water test return positive.

5.2.2.8.1 Impact of the Groundwater Rule on the City

The City currently uses chlorine disinfection at all its groundwater supply locations and is in compliance with monitoring requirements for bacteria sampling.

5.2.2.9 Consumer Confidence Report Rule

The CCR Rule (OAR 333-061-0043) requires systems to prepare and distribute an annual water quality report summarizing information about source water, detected contaminants, compliance, and educational information characterizing the risks from exposure to contaminants in an understandable manner. The CCR must be provided to OAR and delivered to customers by July 1 annually.

5.2.2.9.1 Impact of the CCR Rule on the City

The City is in compliance with Consumer Confidence reporting requirements and makes the CCR available on their website. Appendix 5A has an example of the City's CCR.

5.2.2.10 Public Notification Rule

The Public Notification Rule (OAR 333-061-0042) requires systems to inform customers of any violation of National Primary Drinking Water Regulations or any situation posing a risk to public health. Should the violation occur in an area of the system that is physically or hydraulically isolated from the rest of the system, the City may limit the issuance of the public notice to only the affected area. Ten required elements must be present in each public notice and are detailed in OAR 333-061-0042(4)(a)(A-J). A copy of the public notice must be sent to OHA as required in OAR 333-061-0040(1)(i). There are three tiers of violations with required response times, with the most severe violation, Tier 1, requiring notice to the public and OHA within 24 hours of learning of the situation.

5.2.2.10.1 Impact of the Public Notification Rule on the City

The City has a procedure in place for notifying the public in accordance with the Public Notification Rule if required.

5.2.2.11 National Secondary Drinking Water Regulations

The National Secondary Drinking Water Regulations set non-mandatory water quality standards for 15 contaminants. These are not enforceable but recommended secondary maximum contaminant levels (SMCLs). They establish guidelines for managing aesthetic concerns such as taste, color, and odor that are not considered a risk to human health at the SMCL. Although the SMCLs are not enforced, public notice is required if the fluoride SMCL is exceeded. A list of the SMCLs is presented below in Table 5-6.

Table 5-6|Secondary Drinking Water Standards

Contaminant	SMCL
Aluminum	0.05 - 2.0 mg/L
Chloride	250 mg/L
Color	15 color units
Copper	1.0 mg/L
Corrosivity	Non-corrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 TON (threshold odor number)
pH	6.5 - 8.5
Silver	0.1 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

5.2.2.11.1 Impact of the Secondary Drinking Water Standards on the City

The City currently meets all Secondary Drinking Water Standards. Although they meet regulatory requirements, the City is always working to provide high quality water to its customers and is doing modeling analysis to improve the turnover rate in some of its tanks during non-peak seasons to improve taste and odor issues due to water age.

5.2.2.12 Contaminant Candidate List and Unregulated Contaminant Monitoring Rule

The 1996 amendment to the SDWA requires the EPA to list unregulated contaminants that are known or anticipated to occur in public water systems. Every 5 years, the EPA must publish this list of contaminants called the Contaminant Candidate List (CCL). EPA uses the CCL to identify priority contaminants for decision making and information collection. After publishing, EPA must also review at least five contaminants from the list and determine if they will be regulated in a separate process called Regulatory Determinations.

The EPA also requires larger public water systems to monitor for some unregulated contaminants as part of the Unregulated Contaminant Monitoring Rule (UMCR) to provide a basis for future regulatory actions.

5.2.2.12.1 Impact of the CCLs and UCMR on the City

The CCLs have no direct impact on the City, as the lists by themselves do not impose any requirements on public water systems. However, the EPA may promulgate future regulations based on the listed contaminants. If this occurs, the City will need to follow specific requirements that are contained in the regulations.

The City complies with sampling and testing requirements of the UCMR.

5.3 Summary

By State law (OAR 333-061-0036), the City is required to maintain an ongoing water quality testing and monitoring program. This program is administered by OHA and is comprised of monitoring the water supply for specified chemical and physical contaminants. OHA requires that the source water supply be monitored for the primary and secondary contaminants. Primary contaminant levels are not to be exceeded for health reasons, while secondary contaminants should not be exceeded to improve water color, taste, and odor.

The City is required to monitor inorganic compounds, volatile organic compounds, synthetic organic compounds, and radiological constituents. Distribution system water quality testing requirements include monitoring of many types of components including bacteriological, inorganic chemical, physical, disinfection by-products and disinfection residual, radionuclides, organic chemicals, and any other chemicals for which the state board of health determines maximum contaminant levels.

The City water system is of high quality and complies with all water quality regulations. The most immediate change in the City's water quality sampling could be reaching the threshold of 70,000 people served, which will trigger an increase from 70 to 80 required total coliform samples per month.

Section 6

Section 6

Capital Improvement Plan

6.1 Introduction

This chapter describes the water system Capital Improvement Plan (CIP) for the City of Bend (City) service area to address system condition and hydraulic deficiencies to serve existing and 20-year projected demands. Although the projects are identified to address the 20-year projections, due to funding and staffing constraints they are being implemented over a timeframe longer than 20-years. Projects are grouped in three timeframes. The 10-year horizon covers years 2021 through 2030. The 20-year covers years 2031-2040 and the remaining projects are beyond 2040. The total project cost (2020 dollars) for the entire CIP is \$391 million. The cost for the 10-year timeframe is approximately \$133 million, in the 11- to 20-year timeframe it is approximately \$137 million. The projects slated for beyond 2040 have a total cost of approximately \$121 million.

6.2 Cost Estimates

All project descriptions and estimates represent American Association of Cost Engineers (AACE) International Class 5, planning-level accuracy and opinions of costs (+50 percent -30 percent). Total project costs will depend on actual labor and material costs, site conditions, competitive market conditions, regulatory requirements, project schedule, and other factors. During the design phase final sizing, location, and project components should be verified and a Preliminary Engineering Report (PER) completed. As part of the PER, the cost estimate should be refined. Therefore, project feasibility and any associated risks should be carefully reviewed prior to making specific financial decisions or establishing yearly project budgets to help ensure adequate funding.

Detailed costs using different methodologies based on facility type were derived for use in the optimization model. Unit costs were developed for each type of water system infrastructure considered in the optimization process (e.g., waterlines, new wells, booster stations). The project costs provide the basis for constructing new or upgrading existing infrastructure. Operations and maintenance (O&M) costs provide the basis for annual expenditures to operate and maintain the infrastructure in the water system.

The overall life cycle cost analysis, performed as part of the optimization, utilized an Equivalent Uniform Annual Cost (EUAC) approach to equitably compare infrastructure types that have differing useful lives. EUAC costs were then converted to 2020 dollars. All costs in this section reference U.S. dollars. The Engineering News Record Construction Cost Index (ENR CCI) basis is 12,341 (Seattle, August 2020), which can be used as a reference to future ENR CCI values to escalate to costs in future years. The detailed cost methodology is in Appendix 6A, Appendix 6B, and Appendix 6C.

6.3 Project Categories

As discussed in Section 4, the City has made a significant investment in evaluating the system in a comprehensive and integrated approach, meeting and in some cases exceeding the regulatory requirements. The unique process of optimization allowed for an extensive range of system improvements to be evaluated and ensures that the most hydraulically beneficial and cost-effective solutions are implemented. From these solutions, a comprehensive CIP was developed to address the deficiencies in facility and pipe condition, facility and distribution system capacity, and criticality identified through the system analysis outlined in Section 4.

Projects are grouped into five categories based on the primary deficiency they address: facility capacity, facility condition, pipe capacity, pipe replacement, and other.

6.3.1 Facility Capacity

Facility capacity projects were intended to ensure the system provides the hydraulic capacity to meet regulatory requirements and the City's level of service standards. Many of the identified projects are new facilities with the purpose of meeting future projected demands. This category of projects includes new reservoirs, wells, and pressure reducing valve (PRV) stations.

6.3.2 Facility Condition

Facility condition projects were identified based on the results of the condition assessment. An onsite examination of physical and operating conditions at each facility was performed for all the City's wells, reservoirs, and pump stations. Each facility was ranked, and improvements were identified that are required to maintain current facilities and extend their useful life. Maintenance improvements at facilities include upgrades to pumps and motors, electrical and instrumentation control, and reservoir coatings. The detailed maintenance and improvement recommendations and their associated costs are identified for each facility in the Infrastructure Condition Assessment Report.

6.3.3 Pipe Capacity

Pipe capacity projects were identified to address distribution system deficiencies. These include projects to address velocity, fire flow, and redundancy deficiencies as well as increase hydraulic performance and increase capacity for future projected demands. These projects include upsizing existing system piping and constructing new piping.

6.3.4 Pipe Replacement

The City is committed to an ongoing pipe replacement program. As part of the pipe condition assessment, a replacement rating based on material, diameter, valve frequency, and break history was assigned to each pipe in the system. Pipes with a higher score indicate worse condition and are intended to be prioritized for replacement sooner. The City intends to upsize any 6-inch or smaller piping to 8-inch as part of pipe replacement.

6.3.5 Planning/Conservation

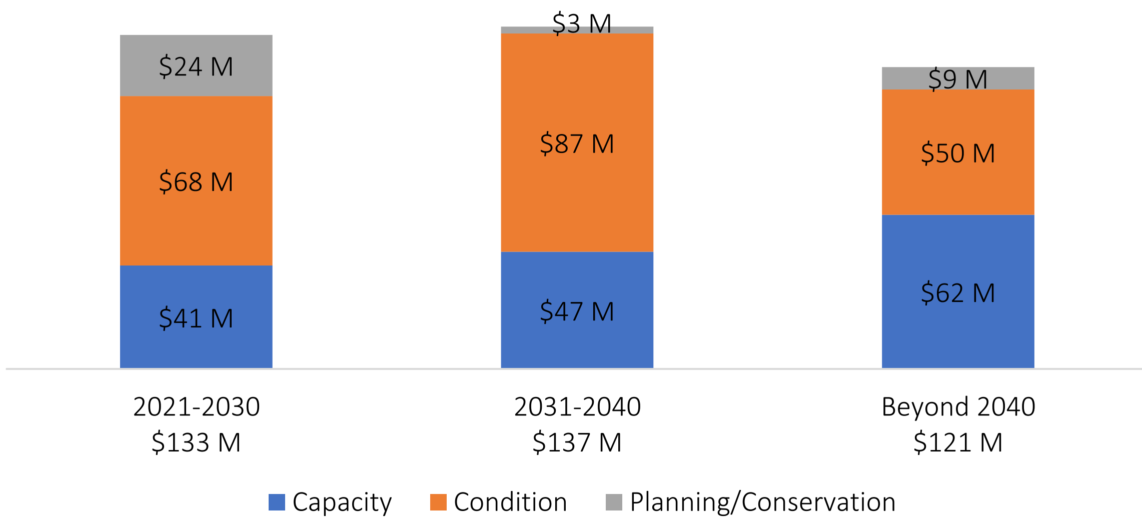
Projects in the Planning/Conservation category are intended to capture projects that are not a result of the deficiencies described in Section 4. These projects contribute to the capacity, condition, and resilience of the system and include things such as regular updates to planning documents including ongoing and regulatorily required updates and progress reports for the Water Management and Conservation Plan (WMCP) and related conservation and demand management programs, improvements and planning at the Outback Site, and other projects that are discussed further in this section.

6.4 Projects

Project locations are depicted in Figure 6-1. Timing and prioritization of projects are based on input from the City based on funding and implementation considerations. The projects are organized in 10-year periods from 2021-2030 and 2031-2040 and then extend beyond 2040. The cost estimates (2020 dollars) for each timeframe by project type are in Figure 6-2. Additionally, most pipe replacement program projects have not been allocated a specific timeframe and will be determined by the City to leverage synergy with other projects such as collection system or transportation projects. The replacement pipes are displayed by rating with the intention that those with higher score are replaced sooner than those with lower ratings. Some of the projects, such as new supply and storage may need to be accelerated to meet demands and other improvements deferred to stay within budget. Or projects may be delayed if demands are lower than projected, for example due to increased conservation program efforts. Projects should be evaluated annually through City reviews of demand growth, available budget, and where development is occurring in the service area.

In addition to the descriptions provided in this section, individual project plates have been developed for each pipe and facility project and are included in Appendix 6D.

Figure 6-2|CIP Cost by Timeframe (2020 Dollars)



6.5 Projects Years 2021-2030

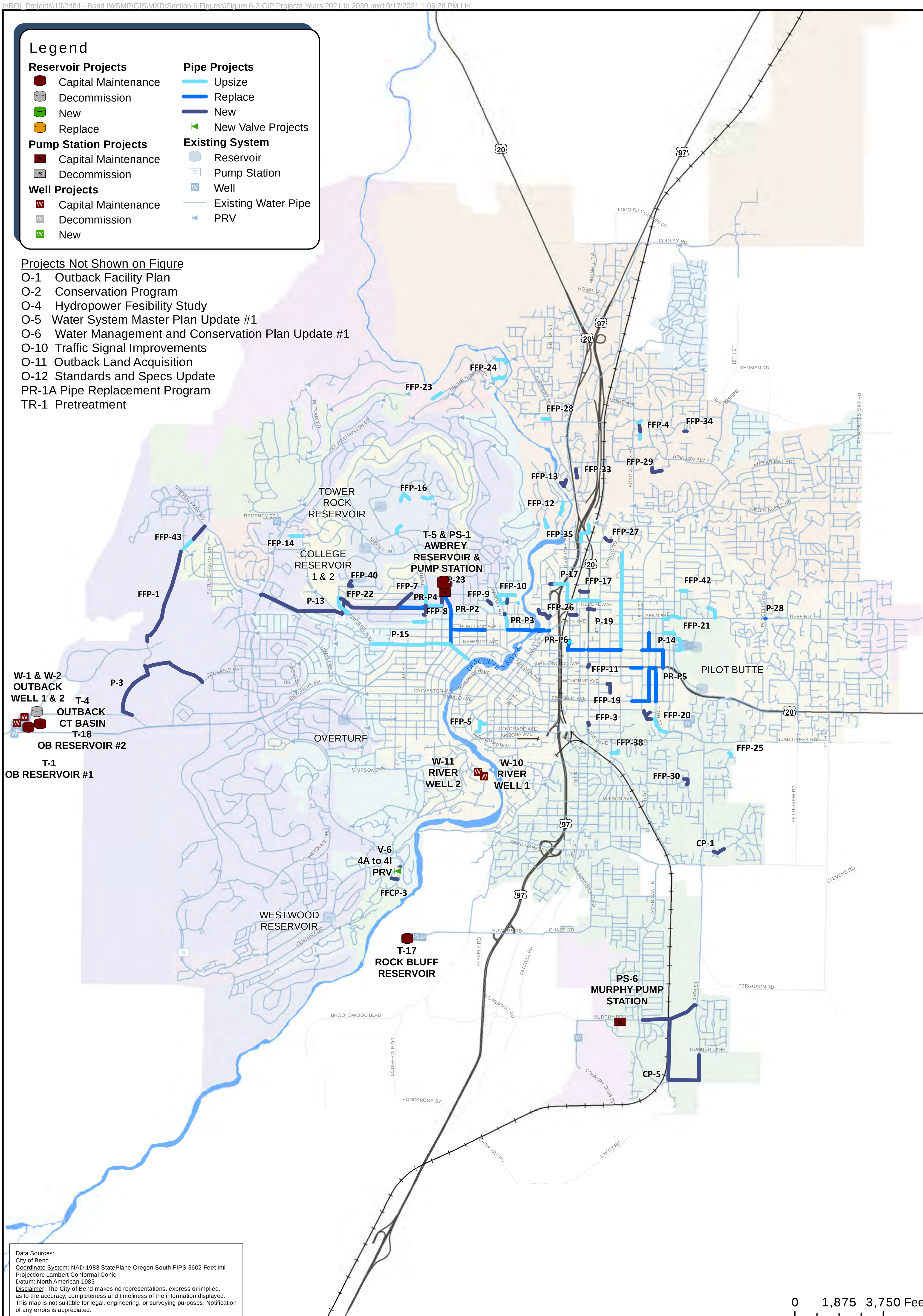
Projects planned for years 2021 to 2030 are displayed in **Figure 6-3**. The projects are organized by project type. The facility types include capital maintenance, decommission, new, and replace. For pipe projects the categories are upsize, replace, new.

The projects prioritized over the next 10 years are intended to address facility condition and piping condition and capacity deficiencies. There are several projects at current facilities. These projects include condition related improvements to the Awbrey Pump Station, Outback Reservoir 1, Awbrey Reservoir, Outback Wells 1 and 2, and the River Wells. Included in facility condition projects is the decommissioning of the Outback Contact Time (CT) Basin. The intent is that the contact time requirements can be met by Outback Reservoir 1, or the Outback Facility Plan will identify another configuration to meet contact time. Additionally, interior coating is slated for the Rock Bluff Reservoir and Outback Reservoir 2.

Also included in the 10-year horizon are a few major piping projects including a new 30-inch Awbrey transmission main that will address capacity issues in the current transmission main and increase capacity for future growth. Upsizing is also planned for portions of piping along Newport Avenue. Many smaller pipe projects to address fire flow deficiencies (identified with FF in the project ID) are also included. A yearly pipe replacement program is planned. In addition to the pipe replacement program, specific pipe replacement projects have been identified near the Awbrey and Pilot Butte Reservoirs. A new PRV from Zone 4A to 4I is included as well.

An update to the Integrated Water System Master Plan (iWSMP), the state required 10-year update to the WMCP, the 5-year WMCP Progress Report, implementation of the conservation program and Standards and Specifications document are planned for the 10-year timeframe as well. Lastly, improvements to the Outback Site including an Outback Facility Plan, to further refine and finalize in detail the work done in the Outback Siting Study including recommended facilities such as pretreatment, new and rebuilt reservoirs, wells, and other water related facilities that may be sited on existing and/or additional lands. The potential for hydropower generation, if approved by City Council and after a Hydropower Feasibility Study, would also be considered as part of the plan. A detailed list and description of all proposed 10-year projects is in Table 6-1 with project plates for each pipe and facility project in Appendix 6D.

For this timeframe, the City has grouped many of the projects that are occurring around major facilities. These include the Awbrey Butte Distribution Improvements (1WABD), Outback Facility Improvements (1WOFI), River Well Improvements (1WWCM), Rock Bluff Reservoir Coating (1WROC), and Pilot Butte Distribution Improvements (1WPDI).



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City of Bend
Integrated Water System
Master Plan

Figure 6-3
CIP Projects
Years 2021 to 2030

Exhibit 26

September 2021

19-2484

Table 6-1|Projects Years 2021-2030

Project ID	Project Name	Project Category	Type of Improvement	Description	Recommended Sizing	Growth Allocation	Cost (2020 $)
CP-1	Ironwood Court Redundant Looping	Pipe Capacity	New Distribution Pipe for Redundancy	8-inch new pipe in Ironwood Court east of Castlewood Drive	8-inch, 510 LF	0%	$239,000
CP-5	Murphy Road Redundant Looping	Pipe Capacity	New Transmission Pipe for Redundancy	12inch and 16-inch new pipe in Murphy Road Area between Brosterhous Road and 15th Street	12-inch to 16-inch, 7420 LF	0%	$0
FFCP-3	New Zone 4I pipe	Pipe Capacity	New Distribution Pipe for Fire Flow and Redundancy	8-inch new pipe connecting Village Office Court and Mt. Bachelor Drive and new PRV piping in Mt. Bachelor Drive to serve Zone 4I	8-inch, 520 LF	0%	$287,000
FFP-1	Transect Area New Development	Pipe Capacity	New and Upsize Transmission Pipe for Fire Flow	24-inch new pipe installed by developer between Sage Steppe Drive and McClain Drive and 8-inch upsized pipe in McClain Drive to Shevlin Meadow Drive	24-inch, 4920 LF	100%	$0
FFP-3	Clay Avenue and 3rd Street Looping Part 1	Pipe Capacity	New Distribution Pipe for Fire Flow	8-inch new pipe connecting dead-end on Clay Avenue to 3rd Street	8-inch, 140 LF	0%	$47,000
FFP-4	Builders Street Looping	Pipe Capacity	New and Upsize Distribution Pipe for Fire Flow	8-inch new and upsized pipe on Builders Street at Boyd Acres Road	8-inch, 850 LF	0%	$535,000
FFP-5	Adams Place Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized dead-end pipe on Adams Place and Delaware Avenue west of Broadway Street	8-inch, 860 LF	0%	$543,000
FFP-7	12th and Juniper Streets Improvements	Pipe Capacity	New and Upsize Distribution Pipe for Fire Flow	8-inch new pipe on Juniper Street between Trenton and Iowa Avenues and on 12th Street between Saginaw and Trenton Avenues. 8-inch upsized pipe in 12th Street between Trenton and West Hills Avenues and in Trenton Avenue between 12th and 10th Streets.	8-inch, 2770 LF	0%	$1,829,000
FFP-8	Quincy Avenue Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized pipe on Quincy Avenue to connect 8-inch pipe to west and 10-inch pipe to east in 12th Street	8-inch, 540 LF	0%	$341,000
FFP-9	4th Street Looping	Pipe Capacity	New Distribution Pipe for Fire Flow	8-inch new pipe connecting dead-end on 4th Street to Utica Avenue	8-inch, 220 LF	0%	$105,000
FFP-10	Awbrey Road and Portland Avenue	Pipe Capacity	New and Upsize Distribution Pipe for Fire Flow	8-inch new and upsized pipe in area between Awbrey Road and Vicksburg Avenue and Portland Avenue and NW 1st Street	8-inch, 2410 LF	0%	$1,788,000
FFP-11	Greenwood Avenue and 3rd Street Intersection New Pipe	Pipe Capacity	New Distribution Pipe for Fire Flow	12-inch new pipe connecting dead-end 6-inch pipe to intersection of Greenwood Avenue and 3rd Street	12-inch, 120 LF	0%	$145,000
FFP-12	River's Edge Golf Course Area Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch and 12-inch upsized pipe in Golf Course Drive South and Rippling River Court	8-inch to 12-inch, 1000 LF	0%	$685,000
FFP-13	Riverhouse Resort Looping	Pipe Capacity	New Distribution Pipe for Fire Flow	8-inch new pipe connecting dead-end service lines around Riverhouse Resort and Shilo Inn near O B Riley Road	8-inch, 550 LF	0%	$345,000
FFP-14	Regency Street Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized dead-end in Regency Street west of College Way	8-inch, 500 LF	0%	$316,000
FFP-16	Zone 1 Dead-End Fire Flow Improvements	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch and 12-inch upsized pipe in Gill Court, Elliot Court, Meldrum Court, and Moore Court dead-end streets in Zone 1	8-inch to 12-inch, 1520 LF	0%	$1,022,000
FFP-17	Highway 20 Looping	Pipe Capacity	New and Upsize Distribution Pipe for Fire Flow	8-inch new pipe connecting dead-ends near Highway 20 and Revere Avenue	8-inch, 950 LF	0%	$600,000
FFP-19	5th Street and Hawthorne Avenue Looping	Pipe Capacity	New Distribution Pipe for Fire Flow	8-inch new pipe on 5th Street between Greeley Avenue and Hawthorne Avenue	8-inch, 500 LF	0%	$316,000
FFP-20	8th Street and Bear Creek Road Looping and Upsize	Pipe Capacity	New and Upsize Distribution Pipe for Fire Flow	8-inch new pipe in 8th Street between Emerson Avenue and Dekalb Avenue and 8-inch upsized pipe in 10th Street and Bear Creek Road between Dekalb Avenue and Alden Avenue	8-inch, 1760 LF	0%	$1,463,000
FFP-21	Pilot Butte and Neff Road Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	12-inch and 8-inch upsized pipe in Pilot Butte and Neff Road between 11th Street and Eastwood Drive	8-inch to 12-inch, 2680 LF	0%	$2,111,000
FFP-22	Cascade View Drive and Trenton Looping	Pipe Capacity	New and Upsize Distribution Pipe for Fire Flow	8-inch upsized pipe on Cascade View Drive and new 8-inch Zone 3 connection in Trenton Avenue	8-inch, 1400 LF	0%	$883,000
FFP-23	Foxwood Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized dead-end pipe in Foxwood	8-inch, 440 LF	0%	$276,000
FFP-24	Silver Buckle and Broken Arrow Road Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized pipe in Silver Buckle and in Broken Arrow Road east of Lower Village Road	8-inch, 1100 LF	0%	$689,000
FFP-25	Karena Court Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized pipe in dead-end on Karena Court at Craven Road	8-inch, 200 LF	0%	$128,000

Project ID	Project Name	Project Category	Type of Improvement	Description	Recommended Sizing	Growth Allocation	Cost (2020 $)
FFP-26	Wall Street and Harriman Street and Highway 20 Looping	Pipe Capacity	New and Upsize Distribution Pipe for Fire Flow	12-inch and 8-inch new pipe to connect dead-ends on Harriman Street and south of Revere Street to Wall Street	8-inch to 12-inch, 1040 LF	0%	$737,000
FFP-27	Xerxes Avenue and 4th Street Looping	Pipe Capacity	New Distribution Pipe for Fire Flow	8-inch new pipe connecting dead-end service line to 4th Street	8-inch, 320 LF	0%	$183,000
FFP-28	Sawyer Reach Lane Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized dead-end pipe north of Sawyer Reach Lane at O B Riley Road	8-inch, 300 LF	0%	$188,000
FFP-29	Peerless Court Looping	Pipe Capacity	New Distribution Pipe for Fire Flow	8-inch new pipe connecting dead-ends on Peerless Court at Brinson Boulevard	8-inch, 600 LF	0%	$375,000
FFP-30	Wilson Avenue and 15th Street Industrial Service Looping	Pipe Capacity	New Distribution Pipe for Fire Flow	8-inch new pipe connecting dead-end industrial services	8-inch, 390 LF	0%	$248,000
FFP-33	Bend River Promenade Looping	Pipe Capacity	New Distribution Pipe for Fire Flow	8-inch new pipe looping dead-end service at Bend River Mall Avenue near O B Riley Road	8-inch, 370 LF	0%	$233,000
FFP-34	High Desert Lane Looping	Pipe Capacity	New Distribution Pipe for Fire Flow	8-inch new pipe connecting dead-end lines south of High Desert Lane	8-inch, 120 LF	0%	$77,000
FFP-35	Addison Avenue Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	12-inch upsized pipe at Highway 97 and Highway 20 near Addison Avenue	12-inch, 1050 LF	0%	$1,873,000
FFP-38	5th Street and Glenwood Drive Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized dead-end pipe off 5th Street south of Glenwood Drive	8-inch, 390 LF	0%	$248,000
FFP-40	Glassow Drive Looping	Pipe Capacity	New Distribution Pipe for Fire Flow	8-inch new pipe connecting Glassow Drive and Rimrock Road near College Reservoir 1	8-inch, 380 LF	0%	$237,000
FFP-42	Seward Avenue Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized dead-end pipe on Seward Avenue between 13th Street and 14th Street	8-inch, 260 LF	0%	$164,000
FFP-43	McClain Drive Upsize	Pipe Capacity	New and Upsize Transmission Pipe	Upsize existing 8-inch to 24-inch	24-inch, 770 LF	0%	$782,000
O-1	Outback Facility Plan	Planning/Conservation	-	Comprehensive assessment of Outback site	-	38%	$500,000
O-2	Conservation Program	Planning/Conservation	-	Implementation of conservation program	-	38%	$1,538,000
O-4	Hydropower Feasibility Study	Planning/Conservation	-	Analysis of addition of hydropower in the system, privately funded	-	38%	$0
O-5	Water System Master Plan Update #1	Planning/Conservation	-	First update to Water System Master Plan	-	38%	$1,000,000
O-6	Water Management and Conservation Plan Update #1	Planning/Conservation	-	10-year update to Water Management and Conservation Plan	-	38%	$200,000
O-10	Traffic Signal Improvements	Planning/Conservation	-	Coordination with transportation project	-	0%	$25,000
O-11	Outback Land Acquisition	Planning/Conservation	-	Land acquisition required for Outback Facility expansion	-	38%	$5,000,000
O-12	Standards & Specs Update	Planning/Conservation	-	Update to Standards and Specifications document	-	0%	$150,000
P-3	Discovery West Looping	Pipe Capacity	New Transmission Pipe for Hydraulic Performance	12-inch and 18-inch and 24-inch new pipe in new development connecting to North Outback Transmission Main, Sage Steppe Drive and Crossing Drive. Project funded primarily by developer.	12-inch to 24-inch, 5550 LF	100%	$0
P-13	New Awbrey Transmission	Pipe Capacity	New Transmission Pipe for Hydraulic Performance	30-inch new pipe in Shevlin Park Road, Utility ROW, and Trenton Avenue from Mt. Washington Avenue to Awbrey Reservoir. Includes trenched construction with rock excavation, fittings, valves, water meters, and surface restoration.	30-inch, 9040 LF	36%	$10,312,000
P-14	Upsize Pilot Butte Reservoir 1 Transmission Pipe	Pipe Capacity	Upsize Transmission Pipe for Hydraulic Performance	18-inch upsized pipe from Pilot Butte Reservoir 1 to Pilot Butte Well 4 Connection	18-inch, 270 LF	0%	$342,000
P-15	Newport Avenue Replacement	Pipe Capacity	Upsize Distribution Pipe for Hydraulic Performance	12-inch upsized pipe in Newport Avenue from College Way to 9th Street. 16-inch replacement pipe in Newport Avenue from 9th Street to the Deschutes River. Includes trenched construction with rock excavation, fittings, valves, and water meters.	12-inch to 16-inch, 4500 LF	43%	$3,984,000
P-17	Revere Division and Thurston Upsize Part 1	Pipe Capacity	Upsize Distribution Pipe for Hydraulic Performance	12-inch upsized pipe in Revere Avenue, Division Street, and Thurston Avenue between 4th Street and Wall Street	12-inch to 16-inch, 2920 LF	55%	$2,077,000
P-19	6th Street Upsize	Pipe Capacity	Upsize Transmission Pipe for Hydraulic Performance	16-inch upsized pipe in 6th Street from Lafayette Avenue to Innes Lane. 12-inch upsized pipe in 6th Street from Innes Lane to Stalker Court	12-inch to 16-inch, 4130 LF	78%	$3,625,000
P-23	Awbrey Reservoir Outlet Transmission Upsize	Pipe Capacity	Upsize Transmission Pipe for Hydraulic Performance	24-inch upsized pipe outlet from Awbrey Reservoir outlet to match 24-inch in 9th Street	24-inch, 320 LF	0%	$260,000
P-28	Neff and Purcell Intersection	Pipe Capacity	New and Upsize Distribution Pipe	Replace pipe in intersection of Neff Road and Purcell Boulevard while road is being resurfaced	16-inch, 20 LF	0%	$19,000

Project ID	Project Name	Project Category	Type of Improvement	Description	Recommended Sizing	Growth Allocation	Cost (2020 $)
PR-1A	Pipe Replacement Program Years 1 to 10	Pipe Replacement	-	Pipe replacement program	-	0%	$33,788,000
PR-P2	Awbrey Butte Distribution Improvements	Pipe Replacement	Replace Distribution Pipe	Phase 1 Awbrey Butte Distribution Improvements Pipe Replacement	24-inch, 2260 LF	0%	$2,737,000
PR-P3	Awbrey Butte Distribution Improvements	Pipe Replacement	Replace and Upsize Distribution Pipe	Phase 3 Awbrey Butte Distribution Improvements Pipe Replacement and Upsize Existing 6-inch pipe to 8-inch	8-inch to 18-inch, 3500 LF	0%	$3,346,000
PR-P4	Awbrey Butte Distribution Improvements	Pipe Replacement	Replace and Upsize Distribution Pipe	Phase 4 Awbrey Butte Distribution Improvements Pipe Replacement and Upsize Existing 6-inch pipe to 8-inch	8-inch, 1260 LF	0%	$1,104,000
PR-P5	Pilot Butte Distribution Improvements	Pipe Replacement	Replace Distribution Pipe	Phase 1 Pilot Butte Distribution Improvements Pipe Replacement	8-inch to 12-inch, 6650 LF	0%	$5,940,000
PR-P6	Pilot Butte Distribution Improvements	Pipe Replacement	Replace and Upsize Distribution Pipe	Phase 2 Pilot Butte Distribution Improvements Pipe Replacement and Upsize Existing 6-inch to 8-inch	8-inch to 12-inch, 2390 LF	0%	$2,314,000
PS-1	Awbrey Pump Station	Facility Condition	Pump Station Capital Maintenance	Condition Related Improvements to 3,900 Gallon Per Minute Pump Station (See Condition Assessment Project List for Additional Details)	-	0%	$3,459,000
PS-6	Replacement of Murphy Pump Station	Facility Condition and Capacity	Replace Pump Station	New pump station with 2,900 gpm capacity. Construction scheduled for Fall 2021. Cost is not included as it is already funded.	-	0%	$0
T-1	Outback Reservoir 1	Facility Condition	Reservoir Capital Maintenance	Condition Related Improvements (See Condition Assessment Project List for Additional Details)	-	0%	$1,585,000
T-4	Outback CT Basin	Facility Condition and Capacity	Decommission Reservoir	Decommission Existing Reservoir	-	0%	$500,000
T-5	Awbrey Reservoir	Facility Condition	Reservoir Capital Maintenance	Condition Related Improvements to 5.0 Million Gallon Reservoir (See Condition Assessment Project List for Additional Details)	-	0%	$3,547,000
T-17	Rock Bluff Reservoir Interior Coating	Facility Condition	Reservoir Capital Maintenance	Rock Bluff Reservoir Interior Coating	-	0%	$700,000
T-18	Outback Reservoir 2 Interior Coating	Facility Condition	Reservoir Capital Maintenance	Outback Reservoir 2 Interior Coating	-	0%	$1,300,000
TR-1	Pretreatment	Planning/Conservation	-	Design and construction of pretreatment at Water Filtration Facility	-	38%	$16,000,000
V-6	New Zone 4A to 4I PRV	Facility Capacity	New PRV	Zone 4A to 4I PRV on Mt. Bachelor Drive	-	0%	$155,000
W-1	Outback Well 1	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 800 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$1,223,000
W-2	Outback Well 2	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 950 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$1,531,000
W-10	River Well 1	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 1,800 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$2,198,000
W-11	River Well 2	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 1,900 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$2,928,000
						Total	$133,425,000

6.6 Projects Years 2031-2040

Projects planned for years 2031 to 2040 are displayed in **Figure 6-4**. The projects include additional piping improvements to address capacity related to fire flow and hydraulic performance deficiencies. Included in these projects is upsizing small diameter pipe in the Awbrey Meadows Development (6B Zone) and upsizing piping along 8th Street to 16-inch.

Capital maintenance projects include condition related improvements to the College Pump Station, Tetherow Pump Station, Murphy Pump Station, Pilot Butte Reservoirs 1, 2, and 3, Bear Creek Wells 1 and 2, Pilot Butte Wells 1 and 3, Rock Bluff Well 2, and Outback Wells 3, 4, and 5. A few facilities including the Westwood Pump Station, Overturf Reservoirs, and Westwood Reservoir are scheduled to be decommissioned. Additional new facilities to meet projected demand growth are also planned in the 20-year horizon. These facilities include a new Overturf Reservoir, Bear Creek Well, two new Zone 4 wells on Wilson Road, and three new PRVs.

Also planned is an update to the WSMP and WMCP as well as the continuation of the conservation program. A detailed list and description of the proposed projects for the 20-year horizon is in **Table 6-2** with project plates for each pipe and facility project in **Appendix 6D**.

6.7 Projects Beyond 2040

Projects planned for years beyond 2040 are displayed in **Figure 6-5**. These projects address improvements needed based on the 20-year demand projection requirements, however due to funding and staffing constraints are assumed for implementation over a longer period. The projects scheduled include the remaining pipe capacity projects to address distribution system deficiencies including two larger projects to convey flow from the Outback Facility and south to the Tetherow area.

Capital maintenance projects include condition related improvements to the Scott Street Pump Station, Outback Reservoir 3, College Reservoirs 1 and 2, Tower Rock Reservoir, Pilot Butte Well 4, Rock Bluff Wells 1 and 3, Shilo Well, Outback Wells 6 and 7, and Copperstone Well. Additionally, Outback Reservoir 2 is scheduled to be replaced with a larger volume reservoir.

New facilities intended to meet projected demands include a new Overturf Zone 5 Reservoir and well, two new Zone 5 wells near Purcell Boulevard and Paula Drive, a new Outback well, and two new PRVs. These facilities are required based on projected demands and their timing should be evaluated based on system demand thresholds as noted on the project plates in **Appendix 6D** and the requirements from **Section 4**.

An update to this iWSMP is also included. A detailed list and description of the proposed projects for beyond the 20-year horizon is in **Table 6-3** with project plates for each pipe and facility project in **Appendix 6D**.

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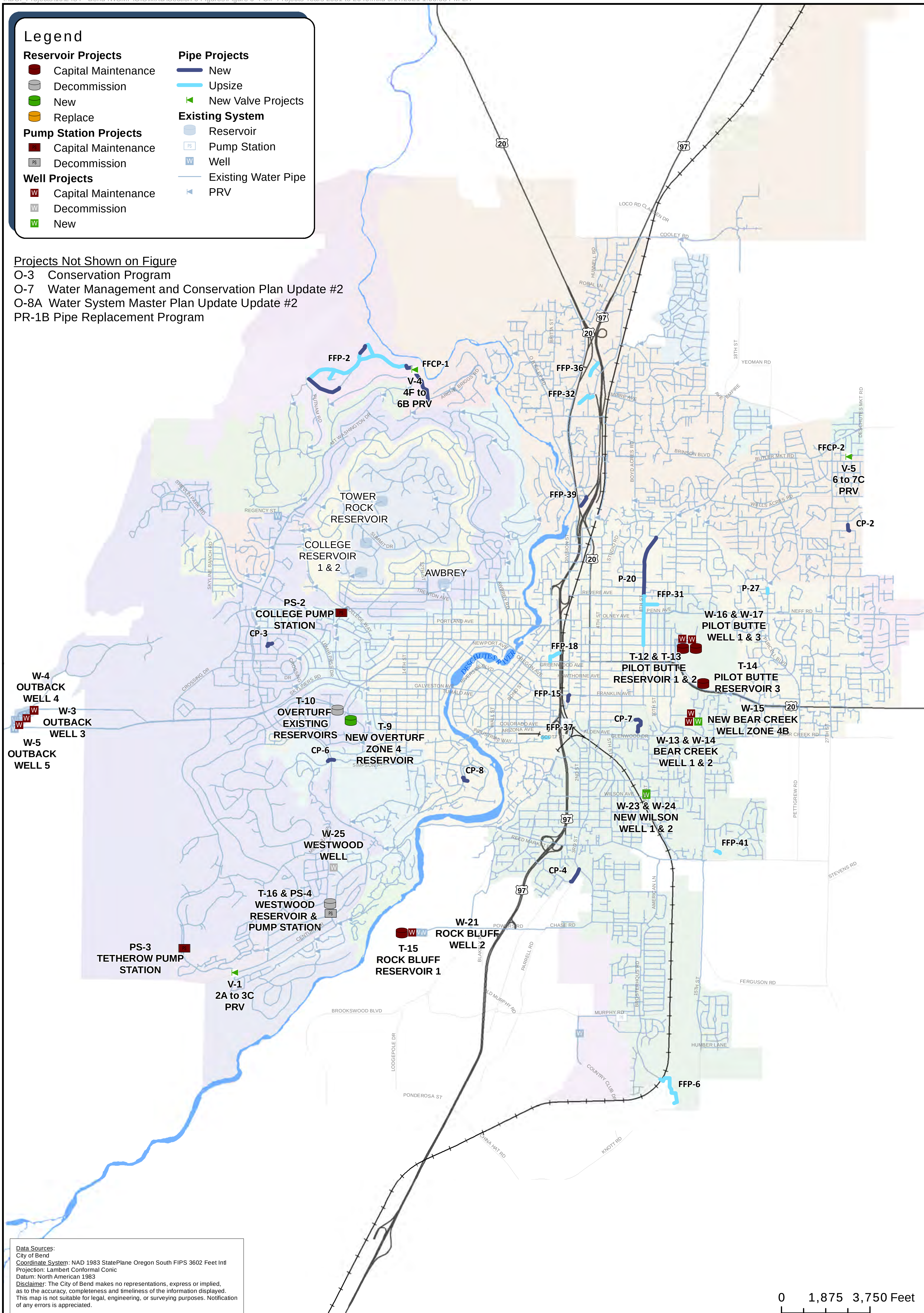


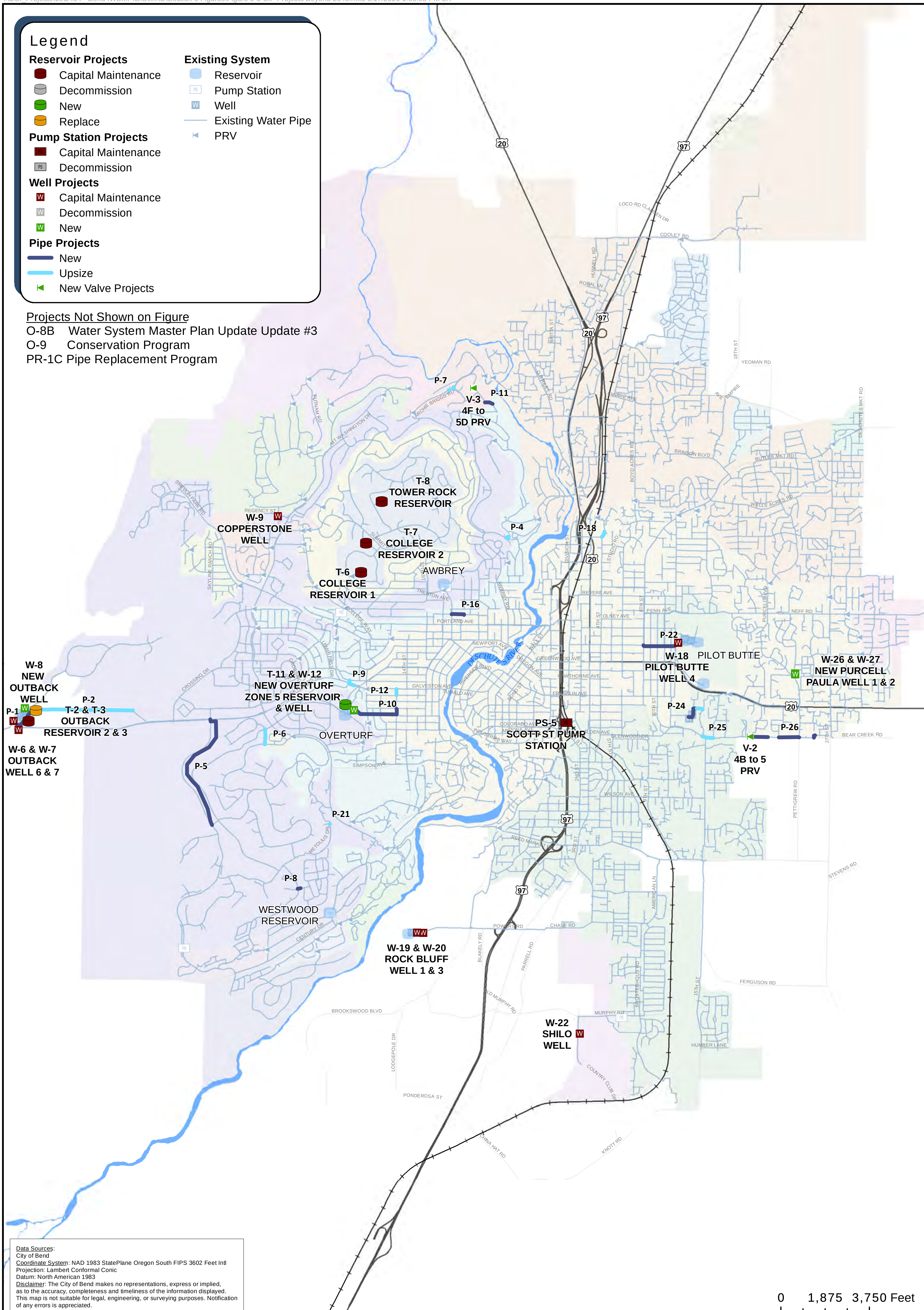
murraysmith

City of Bend
Integrated Water System
Master Plan

Figure 6-4
CIP Projects
Years 2031 to 2040

September 2021

19-2484



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City of Bend
Integrated Water System
Master Plan

Figure 6-5
CIP Projects
Beyond 2040

September 2021

19-2484

Table 6-2 | Projects Years 2031-2040

Project ID	Project Name	Project Category	Type of Improvement	Description	Recommended Sizing	Growth Allocation	Cost (2020 $)
CP-2	Rainier Drive Redundant Looping	Pipe Capacity	New Distribution Pipe for Redundancy	8-inch new pipe connecting from Catholic School to the south to Rainier Drive	8-inch, 280 LF	0%	$176,000
CP-3	High Lakes Elementary Redundant Looping	Pipe Capacity	New Distribution Pipe for Redundancy	12-inch new pipe serving High Lakes Elementary School from John Fremont Street	12-inch, 290 LF	0%	$210,000
CP-4	Fred Meyer Redundant Looping	Pipe Capacity	New Distribution Pipe for Redundancy	8-inch new pipe serving commercial area	12-inch, 660 LF	0%	$776,000
CP-6	Forest Ridge Avenue and Mt. Washington Drive Crossing	Pipe Capacity	New Distribution Pipe for Redundancy	12-inch new pipe crossing Mt. Washington Drive between Forest Ridge Avenue and Green Lakes Loop	8-inch, 310 LF	0%	$359,000
CP-7	Bend High School Redundant Looping	Pipe Capacity	New Distribution Pipe for Redundancy	8-inch new pipe along High School perimeter to connect to existing 6-inch service line	8-inch, 790 LF	0%	$497,000
CP-8	Deschutes Brewery Redundant Looping	Pipe Capacity	New Distribution Pipe for Redundancy	8-inch new pipe connecting to Colorado Avenue north of Emkay Drive	8-inch, 310 LF	0%	$195,000
FFCP-1	Awbrey Meadows pipe	Pipe Capacity	New Distribution Pipe for Fire Flow and Redundancy	8-inch new PRV piping between Archie Briggs Road and Putnam Road to serve Awbrey Meadows	8-inch, 1950 LF	0%	$1,226,000
FFCP-2	New Zone 7C pipe	Pipe Capacity	New Distribution Pipe for Fire Flow and Redundancy	8-inch new PRV piping in Marea Drive at Sandalwood Drive to serve Zone 7C	8-inch, 220 LF	0%	$137,000
FFP-2	Awbrey Meadows	Pipe Capacity	New and Upsize Distribution Pipe for Fire Flow	8-inch new and upsized pipe in Zone 6B	8-inch, 8000 LF	0%	$5,030,000
FFP-3	Clay Avenue and 3rd Street Looping Part 2	Pipe Capacity	New Distribution Pipe for Fire Flow	8-inch new pipe connecting dead-end on Clay Avenue to 3rd Street	8-inch, 140 LF	0%	$100,000
FFP-6	Brosterhous Road Fire Service Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized dead-end pipe east of Brosterhous Road at Knott Road	8-inch, 1860 LF	0%	$898,000
FFP-15	Franklin Avenue and 1st Street Looping	Pipe Capacity	New Distribution Pipe for Fire Flow	8-inch new pipe connecting dead-end pipes north and south of Franklin Avenue on 1st Street	8-inch, 280 LF	0	$299,000
FFP-18	Greenwood Avenue and Hill Street Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	12-inch upsized pipe on Hill Street at Greenwood Avenue	12-inch, 660 LF	0%	$482,000
FFP-31	Quimby Avenue Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized dead-end pipe in Quimby Avenue at 8th Street	8-inch, 590 LF	0%	$372,000
FFP-32	Nels Anderson Road Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized dead-end service lines in Nels Anderson Road Upsize	8-inch, 710 LF	0%	$463,000
FFP-36	Cady Way Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	12-inch upsized dead-end industrial service lines at Cady Way	12-inch, 640 LF	0%	$468,000
FFP-37	Industrial Way Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized dead-end near Industrial Way near Highway 97	8-inch, 250 LF	0%	$159,000
FFP-39	Red Lion Inn Looping	Pipe Capacity	New Distribution Pipe for Fire Flow	12-inch new pipe connecting dead-end service line around Red Lion Inn on Buter Market Road at Division Street	12-inch, 460 LF	0%	$336,000
FFP-41	Castlewood Drive Upsize	Pipe Capacity	Upsize Distribution Pipe for Fire Flow	8-inch upsized dead-end pipes off Castlewood Drive south of Ironwood Drive	8-inch, 230 LF	0%	$144,000
O-3	Conservation Program	Planning/Conservation	-	Continuation of conservation program	-	38%	$1,538,000
O-7	Water Management and Conservation Plan Update #2	Planning/Conservation	-	20-year update Water Management and Conservation Plan	-	38%	$200,000
O-8A	Water System Master Plan Update #2	Planning/Conservation	-	Second update to Water System Master Plan	-	38%	$1,000,000
P-17	Revere Division and Thurston Upsize Part 2	Pipe Capacity	Upsize Distribution Pipe for Hydraulic Performance	12-inch upsized pipe in Revere Avenue, Division Street, and Thurston Avenue between 4th Street and Wall Street	12-inch to 16-inch, 2920 LF	55%	$2,077,000
P-20	8th Street Upsize and Parallel Transmission	Pipe Capacity	New and Upsize Transmission Pipe for Hydraulic Performance	16-inch upsized pipe in 8th Street between Lafayette Avenue and Revere Avenue. 16-inch new pipe in 8th Street between Revere Avenue and Ravenwood Drive.	16-inch, 4740 LF	86%	$5,985,000
P-27	Upsize 6-inch pipe on Purcell Boulevard	Pipe Capacity	Upsize Distribution Pipe for Hydraulic Performance	12-inch upsized pipe in Purcell Boulevard at Loop Road near Full Moon Drive	12-inch, 190 LF	75%	$185,000
PR-1B	Pipe Replacement Program Years 11 to 20	Pipe Replacement	-	Pipe replacement program	-	0%	$66,970,000
PS-2	College Pump Station	Facility Condition	Pump Station Capital Maintenance	Condition Related Improvements to 2,200 Gallon Per Minute Pump Station (See Condition Assessment Project List for Additional Details)	-	0%	$1,276,000
PS-3	Tetherow Pump Station	Facility Condition	Pump Station Capital Maintenance	Condition Related Improvements to 3,200 Gallon Per Minute Pump Station (See Condition Assessment Project List for Additional Details)	-	0%	$1,967,000

Project ID	Project Name	Project Category	Type of Improvement	Description	Recommended Sizing	Growth Allocation	Cost (2020 $)
PS-4	Westwood Pump Station	Facility Condition and Capacity	Decommission Pump Station	Decommission 2,300 Gallon Per Minute Existing Pump Station	-	0%	$160,000
T-9	New Overturf Zone 4 Reservoir	Facility Capacity	New Reservoir	New 4.0 million gallon prestressed concrete reservoir. Includes site development, mechanical, electrical, instrumentation and controls.	-	50%	$11,219,000
T-10	Existing Overturf Reservoirs	Facility Condition and Capacity	Decommission Reservoirs	Decommission Existing Reservoirs	-	0%	$1,100,000
T-12	Pilot Butte Reservoir 1	Facility Condition	Reservoir Capital Maintenance	Condition Related Improvements to 1.5 Million Gallon Reservoir (See Condition Assessment Project List for Additional Details)	-	0%	$1,454,000
T-13	Pilot Butte Reservoir 2	Facility Condition	Reservoir Capital Maintenance	Condition Related Improvements to 1.0 Million Gallon Reservoir (See Condition Assessment Project List for Additional Details)	-	0%	$1,533,000
T-14	Pilot Butte Reservoir 3	Facility Condition	Reservoir Capital Maintenance	Condition Related Improvements to 5.0 Million Gallon Reservoir (See Condition Assessment Project List for Additional Details)	-	0%	$904,000
T-15	Rock Bluff Reservoir 1	Facility Condition	Reservoir Capital Maintenance	Condition Related Improvements to 1.5 Million Gallon Reservoir (See Condition Assessment Project List for Additional Details)	-	0%	$1,429,000
T-16	Westwood Reservoir	Facility Condition and Capacity	Decommission Reservoir	Decommission 0.5 Million Gallon Reservoir Existing Reservoir	-	0%	$340,000
V-1	New Zone 2A to 3C PRV	Facility Capacity	New PRV	Zone 2A to 3C PRV Skyline Ranch Road and Century Drive	-	0%	$155,000
V-4	New Zone 4F to 6B PRV	Facility Capacity	New PRV	New Zone 4F to 6B PRV between Archie Briggs Road and Putnam Road	-	0%	$155,000
V-5	New Zone 6 to 7C PRV	Facility Capacity	New PRV	New Zone 6 to 7C PRV on Marea Drive at Sandalwood Drive	-	0%	$155,000
W-3	Outback Well 3	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 1,050 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	38%	$1,633,000
W-4	Outback Well 4	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 1,150 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	38%	$954,000
W-5	Outback Well 5	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 1,050 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	38%	$912,000
W-13	Bear Creek Well 1	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 1,100 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$2,116,000
W-14	Bear Creek Well 2	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 1,050 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$1,160,000
W-15	New Bear Creek Zone 4 Well	Facility Capacity	New Well	1 New 300 horsepower deep well. Includes well drilling, casing, and pump and standby power generator. Also includes site development, building systems, mechanical, electrical, instrumentation and controls.	-	100%	$4,049,000
W-16	Pilot Butte Well 1	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 750 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$853,000
W-17	Pilot Butte Well 3	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 900 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$1,645,000
W-21	Rock Bluff Well 2	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 800 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$2,382,000
W-23	New Wilson Zone 4 Well 1	Facility Capacity	New Well	New 300 horsepower mid depth wells. Includes well drilling, casing, and pump and standby power generator. Also includes site development, building systems, mechanical, electrical, instrumentation and controls.	-	100%	$4,358,000
W-24	New Wilson Zone 4 Well 2	Facility Capacity	New Well	New 300 horsepower mid depth wells. Includes well drilling, casing, and pump and standby power generator. Also includes site development, building systems, mechanical, electrical, instrumentation and controls.	-	100%	$4,358,000
W-25	Westwood Well	Facility Condition and Capacity	Decommission Well	Decommission 700 Gallon Per Minute Existing Well	-	0%	$180,000
						Total	$136,729,000

Table 6-3 | Projects Beyond 2040

Project ID	Project Name	Project Category	Type of Improvement	Description	Recommended Sizing	Growth Allocation	Cost (2020 $)
P-1	Outback Site Transmission	Pipe Capacity	New Transmission Pipe for Hydraulic Performance	16-inch and 30-inch pipe parallel to connect North and South Outback Transmission Mains	16-inch to 30-inch, 1070 LF	100%	$815,000
P-2	Outback North Transmission Replacement	Pipe Capacity	Upsize Transmission Pipe for Hydraulic Performance	30-inch new pipe to replace existing 14-inch and 16-inch parallel pipe that is in poor condition.	30-inch, 4320 LF	38%	$3,927,000
P-4	Zone 3 to 4A Mt. Washington Drive and Rivers Edge PRV Pipe Upsize	Pipe Capacity	Upsize Transmission and Distribution Pipe for Hydraulic Performance	12-inch and 16-inch upsized pipe crossing Mt. Washington Drive at Pro Shop Drive	12-inch to 16-inch, 200 LF	100%	$246,000
P-5	Skyline Ranch Road Parallel	Pipe Capacity	New Transmission Pipe for Hydraulic Performance	18-inch parallel pipe in Skyline Ranch Road from Skyliners Road to Broken Top Road.	18-inch, 5590 LF	100%	$5,923,000
P-6	Niagara Court Upsize	Pipe Capacity	Upsize Distribution Pipe for Hydraulic Performance	12-inch upsized pipe in Niagara Court from Hosmer Lake Drive to Green Lakes Loop	12-inch, 650 LF	100%	$477,000
P-7	Archie Briggs and Falcon Ridge Upsize	Pipe Capacity	Upsize Transmission Pipe for Hydraulic Performance	16-inch upsized pipe crossing Archie Briggs Road and Falcon Ridge	16-inch, 90 LF	75%	$94,000
P-8	Mirror Lake Place Looping	Pipe Capacity	New Distribution Pipe for Hydraulic Performance	8-inch new pipe on Mirror Lake Place from dead-end east of Fisher Lake Lane to Meeks Trail	8-inch, 130 LF	0%	$79,000
P-9	Skyliners Road and Flagline Drive Upsize	Pipe Capacity	Upsize Distribution Pipe for Hydraulic Performance	12-inch upsized pipe in Skyliners Road and Flagline Drive	12-inch, 380 LF	100%	$385,000
P-10	New Zone 5 Overturf Reservoir and Well Transmission	Pipe Capacity	New Transmission Pipe for Hydraulic Performance	16-inch pipe in Cumberland Avenue from New Overturf Zone 5 Reservoir to 15th Street. Includes trenched construction with rock excavation, fittings, valves, water meters, and surface restoration.	16-inch, 2040 LF	100%	$1,564,000
P-11	Zone 4F and Zone 4A Distribution Connection	Pipe Capacity	New and Upsize Distribution Pipe for Hydraulic Performance	8-inch upsized pipe Zone 4F pipe at Archie Briggs Road and NW Stoneridge and new 8-inch Zone 4F to 4A connection	8-inch, 370 LF	100%	$257,000
P-12	15th Street Upsize	Pipe Capacity	Upsize Distribution Pipe for Hydraulic Performance	12-inch upsized pipe in 15th Street from Galveston Avenue to Fresno Avenue	12-inch, 260 LF	56%	$192,000
P-16	Roanoke Avenue Looping	Pipe Capacity	New Distribution Pipe for Hydraulic Performance	8-inch new pipe in Roanoke Avenue from dead-end west of 7th Street to 9th Street	8-inch, 540 LF	44%	$340,000
P-18	4th Street Upsize	Pipe Capacity	Upsize Distribution Pipe for Hydraulic Performance	12-inch upsized pipe in 4th Street north of Yale Avenue	12-inch, 250 LF	100%	$297,000
P-21	Metolius Drive Upsize	Pipe Capacity	Upsize Distribution Pipe for Hydraulic Performance	12-inch upsized pipe in Metolius Drive at Bridge Creek Drive	12-inch, 20 LF	56%	$19,000
P-22	Pilot Butte Parallel Transmission on Lafayette Avenue	Pipe Capacity	New Transmission Pipe for Hydraulic Performance	24-inch parallel new pipe in Lafayette Avenue between east of 12th Street and 8th Street	24-inch, 1400 LF	100%	$1,344,000
P-24	New and Upsize Bear Creek Well Transmission	Pipe Capacity	New and Upsize Transmission Pipe for Hydraulic Performance	18-inch new and upsized pipe to connect Bear Creek Wells Transmission to 15th Street	18-inch, 940 LF	100%	$894,000
P-25	Bear Creek Road Upsize 15th Street to McCartney Drive	Pipe Capacity	Upsize Transmission Pipe for Hydraulic Performance	12-inch upsized pipe in Bear Creek Road between McCartney Drive and 15th Street	12-inch, 490 LF	100%	$573,000
P-26	Bear Creek Road Connections	Pipe Capacity	New Distribution Pipe for Hydraulic Performance	12-inch and 8-inch new connections on Bear Creek Road between Cessna Drive and Janalee Place	8-inch to 12-inch, 1640 LF	38%	$786,000
PR-1C	Pipe Replacement Program Years 21 to 30	Pipe Replacement	-	Pipe replacement program	-	0%	$35,620,000
PS-5	Scott Pump Station	Facility Condition and Capacity	Pump Station Capital Maintenance	Condition Related Improvements to 3,000 Gallon Per Minute Pump Station (See Condition Assessment Project List for Additional Details)	-	0%	$1,465,000
T-2	Replacement Outback Reservoir 2	Facility Condition and Capacity	Replace Reservoir	New 7.0 million gallon prestressed concrete reservoir. Includes site development, mechanical, electrical, instrumentation and controls.	-	43%	$17,866,000
T-3	Outback Reservoir 3	Facility Condition	Reservoir Capital Maintenance	Condition Related Improvements to 3.6 Million Gallon Reservoir (See Condition Assessment Project List for Additional Details)	-	0%	$2,284,000

Project ID	Project Name	Project Category	Type of Improvement	Description	Recommended Sizing	Growth Allocation	Cost (2020 $)
T-6	College Reservoir 1	Facility Condition	Reservoir Capital Maintenance	Condition Related Improvements to 0.5 Million Gallon Reservoir (See Condition Assessment Project List for Additional Details)	-	0%	$987,000
T-7	College Reservoir 2	Facility Condition	Reservoir Capital Maintenance	Condition Related Improvements to 1.0 Million Gallon Reservoir (See Condition Assessment Project List for Additional Details)	-	0%	$944,000
T-8	Tower Rock Reservoir	Facility Condition	Reservoir Capital Maintenance	Condition Related Improvements to 1.0 Million Gallon Reservoir (See Condition Assessment Project List for Additional Details)	-	0%	$1,257,000
T-11	New Overturf Zone 5 Reservoir	Facility Capacity	New Reservoir	New 3.0 million gallon prestressed concrete reservoir. Includes site development, mechanical, electrical, instrumentation and controls.	-	100%	$9,009,000
V-2	New Zone 4B to 5 PRV	Facility Capacity	New PRV	Zone 4B to 5 PRV Bear Creek Road	-	38%	$155,000
V-3	New Zone 4F to 5D PRV	Facility Capacity	New PRV	Zone 4F to 5D PRV Summerfield Road	-	38%	$155,000
W-6	Outback Well 6	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 1,100 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	38%	$2,660,000
W-7	Outback Well 7	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 1,300 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$730,000
W-8	New Outback Well	Facility Capacity	New Well	1 New 185 horsepower shallow well. Includes well drilling, casing, and pump and standby power generator. Also includes site development, building systems, mechanical, electrical, instrumentation and controls.	-	100%	$2,711,000
W-9	Copperstone Well	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 950 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$1,676,000
W-12	New Overturf Zone 5 Well	Facility Capacity	New Well	1 New 200 horsepower mid depth well. Includes well drilling, casing, and pump and standby power generator. Also includes site development, building systems, mechanical, electrical, instrumentation and controls.	-	100%	$3,386,000
W-18	Pilot Butte Well 4	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 1,150 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$774,000
W-19	Rock Bluff Well 1	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 750 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$812,000
W-20	Rock Bluff Well 3	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 800 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$830,000
W-22	Shilo Well	Facility Condition	Well Capital Maintenance	Condition Related Improvements to 1,200 Gallon Per Minute Well (See Condition Assessment Project List for Additional Details)	-	0%	$1,926,000
W-26	New Purcell Paula Zone 5 Well 1	Facility Capacity	New Well	New 300 horsepower mid depth well. Includes well drilling, casing, and pump and standby power generator. Also includes site development, building systems, mechanical, electrical, instrumentation and controls.	-	100%	$4,321,000
W-27	New Purcell Paula Zone 5 Well 2	Facility Capacity	New Well	New 300 horsepower mid depth well. Includes well drilling, casing, and pump and standby power generator. Also includes site development, building systems, mechanical, electrical, instrumentation and controls.	-	100%	$4,321,000
O-8B	Water System Master Plan Update #3	Planning/Conservation	-	Third update to Water System Master Plan	-	38%	$1,000,000
O-9	Beyond 2040 Conservation Program	Planning/Conservation	-	Continuation of conservation program	-	38%	$7,998,000
						Total	$121,099,000

6.8 Summary

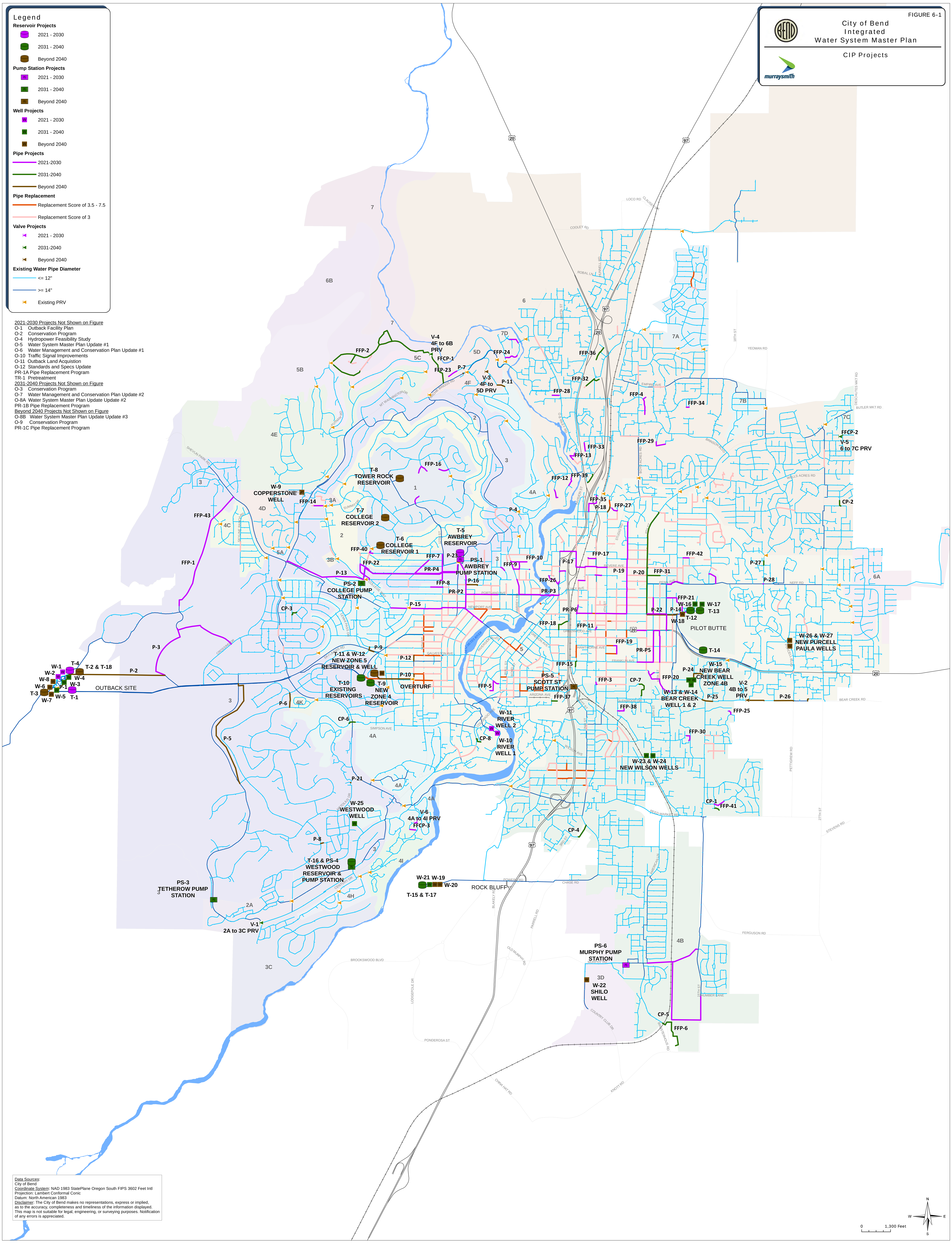
The Capital Improvement Plan identifies projects to address existing system condition and hydraulic capacity deficiencies and serve future growth. It includes recommendations to provide capacity through the 20-year growth projections, which are based on historic demands. However, the improvement timeline is spread beyond 20 years due to constraints in funding and staff resource availability to implement the plan. Recommended projects are divided across three timeframes, those within the 10-year, 20-year, and beyond 20-year horizon.

Some of the projects, such as new supply and storage may need to be accelerated to meet demands and other improvements deferred to stay within budget. Or projects may be delayed if demands are lower than projected, for example due to the continuing trend of decreasing per capita demands, or success in implementation of increased conservation program efforts. Projects should be evaluated annually through City reviews of demand growth, available budget, and where development is occurring.

The projects prioritized over the next 10 years are intended to address facility condition and piping condition and capacity deficiencies. There are several condition projects at current facilities that include the Awbrey Pump Station, Outback Reservoir 1, Awbrey Reservoir, Outback Wells 1 and 2, and the River Wells. Included in facility condition projects is the decommissioning of the Outback Contact Time (CT) Basin. The intent is that the contact time requirements can be met by Outback Reservoir 1, or the Outback Facility Plan will identify another configuration to meet contact time. Additionally, interior coating is slated for the Rock Bluff Reservoir and Outback Reservoir 2.

Also included in the 10-year horizon are some major piping projects including a new 30-inch Awbrey transmission main, and upsizing portions of piping along Newport Avenue. Many smaller pipe projects to address fire flow deficiencies and a yearly pipe replacement program are planned. Planning projects include updates to this iWSMP and the WMCP and an Outback Facility Plan along with additional improvements at Outback including pretreatment that would allow the City to continue operating in the event of a wildfire or other water quality event, incorporation of required federal security recommendations, and land acquisition for the recommended facilities. Future planning projects could include an analysis and possible implementation of hydropower generation that would work in conjunction with pretreatment. Implementation of the expanded conservation program and Standards and Specifications document are planned for the 2021-2030 timeframe as well.

Projects focus on replacing and installing new pipe to address distribution system deficiencies and work towards a greater annual pipe replacement rate to attain a program more consistent with expected pipe replacement life cycles. Considerable investment in existing infrastructure will be required at most existing facilities to address deferred maintenance and extend useful life. New facilities will serve growth and be required as demands increase. The total CIP cost is approximately \$391 million (in 2020 dollars), with \$133 million scheduled for 2021-2030, \$137 million in years 2031-2040 and \$121 million beyond 2040.



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Section **7**

Section 7

Financial Plan

7.1 Introduction

This financial plan was prepared by FCS Group to determine the funding requirements to provide water service to the City of Bend (City) customers. The purpose of this section is to document the City's financial plan to fund ongoing system operations and the escalated costs of the capital improvement plan (CIP) recommended in Section 6. The plan demonstrates the ability of the water utility to maintain sufficient funds to construct, operate, and manage the system on a continuing basis based on a 30-year implementation timeframe of the CIP.

7.2 Financial Structure

This section summarizes the current financial structure used as the baseline for the capital financing strategy and financial forecast developed for this iWSMP.

7.2.1 Elements of a Financial Plan

The water utility is responsible for funding all of its costs. The primary source of funding is derived from ongoing monthly charges for service, with additional revenues coming from system development charges, installation fees, reconnect fees, and other miscellaneous revenue. The City controls the level of user charges and, subject to the City Council, can adjust user charges as needed to meet financial objectives.

The financial plan can only provide a qualified assurance of financial feasibility if it considers the total system costs of providing water services, both operating and capital. To meet these objectives, the following elements have been completed.

7.2.1.1 Capital Funding Plan

The Capital Funding Plan identifies the total CIP obligations of the planning period. The plan defines a strategy for funding the CIP, including an analysis of available resources from rate revenues, existing reserves, connection charges, debt financing, and any special resources that may be readily available (e.g., grants, developer contributions, etc.). The capital funding plan impacts the financial plan through the capital financing strategy, which incorporates the use of debt financing (resulting in annual debt service) and assumed rate revenue available for capital funding.

7.2.1.2 Financial Forecast

The Financial Forecast identifies future annual non-capital costs associated with the operation, maintenance, and administration of the water system. Included in the financial plan is a reserve analysis that forecasts cash flow and fund balance activity, along with testing for satisfaction of actual or recommended minimum fund balance policies. The financial plan ultimately evaluates the sufficiency of utility revenues in meeting all obligations, including cash uses such as operating expenses, debt service, capital outlays, and reserve contributions, as well as any coverage requirements associated with long-term debt. The plan also identifies the future adjustments required to fully fund all utility obligations in the planning period.

7.3 Capital Funding Plan

The CIP and operating project costs total approximately$164 million (escalated) over the 10-year planning horizon. The full CIP in **Section 6** plus some additional operating project costs is $581 million (escalated) and assumed over a 30-year implementation period in this financial plan. The historical 10-year average of the engineering news record (ENR) construction cost index (2.7 percent annually) has been applied to capital costs to estimate the project cost at the year of planned spending. The ENR is an index that tracks how the cost of material, labor and other factors have changed over time. Applying an ENR index is common practice to estimate the anticipated capital spending during the year of planned construction to determine total resource needs in any given year. It should be noted that the demand projections in **Section 2** and analysis in **Section 4** assume a 20-year planning period through 2040. However, due to funding and staffing constraints the CIP and financial plan are assumed for implementation over a longer, 30-year period.

A summary of the 10-year and 30-year CIP is shown in **Table 7-1.** As shown, each year has varied capital cost obligations depending on construction schedules and infrastructure planning needs. Approximately 28 percent of the escalated capital costs are included in the 10-year planning period. **Table 7-2** provides more detail for each fiscal year (FY) of the 10-year CIP.

Table 7-1|10- and 30-Year CIP (Escalated $ in millions)

Fiscal Year (FY)	Capital Expenditures
FY 2021	$5.3
FY 2022	$11.5
FY 2023	$13.9
FY 2024	$18.4
FY 2025	$32.1
FY 2026	$24.6
FY 2027	$11.5
FY 2028	$8.6
FY 2029	$16.2
FY 2030	$21.8
10-Year Total	**$163.9**
FY 2031 - FY 2050	$416.9
30-Year Total	**$580.8**

Table 7-2|10 Year CIP (Escalated $ in millions)

Project Type	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030	Total
Capacity	$0	$0	$0.1	$0.1	$0.8	$0	$0.8	$0.4	$7.9	$9.9	$20.0
Condition	$0.5	$5.0	$10.1	$16.3	$29.3	$22.5	$10.1	$7.6	$7.7	$7.8	$116.9
Planning/Conservation	$4.8	$6.5	$3.7	$2.0	$2.0	$2.1	$0.6	$0.6	$0.6	$4.1	$27.0
Total	**$5.3**	**$11.5**	**$13.9**	**$18.4**	**$32.1**	**$24.6**	**$11.5**	**$8.6**	**$16.2**	**$21.8**	**$163.9**

Hydraulic capacity projects are investments in the system to address existing fire flow, velocity, and pressure deficiencies as well as future improvements to provide capacity for growth. Condition projects address the changes to safety, structural and security standards over time as well as targeting undersized and substandard pipe to avoid failures and maintain consistent service. Additional detail related to the capital improvement program can be found in **Section 6** of this iWSMP.

7.3.1 Capital Financing Strategy

An ideal capital financing strategy would include the use of grants and low-cost loans when a debt issuance is required. However, these resources are very limited and competitive in nature and do not provide a reliable source of funding for planning purposes. It is recommended that the City pursue these funding avenues but assume bond financing to meet the needs for which the City's available cash resources are insufficient. Revenue bonds have been used as the debt funding instrument in this analysis. The capital financing strategy developed to fund the CIP identified in this iWSMP assumes the following funding resources:

- Accumulated cash reserves – The total amount of available operating and capital cash resources
- Transfers of excess cash (over minimum balance targets) from the Operating Fund – The total amount of annual cash contributions available to transfer to the capital fund after all operating and debt service obligations are met;
- System development charge revenues - A connection charge such as the City's system development charge refers to a one-time charge imposed on new customers as a condition of connecting to the water system.;
- Interest earned on capital fund balances and other miscellaneous capital resources; and
- Bond financing - Revenue bonds are commonly used to fund utility capital improvements. The debt is secured by the revenues of the issuing utility. With this limited commitment, revenue bonds typically bear higher interest rates than FFC loans and may require security conditions related to the maintenance of dedicated reserves (a bond reserve) and/or financial performance (added bond debt service coverage). The City agrees to satisfy these requirements as a condition of bond sale.

- Based on information provided by the City, the water utility began FY 2021 with $58.3M in total funds.

The cash resources described above are anticipated to fund 65 percent of the 10-year CIP and 75 percent of the 30-year CIP. The remaining funding will come from new debt obligations of nearly $58 million in the initial 10-year period, followed by an additional $86.4 million through FY 2050.

Table 7-3 presents the corresponding 30-year capital financing strategy.

Table 7-3|30-Year Capital Funding Strategy (Escalated $ in millions)

Year	Capital Expenditures	Revenue Bond Financing	Cash Funding	Total Financial Resources
FY 2021	$5.3	$0	$5.3	$5.3
FY 2022	$11.5	$0	$11.5	$11.5
FY 2023	$13.9	$0	$13.9	$13.9
FY 2024	$18.4	$0	$18.4	$18.4
FY 2025	$32.1	$0	$32.1	$32.1
FY 2026	$24.6	$23.9	$0.7	$24.6
FY 2027	$11.5	$0	$11.5	$11.5
FY 2028	$8.6	$0	$8.6	$8.6
FY 2029	$16.2	$16.2	$0	$16.2
FY 2030	$21.8	$17.7	$4.1	$21.8
Subtotal	**$163.9**	**$57.8**	**$106.1**	**$163.9**
FY 2031 – FY 2050	$416.9	$86.4	$330.6	$416.9
Total	**$580.8**	**$144.2**	**$436.7**	**$580.8**

7.3.2 Other Alternative Financing Resources

This section outlines various grant and low-cost loan opportunities available to the City through federal and state agencies to fund the CIP identified in the iWSMP.

7.3.2.1 Grants and Low-Cost Loans

Historically, federal and state grant programs were available to local utilities for capital funding assistance. However, these assistance programs have been mostly eliminated, substantially reduced in scope and amount, or replaced by loan programs. Remaining miscellaneous grant programs are generally lightly funded and heavily subscribed. Nonetheless, even the benefit of low-interest loans makes the effort of applying worthwhile. Grants and low-cost loans for Oregon utilities are available from the Department of Environmental Quality's Clean Water State Revolving Fund Program (CWSRF). This program supports communities by funding projects that improve water quality and environmental outcomes for the State of Oregon. CWSRF has three application deadlines in 2021 with applications available online.

In addition, federal assistance is available through the Water Infrastructure Funding Innovation Act (WIFIA). WIFIA was established in 2014 as a federal credit program administered by the Federal Environmental Protection Agency for eligible water and wastewater infrastructure projects. Additional information regarding funding availability and the application process can be found online.

7.4 Financial Forecast

The financial forecast, or revenue requirement analysis, forecasts the amount of annual revenue that needs to be generated by user rates. The analysis incorporates operating revenues, O&M expenses, debt service payments, rate-funded capital needs, and any other identified revenues or expenses related to operations. The objective of the financial forecast is to evaluate the sufficiency of the current level of rates. In addition to annual operating costs, the revenue needs also include debt covenant requirements and specific fiscal policies and financial goals of the City.

The analysis determines the amount of revenue needed in a given year to meet that year's expected financial obligations. For this analysis, two revenue sufficiency tests have been developed to reflect the financial goals and constraints of the City: cash needs must be met; and debt service coverage requirements must be realized. In order to operate successfully with respect to these goals, both tests of revenue sufficiency must be met.

7.4.1 Cash Test

The cash flow test identifies all known cash requirements for the City in each year of the planning period. Typically, these include O&M expenses, debt service payments, rate-funded system reinvestment funding or directly funded capital outlays, and any additions to specified reserve balances. The total annual cash needs of the City are then compared to projected cash revenues using the current rate structure. Any projected revenue shortfalls are identified, and the rate increases necessary to make up the shortfalls are established.

7.4.2 Coverage Test

The coverage test is based on a commitment made by the City when issuing revenue bonds and some other forms of long-term debt. For the purposes of this analysis, revenue bond debt is assumed for any needed debt issuance. As a security condition of issuance, the City would be required per covenant to agree that the revenue bond debt would have a higher priority for payment (a senior lien) compared to most other expenditures; the only outlays that are higher in the bond declaration flow of funds payment order are O&M expenses. Debt service coverage is expressed as a multiplier of the annual revenue bond debt service payment. The current rate covenant for the City's current outstanding bonds states the net revenue generated in any fiscal year must at least equal:

a) 1.25 times annual bond debt service due in that fiscal year,

b) 1.15 times annual bond debt service due in that fiscal year, excluding SDC fees,

c) 1.0 times the annual bond debt service due in that fiscal year for any subordinated obligations (e.g., low interest loans) and d) any amounts owed by the City to a credit provider for surety premium payments. The excess cash flow derived from the added coverage, if any, can be used for any purpose, including funding capital projects.

The City has a fiscal policy for the water fund of maintaining a minimum debt coverage ratio of 1.50 or "at a level sufficient to protect the credit rating of the water…system." Along with monitoring the required debt ratios identified in the bond covenant, the financial analysis uses and satisfies the higher 1.50 minimum city policy target.

In determining the annual revenue requirement, both the cash and coverage sufficiency test must be met, and the test with the greatest deficiency drives the level of needed rate increase in any given year.

7.4.3 Current Financial Structure

The City maintains a fund structure and implements financial policies that target management of a financially viable and fiscally responsible water system.

7.4.3.1 Fiscal Policies

The fiscal policies of the City include reserve policies specifically for the water, water reclamation and stormwater funds. A brief summary of the City's water ending fund balance and reserve requirement policies are discussed below. Fiscal policies are adopted by City Council and reviewed and amended as needed.

7.4.3.1.1 Operating Undesignated Reserves

Operating undesignated reserves are designed to provide a liquidity cushion to ensure that adequate cash working capital will be maintained to deal with significant cash balance fluctuations, such as seasonal fluctuations in billings and receipts, unanticipated cash expenses, or lower than expected revenue collections. Like other types of reserves, operating reserves also serve another purpose: they help smooth rate increases over time. Target funding levels for an operating reserve are generally expressed as a certain number of days of O&M expenses, with the minimum requirement varying with the expected revenue volatility. Industry practice for utility operating reserves ranges from 30 days to 120 days of O&M expenses, with the lower end more appropriate for utilities with stable revenue streams and the higher end more appropriate for utilities with significant seasonal or consumption-based fluctuations. The City's current policy is to maintain operating undesignated reserves of at least 25 percent or 3 months (90 days) of the operating budget for the water fund.

7.4.3.1.2 Rate Stabilization Reserves

Rate stabilization reserves are cash reserves that can mitigate the impacts of occasional revenue shortfalls. Revenue shortfalls can occur because of several factors, including weather factors economic conditions, increased water conservation, or other unforeseen circumstances. Rate stabilization reserves can protect against or help smooth out revenue volatility resulting from these factors and help ensure adequate fiscal resources during such times that could otherwise require large rate spikes. The City's current water fund policy is to maintain this reserve at no less than $1.5 million.

7.4.3.1.3 Capital Fund

A capital contingency reserve is an amount of cash set aside in case of an emergency should a piece of equipment or a portion of the utility's infrastructure fail unexpectedly. The reserve also could be used for other unanticipated capital needs, including capital project cost overruns. Industry practices range from maintaining a balance equal to 1.00 to 2.00 percent of fixed assets, an amount equal to a 5-year rolling average of CIP costs, or an amount determined sufficient to fund equipment failure (other than catastrophic failure). The final target level should balance industry standards with the risk level of the City. The City currently aims to maintain a residual capital balance of $5.0 million. This value was determined to be sufficient in the event of an equipment failure by the City.

7.4.3.1.4 Debt Service Reserves

Debt service reserves are reserves used to pay debt service if revenues are insufficient to satisfy annual debt service requirements. Most often, this reserve is established as a legal covenant of a debt issuance and is used in whole or in part to pay debt service in the event of a revenue shortfall. A debt service reserve is most common for revenue bond issues but may be required or voluntarily established by the City for other types of subordinate indebtedness. The City currently does not have any required debt service reserves.

The City's fiscal policies for the water fund note that the ending fund balance and reserves will be prioritized as follows:

- Required debt service reserves
- Operating reserves
- Rate stabilization reserves and
- Repair and replacement reserves

In the event that reserve funds decrease to levels below the levels established by policy, the City will develop a plan to restore reserves to the required levels. Ideally, the minimum reserve balances shall be replenished in the following year with replenishment no longer than five years.

7.4.3.1.5 System Reinvestment

System reinvestment funding promotes system integrity through reinvestment in the system. Target system reinvestment funding levels are commonly linked to annual depreciation expense as a measure of the decline in asset value associated with routine use of the system. Particularly for utilities that do not already have an explicit system reinvestment policy in place, implementing a funding level based on full depreciation expense could significantly impact rates. A common alternative benchmark is annual depreciation expense net of debt principal payments on outstanding debt. This approach recognizes that customers are still paying for certain assets through the debt component of their rate and intends to avoid simultaneously charging customers for an asset and its future replacement. The specific benchmark used to set system reinvestment funding targets is a matter of policy that must balance various objectives, including managing rate impacts, keeping long-term costs down, and promoting “generational equity” (i.e., not excessively burdening current customers with paying for facilities that will serve a larger group of customers in the future).

The utility is not currently funding a dedicated annual budget account line item for system reinvestment, nor has a specified funding amount been included for system reinvestment in this analysis. Rather, the City directs the remaining revenues after the O&M and debt service expenses have been satisfied to first fund the operating fund target and then capital needs. As a result, rate revenues do contribute to the funding of capital projects, but the level of funding is not consistent from year to year. Over the ten-year rate setting period, capital funding from rates varies from $3.8 million to $6.1 million depending on the year. While the City does not have a dedicated annual budget line-item funding provision targeted, they do aim to cash fund all projects that are repairing or replacing existing infrastructure. It is recommended that the City consider a dedicated rate funding system reinvestment strategy in the future to smooth rate impacts of cash-funding repair and replacement projects over the long-term.

7.4.3.2 Financial Plan

The financial plan is established from the 2021-2023 biennial budget documents along with other key factors and assumptions to develop a complete portrayal of the City’s annual financial obligations for the water utility. The following is a list of the key revenue and expense factors and assumptions used to develop the financial forecast.

- Operational Revenue – The City has two main revenue sources: 1) water service charges (rate revenue); and 2) miscellaneous (non-rate) revenue. FY 2021 rate revenues are based on the City’s year-end estimate utilizing the trends of year-to-date actuals with customer growth added for future years. In the event of a forecasted annual shortfall, rate revenue can be increased to meet the annual revenue requirement. For the purpose of this financial forecast, non-rate revenues are forecast to increase with customer growth or not escalate depending on the nature of the revenue.

- System Development Charge Revenue – the existing connection charges are applied to the projected new connections to forecast revenue. Based on the growth assumptions described above, the connection charge will generate an average of $3.5 million annually from FY 2021-FY 2030. This equates to an average of 572 new connections per year. Connection charge revenue is directed towards annual capital needs.

- **Growth** – Rate revenue is escalated based on the population growth rates developed by the City in their ten-year outlook. The annual growth rate is projected to be 1.42 percent from FY 2021-FY 2025 before dropping to 1.00 percent annually for the remainder of the forecast. It should be noted that the population growth rate assumed for the financial analysis is projected at lower rates than the water system growth discussed in **Section 2**. Growth rates for the financial projections are lower than those used for future water demand to be conservative from a revenue generation perspective and not overestimate financial revenues.

- **Expenses** – O&M expense projections are based on the 2021-2023 biennial budget and forecasted to increase with general cost inflation of 2.20 percent, labor cost inflation of 4.31 percent, average benefit cost inflation of 6.85 percent, electricity cost inflation of 3.40 percent, chemical cost inflation of 4.40 percent and internal transfer cost inflation averaging 6.47 percent.

- **Existing Debt** – The City currently has one outstanding 2016 Series revenue bond with full repayment planned for FY 2037 and three full faith and credit loans (FF&C), one with full repayment in FY 2021, the second with full repayment in FY 2031 and the third planned for full repayment by FY 2040. Annual debt service payments on existing debt average $4.2 million annually through FY 2037 when they drop to $93,000 annually for the remaining term on the final FF&C loan.

- **Future Debt** – The capital funding strategy developed for this iWSMP forecasts the need for two debt issuances within the ten-year rate setting period: $23.9 million in new debt proceeds in FY 2026, followed by $33.9 million in FY 2029. In order to fully fund the capital program identified in this iWSMP, $86.4 million in additional debt issuances are required from FY 2031-FY 2050. Annual new debt service payments are forecast to increase from $2.0 million with the first issuance to a maximum of $11.3 million in FY 2045. The analysis performed assumes revenue bond financing.

- **Revenue Bond Assumptions** – Future debt is assumed to be revenue bonds each with a 20-year term, a 5.00 percent interest rate and a 2.00 percent issuance cost.

- **Transfer to Capital** – Any Operating Fund balance above the minimum requirement is assumed to be available to fund capital projects and projected to be transferred to the Capital Fund each year. The FY 2021 Operating Fund balance is expected to end the year at 90 days of O&M expenses, or $3.2 million. The Capital Fund balance is expected to end the year at $57.3 million.

Although the financial plan is completed for the 30-year time horizon of this iWSMP, the rate strategy focuses on the shorter-term planning period of FY 2021 through FY 2030. As is the current practice, the City will revisit the proposed rates each year to ensure that the rate projections developed remain adequate. Any significant changes should be incorporated into the financial plan and future rates should be adjusted as needed.

Table 7-4 summarizes the annual revenue requirements based on the forecast of revenues, expenditures, fund balances, and fiscal policies.

Table 7-4 | 10-Year Financial Forecast ($ in millions)

Revenue Requirement	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Revenues										
Rate Revenues (existing rates)	$20.6	$20.9	$21.2	$21.5	$21.8	$22.0	$22.2	$22.5	$22.7	$22.9
Non-Rate Revenues	$1.9	$1.6	$1.6	$1.6	$1.9	$1.8	$1.4	$1.3	$2.0	$1.6
Total Revenues	**$22.5**	**$22.5**	**$22.8**	**$23.1**	**$23.7**	**$23.8**	**$23.6**	**$23.8**	**$24.7**	**$24.5**
Expenses										
Cash Operating Expenses	$12.9	$14.7	$15.1	$16.9	$17.1	$18.6	$18.9	$19.7	$21.1	$21.2
Existing Debt Service	$5.6	$4.2	$4.2	$4.2	$4.2	$4.2	$4.2	$4.2	$4.2	$4.2
New Debt Service	$0	$0	$0	$0	$0	$1.3	$2.0	$2.0	$3.9	$4.7
Total Expenses	**$18.5**	**$18.9**	**$19.3**	**$21.1**	**$21.3**	**$24.1**	**$25.1**	**$25.9**	**$29.2**	**$30.1**
Total Surplus (Deficiency)	$4.0	$3.6	$3.5	$2.0	$2.4	($0.3)	($1.5)	($2.1)	($4.5)	($5.6)
Proposed Rate Strategy	0.0%	3.0%	3.0%	4.0%	4.0%	4.0%	4.5%	4.5%	4.5%	4.5%
Cash Flow after Rate Increase	$4.0	$4.2	$4.8	$4.2	$5.6	$3.9	$4.0	$4.7	$3.8	$4.1

The financial forecast indicates that the utility is currently covering all financial obligations under existing rates, however as the City prepares to fund the needed capital improvements identified in the iWSMP, rates will need to increase annually to support the capital funding plan. The financial plan proposes the following rate increases and debt issuances to satisfy the identified future obligations of the utility:

- 3.0 percent in FY 2022 & FY 2023, 4.0 percent from FY 2024 – FY 2026, followed by 4.5 percent through FY 2030
- Two new revenue bonds proposed in the ten-year planning period:
  - $23.9M revenue bond in FY 2026 and $33.9M revenue bond in FY 2029.
  - Annual new debt service payments are forecast to increase from $2.0 million with the first issuance to $4.7 million by the second new debt issuance. Including this new debt, total debt service will increase from $5.6 million in FY 2021 to $8.9 million by FY 2030.

7.4.3.3 City Reserves

Table 7-5 shows a summary of the projected Undesignated Operating Reserve and residual Capital Reserve ending balances through FY 2030 based on the rate forecasts presented above. The undesignated operating reserve is maintained at a minimum of 3 months of O&M expenses, and the capital reserve balance fluctuates depending on the level of CIP funded; however, it never falls below the minimum target of $5.0 million.

Table 7-5|Ending Reserve Balance Summary ($ in millions)

Ending Reserve Balances	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Undesignated Operating	$3.2	$3.6	$3.7	$4.2	$4.2	$4.6	$4.7	$4.9	$5.2	$5.2
Capital	$57.3	$53.2	$47.8	$37.1	$14.7	$20.5	$16.1	$15.3	$39.7	$25.5
Total	**$60.5**	**$56.8**	**$51.5**	**$41.3**	**$18.9**	**$25.1**	**$20.8**	**$20.2**	**$44.9**	**$30.7**

7.5 Current and Projected Rates

The existing water rates include one rate structure that is applied to all customers. The minimum monthly charge is applied by meter size and does not include any water allowance. All water use is charged on a per 100 cubic foot basis.

The financial forecast discussed above indicates that the utility is currently covering all financial obligations under existing rates, however as the City prepares to fund the needed capital improvements identified in the iWSMP, rates will need to increase annually to support the capital funding plan. Rates are forecast to increase 3.0 percent in FY 2022 & FY 2023, 4.0 percent in FY 2024 – FY 2026, followed by 4.5 percent thereafter. **Table 7-6** shows the existing rates schedule and projected rates with increases applied uniformly to all rate components for all meter sizes.

Table 7-6|Current and Projected Schedule of Rates

Inside City	Existing Rates	Proposed Rates								
	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Annual Rate Increase		***3.0%***	***3.0%***	***4.0%***	***4.0%***	***4.0%***	***4.5%***	***4.5%***	***4.5%***	***4.5%***
3/4”	$23.60	$24.31	$25.04	$26.04	$27.08	$28.16	$29.43	$30.76	$32.14	$33.59
1”	$27.15	$27.96	$28.80	$29.96	$31.15	$32.40	$33.86	$35.38	$36.97	$38.64
1-1/2”	$35.93	$37.01	$38.12	$39.64	$41.23	$42.88	$44.81	$46.82	$48.93	$51.13
2”	$46.50	$47.90	$49.33	$51.31	$53.36	$55.49	$57.99	$60.60	$63.33	$66.17
3”	$74.74	$76.98	$79.29	$82.46	$85.76	$89.19	$93.21	$97.40	$101.78	$106.36
4”	$106.46	$109.65	$112.94	$117.46	$122.16	$127.05	$132.76	$138.74	$144.98	$151.50
6”	$194.57	$200.41	$206.42	$214.68	$223.26	$232.19	$242.64	$253.56	$264.97	$276.90
8”	$300.32	$309.33	$318.61	$331.35	$344.61	$358.39	$374.52	$391.37	$408.99	$427.39
10”	$423.75	$436.46	$449.56	$467.54	$486.24	$505.69	$528.45	$552.23	$577.08	$603.04
12”	$568.27	$585.32	$602.88	$626.99	$652.07	$678.16	$708.67	$740.56	$773.89	$808.71
All Water Use (per 100 cu. ft.)	$1.96	$2.02	$2.08	$2.16	$2.25	$2.34	$2.44	$2.55	$2.67	$2.79

7.6 Summary

The results of this analysis indicate that annual rate increases are needed to provide revenue sufficient to cover all financial obligations of the utility. Rate increases are proposed at 3.0 percent in FY 2022 & FY 2023, 4.0 percent from FY 2024 to FY 2026, followed by 4.5 percent through FY 2030.

The analysis performed in this section assumes revenue growth and expense inflationary factors discussed previously. If the forecasting factors change significantly, the existing rate strategy may need to be updated and revised.

The City will continue to review and update the key underlying assumptions that compose the multi-year financial plan at least annually, to ensure that adequate revenues are collected to meet the City’s total financial obligations.

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WATER RIGHTS IN OREGON

An Introduction to Oregon's Water Laws

OREGON
WATER RESOURCES DEPARTMENT

2018

Water Quantity Conversion Table

Water measurements are generally described using rate and volume. When applying for a permit to use water, an applicant is required to submit all measurements in one of the following terms.

When referring to a rate to be diverted, the terms commonly used are cubic feet per second (cfs) or gallons per minute (gpm). When discussing volumes of water (duty), such as amount applied to land, reservoir storage capacity, or yearly consumption, the term used is acre-feet (af).

Applications for water use specify the appropriate measurement to use when providing information to the Department.

Rates of Flow

One (1) cubic foot per second (cfs) is a rate of water flow that will supply one cubic foot of water in one second and is equivalent to flow rates of:

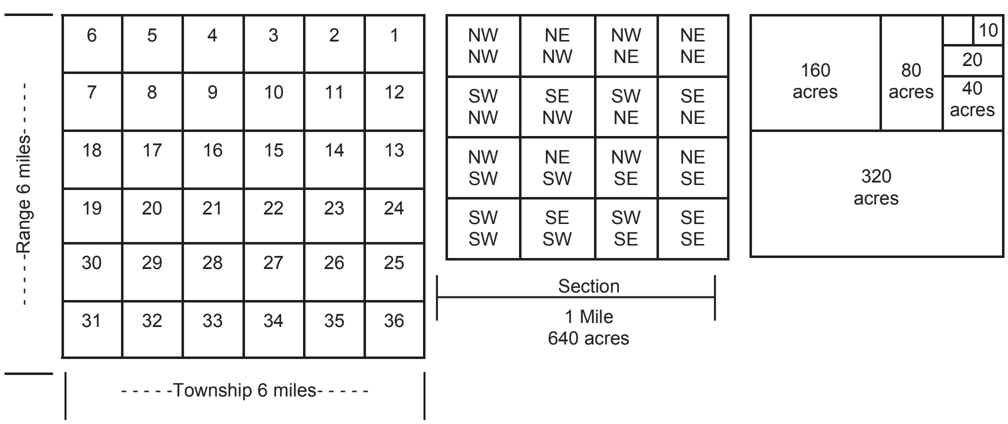
1 cfs =	7.48 gallons per second
	448.8 gallons per minute
	646,272 gallons per day
	1.98 acre-feet per day

Volume Measurement

One (1) acre-foot is the volume of water that will cover one acre to a depth of one foot and is equal to:

1 af =	43,560 cubic feet
	325,851 gallons

Land Subdivision



Contents


2 WATER RIGHTS IN OREGON

THE WATER RESOURCES COMMISSION AND DEPARTMENT

"To serve the public by practicing and promoting responsible water management through two key goals:

- *to directly address Oregon's water supply needs, and*
- *to restore and protect streamflows and watersheds in order to ensure the long-term sustainability of Oregon's ecosystems, economy, and quality of life."*

The Water Resources Commission is a seven-member citizen body established by statute to set water policy for the state and oversee activities of the Water Resources Department in accordance with state law. Members are appointed by the Governor, subject to confirmation by the Oregon Senate, to serve a four-year term. One member is appointed from each of five regional river basin management areas, and two "at large" members are appointed, one each from east and west of the Cascades.

In 2017, the Oregon Water Resources Commission updated the state's Integrated Water Resources Strategy (Strategy), which contains recommendations to help understand and meet the state's instream and out-of-stream water needs into the future. Developed with the state's other natural resources and economic development agencies, the Strategy serves as a roadmap for addressing water quantity, water quality, and ecosystem issues. The Strategy is updated every five years.

The Water Resources Department is the state agency charged with administration of the laws governing the allocation of surface water and groundwater resources. The Department is organized into five divisions - Field Services, Technical Services, Water Right Services, Administrative Services, and the Director's Office - all operating under the immediate authority of the Director.

The Director is appointed by the Governor to serve a four-year term, subject to confirmation by the Oregon Senate. The Director is charged with applying the Commission's policies and rules through Department programs. In addition, the Director has independent responsibility for general stream adjudications.

1. Oregon Water Laws

water management in Oregon

The Water Code

For more information, refer to ORS 537.110.

Under Oregon law, all water belongs to the public. With some exceptions, cities, irrigators, businesses, and other water users must obtain a permit or license from the Water Resources Department to use water from any source - whether it is underground, or from lakes or streams. Generally speaking, landowners with water flowing past, through, or under their property do not automatically have the right to use that water without authorization from the Department.

Prior Appropriation

Oregon's water laws are based on the doctrine of prior appropriation. This means the first person to obtain a water right on a stream is the last to be shut off in times of low streamflows. In water-short times, the water right holder with the oldest date of priority can demand the water specified in his or her water right without regard for the needs of junior users. If there is a surplus beyond what is necessary to fulfill the senior right, the water right holder with the next senior priority date can take what is available to satisfy needs under his or her right. This continues down the line until there is no surplus or until all rights are satisfied. The date of application for a permit to use water usually becomes the priority date of the right.

With some exceptions, a water right, permit, or license is required to use the waters of Oregon. The water must be used for a beneficial purpose, without waste.

East of the Mississippi River, the riparian doctrine usually applies. Under the riparian doctrine, only landowners with water flowing through their property have claims to the water. By contrast, the prior appropriation doctrine is the basis of water law for most of the states west of the Mississippi. In Oregon, the prior appropriation doctrine was adopted into statute on February 24, 1909 and introduced state control over the right to use water. Before then, water users had to depend on themselves or local courts to defend their rights to water.

OREGON'S WATER CODE

four fundamental provisions

- **Beneficial purpose without waste**
  Surface or groundwater may be legally diverted for use only if it is used for a beneficial purpose without waste.

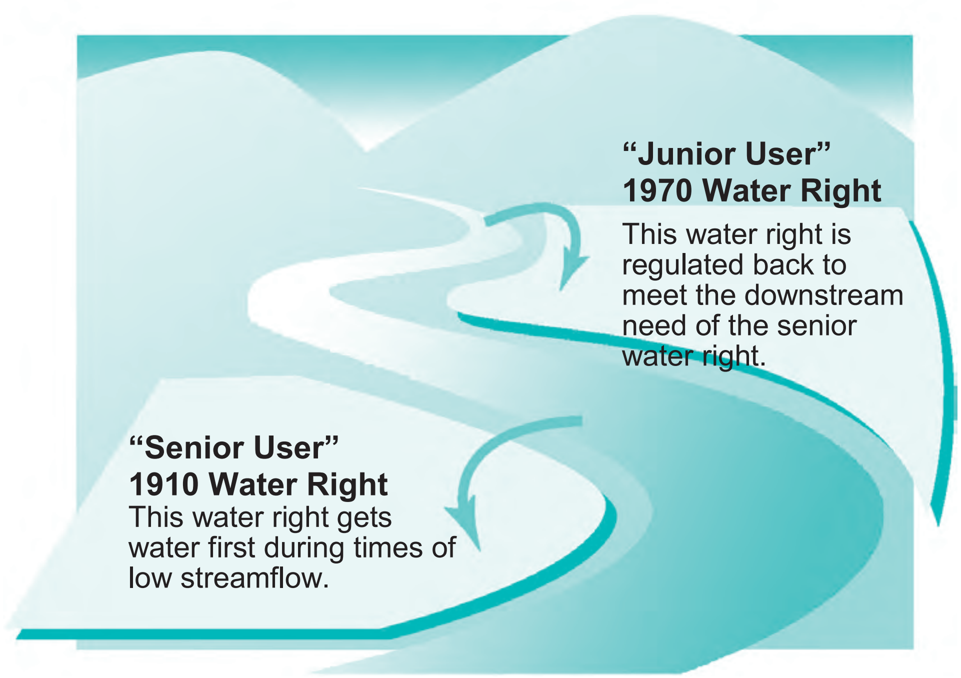
- **Priority**
  The water right priority date determines who gets water in a time of shortage. The more senior the water right, the longer water may be available in a time of shortage.

- **Appurtenancy**
  Generally, a water right is attached to the land described in the right, as long as the water is used. If the land is sold, the water right typically goes with the land to the new owner.

- **Must be used**
  Once established, a water right must be used as provided in the right at least once every five years. With some exceptions established in law, after five consecutive years of non-use, the right is considered forfeited and is subject to cancellation.

Generally, Oregon law does not provide a preference for one kind of use over another. If there is a conflict between users, the date of priority determines who may use the available water. If the rights in conflict have the same date of priority, then the law indicates domestic use and livestock watering have preference over other uses. However, if a drought is declared by the Governor, the Commission can adopt rules that give preference to stock watering and human consumptive purposes, regardless of the priority dates.

Prior Appropriation: an example
"First in time, first in right"



An example of prior appropriation at work

Prior appropriation ensures that the first water user to obtain water rights has first access to water in times of shortage. If a "downstream" landowner has the earlier priority date (initiating for example, his or her water right in 1910) the "upstream" landowner (with a 1970 right in this example) may have to let the water pass unused to meet the needs of the senior, downstream water right holder.

A few uses of surface water are exempt from the requirement to obtain a permit. These are called "exempt uses."

Exempt uses of surface water include:

1. Natural springs: use of a spring that, under natural conditions, does not form a natural channel and flow off the property where it originates at any time of the year.

2. Stock watering: use of water for stock watering from a permitted reservoir to a tank or trough, and, under certain conditions, use of water piped from a surface source to an off-stream livestock watering tank or trough.

3. Fish protection: egg incubation projects under the Salmon and Trout Enhancement Program (STEP) are exempt. Water used for fish screens, fishways, and bypass structures are also exempt.

4. Fire control: the withdrawal of water for emergency firefighting or certain non-emergency firefighting training.

5. Forest management: certain activities such as slash burning and mixing pesticides. To be eligible, a user must notify the Oregon Water Resources Department and the Oregon Department of Fish and Wildlife and must comply with any restrictions relating to the source of water that may be used.

For more information, refer to ORS 537.141, 537.142, 537.800,

6. Certain land management practices: where water use is not the primary intended activity.

7. Rainwater: collection and use of rainwater from an artificial impervious surface (like a building's roof).

8. Reuse of water: pursuant to a registration under ORS 537.132.

Exempt uses of groundwater include:

1. Stock watering.

2. Lawn or noncommercial garden: watering of not more than one-half acre in area. Irrigation of a commercial crop requires a water use authorization and is not exempt.

3. Single or group domestic purposes: not exceeding 15,000 gallons per day.

4. Single industrial or commercial purposes: not exceeding 5,000 gallons per day. Does not include irrigation or watering to promote plant growth.

5. Down-hole heat exchange uses.

6. Watering school grounds: ten acres or less, of schools located within a critical groundwater area.

7. Fire control: In addition, the withdrawal of water for emergency firefighting or certain non-emergency firefighting training, is an exempt use of groundwater as provided under ORS 537.141.

8. Reuse of water: under ORS 537.141 (1) (i).

Note: While these water uses do not require a permit, the use is only allowed if the water is used for a "beneficial purpose without waste" and may be subject to regulation in times of water shortage. Wells supplying water for exempt groundwater uses must comply with Oregon's minimum well construction standards for the construction, maintenance, and abandonment of any well.

For more information, refer to ORS 537.545 and 537.141

2. Water Protections and Restrictions

managing water appropriations - protecting the resource

Basin-by-Basin Water Use Restrictions

Some waters within the state may be closed to new appropriation by legislative action or restricted by an administrative rule or order of the Water Resources Commission. These restrictions on new uses from streams and groundwater aquifers are adopted to ensure sustained supplies for existing water users and to protect important natural resources. Except in very severe situations (e.g., critical groundwater areas), these restrictions do not affect existing water uses, only the Department's ability to authorize new uses in these basins.

Water measurement is an essential component of distributing water to senior rights during low stream-flows.

These measurements help the Department monitor the state's water resources and plan for future needs in each basin.

Basin Programs

The Water Resources Commission adopts basin programs to set policies for managing administrative basins. A map of the state's river basins is on the last page of this booklet.

The Commission has adopted basin programs for all but one of the state's 18 administrative basins. Although the Commission has not adopted a comprehensive basin program for the Klamath basin, use of water in the basin is still subject to other administrative rules.

Basin programs include water-use "classifications" that describe the types of new water right applications that may be considered by the Department. Applicants should check with the Department before submitting an application to determine what classifications have been adopted for the proposed source of water.

The Commission may revise classifications in basin programs when the lack of available water or other factors indicate that new appropriations should not be allowed. Any change in the classification of a stream or aquifer restricts only new uses of water.

Critical Groundwater Areas

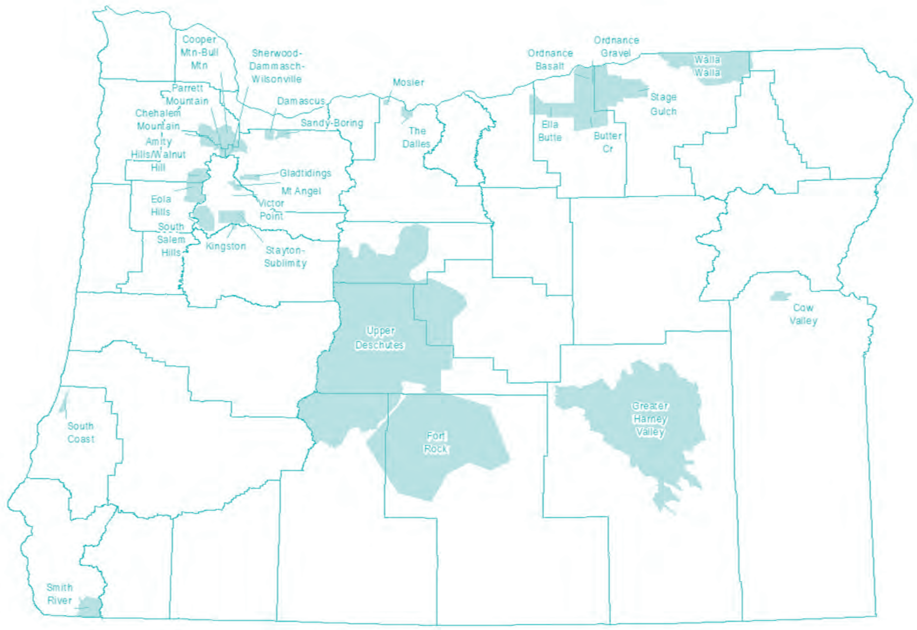
The Water Resources Commission may declare a critical groundwater area to restrict water withdrawal where the resource is overdrawn or where a pattern of interference between wells and other groundwater or surface water users exists. The law is designed to prevent excessive declines in groundwater levels and protect the right of senior users. The order setting the limits of the critical area may restrict both existing and future uses in order to stabilize the resource and may also provide for certain uses of water to have preference over other uses, regardless of established water right priority dates. Critical groundwater areas also can be declared if there is deterioration of groundwater quality, although this has not been the reason for any critical groundwater area to date.

Oregon has declared seven critical groundwater areas. The critical areas are Cow Valley near Vale; The Dalles in Wasco County; Cooper Mountain-Bull Mountain in Washington County; and the Butter Creek, Ordnance (alluvial and basalt) and Stage Gulch areas in Morrow and Umatilla Counties.

Groundwater Classified Areas

The Commission has established 12 "groundwater classified areas" (also referred to as limited areas) in the northern Willamette Valley. The classified areas generally allow for new exempt groundwater uses but place restrictions on new uses that require a permit. These areas are in the following approximate locations: Sandy-Boring, Damascus, Gladtidings, Kingston, Mt. Angel, Sherwood-Dammasch-Wilsonville, Stayton-Sublimity, Parrett Mountain, Chehalem Mountain, Eola Hills, South Salem Hills, and Amity Hills-Walnut Hill. The Willamette and Sandy Basin programs list the limitations in these classified areas. Outside the Willamette Valley are the South Coast, Fort Rock, Ella Butte, Harney Valley, Walla Walla, and Smith River classified areas. Through changes to the basin programs, new water rights in these areas are restricted to a few designated uses.

The Department's role is to protect existing water rights by preventing excessive groundwater declines, restoring aquifer stability, and preserving aquifers with limited storage capacity for designated high public value uses. The Department may find other areas where use from basalt and other aquifers must be limited. Such limitation may apply to a specific aquifer or geologic formation. In some cases, water may still be available at a different depth from a different geologic formation.



Groundwater Management Areas

Groundwater Withdrawal Areas

The Commission may withdraw aquifers from new appropriations where additional use is not sustainable. Victor Point near Silverton in Marion County and an area around Mosier in Wasco County are the only groundwater areas withdrawn at this time.

Serious Water Management Problem Areas

The Commission may require installation of a measuring device if it finds water use information is necessary because of serious water management problems caused by groundwater level decline, unresolved user disputes, or frequent water shortages. The basalt aquifer system of the Walla Walla Subbasin near Milton-Freewater in Umatilla County is a designated serious water management problem area.

Groundwater Mitigation Problem Areas

The Commission created rules defining a program to mitigate groundwater impacts to state Scenic Waterways in a portion of the Upper Deschutes Basin and Deschutes County. This is the only area with a defined mitigation program.

3. Obtaining New Water Rights

gaining authorization to use water

Most water rights are obtained in a three-step process. The applicant first must apply to the Department for a permit to use water. Once a permit is granted, the applicant must construct a water system and begin using water. After water is applied, the permit holder must hire a certified water right examiner to complete a survey of water use and submit to the Department a map and a report detailing how and where water has been applied. If water has been used according to the provisions of the permit, a water right certificate is issued after evaluation of the report findings.

In most areas of the state, surface water is no longer available for new uses in summer months. Groundwater supplies are also limited in some areas. Allocation of new uses of water is done carefully to preserve the investments already made in the state, whether in cities, farms, factories, or improvement of fish habitat.

Water rights are not automatically granted. Opportunities are provided for other water right holders and the public to protest the issuance of a permit. Water users can assert that a new permit may injure or interfere with their water use, and the public can claim that issuing a new permit may be detrimental to the public interest. This provides protection for both existing water users and public resources.

Water-Use Permits

The First Step: requesting a water-use permit

For more information, refer to ORS 537.130 and ORS 537.615

A permit is the authorization from the Department to begin constructing a water system and begin using water. Once the Department issues a permit, if the user complies with the conditions of the permit and develops his or her water right, the Department cannot later decide to revoke or change the permit or impose new standards for use.

For an application to be considered, an applicant must submit a completed application to the Department along with other information and maps, as required by statute. Types of information that may be required:

1. A legal description of the property involved (may be found on a deed, land sales contract, or title insurance policy).

2. A map showing the features of the proposed use and proposed source located according to township, range, and section, including any roads or other rights-of-way crossed by proposed diversion and conveyance works.

3. In most cases, a statement declaring whether the applicant has written authorization permitting access to land not owned by the applicant (including land crossed by proposed diversion and conveyance works).

4. The names and addresses of any other property owners that may be affected by the proposed development.

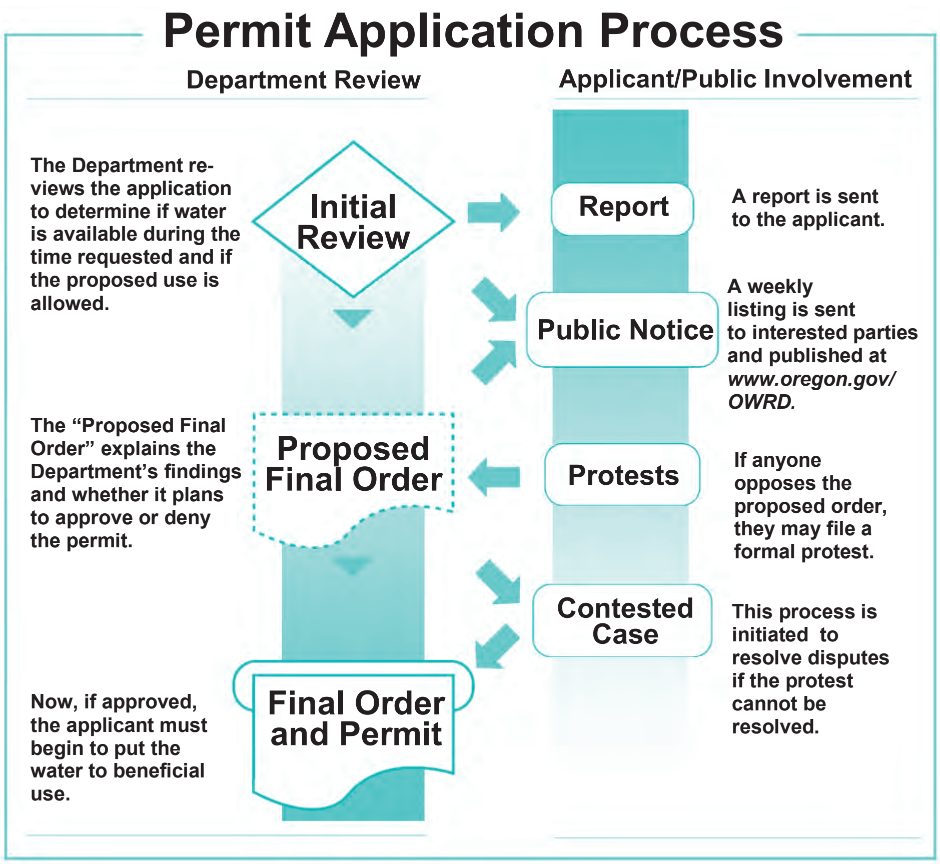
5. Land-use information obtained from the affected local government planning agency.

6. A supplemental form (if necessary) such as Form I for irrigation or Form M for a municipal right.

Applications and more detailed instructions are available at all Department offices and on the Department's website at *www.oregon.gov/OWRD*

Oregon law also requires that the applicant pay a fee set by statute. This fee contributes to the costs of reviewing and handling the application. A fee schedule is available from the Department on request and can be found online at *www.oregon.gov/OWRD*.

It is important that application instructions are carefully followed. If application materials are incomplete, they will be returned to the applicant.



Pre-application consultation

To inquire about a pre-application conference, please contact the Salem office at: (503) 986-0900.

Applicants with complex requests or applicants who are unfamiliar with the application process are encouraged to contact the Department to schedule a "pre-application conference." The Department's Water Rights Section staff are available to meet with applicants about their proposed project.

Application review

During the application review stage, applications are examined by the Department to ensure that allowing the proposed use will not cause injury to other users or harm public resources. The Department also determines if water is likely to be available for use and considers many other factors in its analysis of the application. These factors include basin plan restrictions that might prohibit certain uses or further appropriations, local land use restrictions, water quality, and other state and federal rules. For example, if approving a water right application in or above a state scenic waterway, the Department is required by law to find that the proposed use will not impair the recreational, fish, and wildlife values in the scenic waterway. The Department has prepared estimates of the streamflow levels needed to satisfy these uses. These flows may be used in determining whether new water rights in or above a scenic waterway should be authorized.

Also during the application review stage, other water right holders, government agencies, and the public may comment on or protest the application. For example, the Department consults with the Oregon Department of Fish and Wildlife to evaluate impacts on sensitive, threatened, or endangered species, and to ensure instream values are protected.

When applicants seek to use stored water only, the application will receive an expedited review leading directly to a final order, unless public interest issues are identified following the public notice of filing. If such issues are raised adequately, the application will undergo the standard review process to allow thorough public participation.

If protests are filed the Department may schedule a contested case hearing to resolve issues raised in the protest (s) which extends the process.

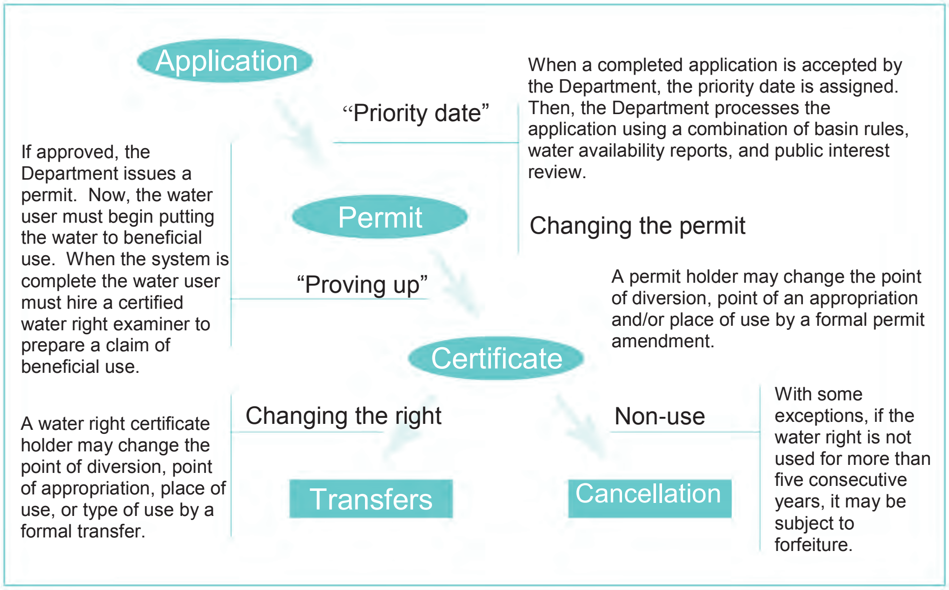
The Second Step: constructing the system and using water

Once the Department determines that a new water use can be allowed, a permit is issued. The permit will contain time limits to develop the water use. Many water right permits include conditions requiring water meters or measuring devices to be installed, and water use or water level reports to be submitted to the Department. Other conditions may also be placed on the permit, such as installing and maintaining fish screens.

Permits generally require the water user to develop the water use within five years. The permit holder may apply for an extension of time to fully develop the water use. The Department considers each request for an extension of time on a case-by-case basis. If there is good cause for not completing the water use in a timely manner and the permit holder has shown diligence in trying to meet the requirements of the permit, an extension may be granted.

Changing or modifying a permit (Permit Amendment)

The point of diversion or appropriation and the place of water use under a permit may be changed by submitting an application to the Department. It should be noted that the type of use cannot be changed in a permit amendment. The application is similar to a transfer application (discussed on pages 29-33), except the required map does not have to be prepared by a certified water right examiner. The change in the permit will be allowed only if it will not enlarge the



permit and not cause injury to other water rights. Under certain, limited circumstances, permit holders may also change a surface water point of diversion to a nearby groundwater source. The other terms and conditions in the permit cannot be changed.

The Third Step: "proving up" the water use

Once the water project is completed, the permit holder must demonstrate to the Department that work has been completed. Except for certain smaller reservoirs, as described on pages 22-23, the water user must hire a certified water right examiner (CWRE) to survey the extent of water use. This survey, which is called a "claim of beneficial use" and includes a map, must be submitted within one year of completion (making full beneficial use of the water) or before the " C " date (completion date specified in the permit), whichever is sooner. This allows the Department to evaluate the extent of water use developed within the terms and conditions of the permit. CWREs are registered, professional surveyors, geologists, or engineers who have passed a test given by the Oregon State Board of Examiners for Engineering and Land Surveying. For a list of CWREs, see the Department website *www.oregon.gov/OWRD*.

In some instances, personnel from the Department may conduct a brief field inspection to check the accuracy of the survey supplied by the CWRE. The inspector may want to check the size and type of equipment or verify that the amount of water requested has been put to use according to the permit. If necessary, water measurements may be taken.

Oregon's water law provides that a certificate may be issued only for the quantity of water that is used beneficially: the quantity of water that can be applied without waste or the amount allowed by the permit, whichever is less.

Water Use Measurement And Reporting

Good water management decisions are made possible when they are based on reliable information about water resources. Water-use data is a fundamental tool to ensure efficient water management, effective water distribution, and to help plan for future water needs. The information is also used to ground truth demand projections or modeling efforts by state and local entities. Water users who keep track of their use are better able to demonstrate the validity of their water rights. Oregon requires governmental entities such as irrigation districts and public water providers to measure and report water use. Certain types of water use are also required to be measured and reported, in accordance with the conditions of a water right or permit.

Final Certificates: the "perfected" water right

With the final proof survey map and water-use report, the Department will determine if the permit holder has met the conditions of the permit. If so, a water right certificate is issued. The water right certificate will continue to be valid as long as the water is used according to the provisions of the water right at least once every five years. (For exceptions to this requirement, see page 35 on cancellation of water rights.)

The amount of water allowed in the certificate will be an instantaneous rate and/or an annual volume. The appropriator may divert a certain maximum rate, but may not exceed the total amount allowed for the year. The instantaneous rate is usually expressed in cubic feet per second (cfs) or gallons per minute (gpm) and the annual amount in acre-feet (af). A conversion table for cfs, gpm, and af is located on the inside front cover of this booklet.

A water right permit or certificate will not guarantee water for the appropriator. Under the prior appropriation doctrine, the water right authorizes diversion of water only to the extent water is available. The amount of water available to a water right holder depends on the water supply and the needs of senior water rights, including water rights for instream use.

Water Dedicated to Instream Uses

For more information, refer to ORS 537.336.

The Department also approves water rights for protecting fish, minimizing the effects of pollution, or maintaining recreational uses. These water rights are called "instream water rights." Instream water rights establish flow levels to remain in a stream on a month-by-month basis and are usually set for a certain stream reach and measured at a specific point on the stream. Instream water rights have a priority date and are regulated in the same way as other water rights.

The authority to establish instream water rights was passed by the 1987 Legislature. This law allows the Departments of Fish and Wildlife, Environmental Quality, and Parks and Recreation to apply for instream water rights. The law gives instream water rights the same status as other water rights. However, in a Governor-declared drought, Oregon law allows the Department to give preference to human consumption and livestock watering over other uses, including instream uses.

Instream water rights are not guarantees that a certain quantity of water will be present in the stream. When the quantity of water in a stream is less than the instream water right, the Department will require more junior water right holders to stop diverting water. However, under Oregon law, an instream water right cannot affect a use of water with a senior priority date.

For more information, refer to ORS 537.348 and OAR 690-077 and OAR 690-380.

Oregon law also allows water right holders to sell, lease, or donate water rights to be converted to instream water rights. This is done through a short-term lease agreement or by a formal transfer of the existing right from the current use to a new type of instream use. Instream leases and transfers are discussed on pages 31-32.

Rights to Store Water

Reservoirs and Ponds

For more information, refer to ORS 537.400.

The construction of a reservoir or pond of any size to store water requires a water right permit from the Department. A water right permit allows storage of streamflow typically during the winter months.

A permit for a reservoir with the sole purpose of storing water is considered the primary permit. Permittees intending to use stored water will need an additional water use permit (commonly referred to as a secondary permit.)

A holder of a water right to the natural flow of a stream has no right to water stored in the reservoir of another water right holder. A reservoir water right holder usually does not have to release stored water to satisfy the needs of senior, natural flow rights on the same stream system. The operator of the reservoir must, however, provide some means of passing natural streamflow through or around the reservoir to satisfy downstream water rights and pass live flow outside the storage season.

Standard Water Right Permit and Safety Review for Dams

Reservoirs with a dam 10 feet or greater in height and that store 9.2 acre-feet or more must be designed by and constructed under the supervision of a registered professional engineer. Design, construction, and operation of dams for these reservoirs must comply with the dam safety regulations in Oregon Administrative Rules (OAR) 690-020-0000 through 690-020-0500. The engineered drawings and specifications must be approved by the Department prior to construction of such dam.

Alternate review process for smaller reservoirs

An alternative permit application process is available to persons interested in building small reservoirs storing less than 9.2 acre-feet of water or in reservoirs with dams less than 10 feet in height. The process involves review of the project by the watermaster and the Oregon Department of

For more information, refer to ORS 537.409.

Fish and Wildlife prior to application, which allows an expedited review (less than six months). For certain reservoirs or ponds filed under this process, those that store less than 9.2 acre-feet and do not have a secondary permit to use the stored water, a CWRE survey is not required to receive a water right certificate. Instead, permittees may submit information on the dimensions, capacity, and location of such reservoirs to the Department. If you have questions about which type of application process is best for you, please call the Department at (503) 986-0900 or contact your local watermaster (see pages 42-43).

For more information about Dam Safety please refer to Appendix B on page 48.

Storing groundwater

If allowed by a groundwater right, groundwater may be stored in a reservoir prior to beneficial use. If such reservoirs interact with surface water, the Department may require a separate reservoir application.

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4. Other Water Rights

authorizations for water use

Rights Through Customary Use

For more information, refer to ORS 539.240.

If water was used prior to enactment of Oregon's 1909 water code and has been used continuously since then, the property owner may have a "vested" water right. Because a water right is attached to the place of use, this is true even if the ownership of the property has changed.

A claim to a vested water right can be determined and made a matter of record only through a legal process known as an "adjudication proceeding." The responsibility of the Department in the adjudication process is to gather information about the use of water and present its findings to the circuit court in the county where the water is used. The court then issues a decree that states who has the right to use water, the amount and location of water use, and the priority date for each right. The Water Resources Department then issues a water right certificate for each decreed right. The date of priority for a right determined through an adjudication proceeding is usually the date construction of the project began or the date when water was first used on the property.

Legislation passed in 1987 required persons claiming pre-1909 rights in areas not yet adjudicated to file surface water registration statements before December 31, 1992.

For more information, refer to ORS 539.300.

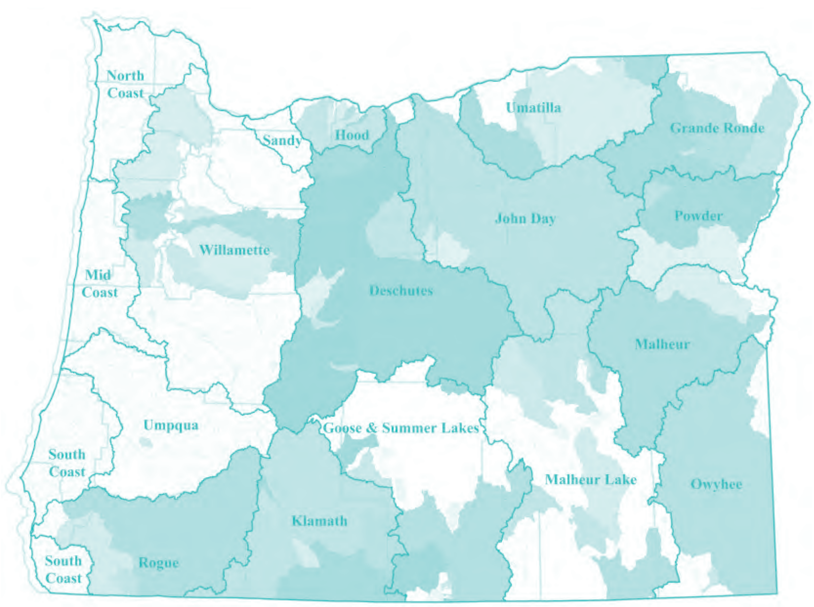
Failure to file this registration statement by the deadline created the rebuttable presumption that the person had no claim to a water right. These statements do not automatically guarantee rights will be granted to those who have filed. Each vested right will be determined through the courts in an adjudication proceeding.

Adjudication proceedings are also used to determine the water rights for federal reservations of land. This includes American Indian reservations and other federal land reservations.

Legislation passed in 1987, and amended in 1993, allows the Director of the Department to act on behalf of the State of Oregon to negotiate settlements for federal reserved water rights of federally recognized rights.

Adjudication proceedings have been completed for most of the major stream systems in eastern and southern Oregon and a few of the larger tributaries to the Willamette River, although these adjudications may not have included federal reserved claims. Nearly 100 decrees have been issued on individual streams in Oregon, and water right certificates have been issued for most of the decrees. An adjudication proceeding is in process in the Klamath Basin.

Adjudicated Areas Within Oregon



Limited Licenses

For more information, refer to ORS 537.143 & OAR 690-340.

Oregon law also provides a method for obtaining permission to divert and use water for a short-term or fixed duration not to exceed five years. Under current law, certain types of uses can be allowed using a "limited license," provided that water is available and the proposed use will not injure other water rights. These authorizations allow landowners and developers to use water for purposes that do not require a permanent water right. A limited license may be available as soon as three weeks after filing an application with the Department.

Limited licenses are "junior" to all other uses and subject to revocation at any time. There is no guarantee that water will be available.

Uses under a limited license may include, but are not limited to, road construction, fire-fighting training, general construction, rangeland management, and emergency use authorization. Uses of a longer duration may also qualify for limited licenses.

Generally, irrigation uses are not allowed under a limited license. In some cases, however, a limited license may be used to establish a crop that will not require further irrigation once established. In cases of severe drought, the Department may issue limited licenses so landowners can avoid irreparable crop damage by continuing the use of water after the close of the irrigation season. In addition, a limited license may be used for irrigation purposes in cases where the license is issued for use of stored water, provided certain criteria are met.

The Department conducts a review of an application for limited license to assess the proposed use for water availability and public interest concerns such as threatened or endangered fish, water quality, limited streams, or scenic waterways. The Department provides an opportunity for the public to comment on a proposed limited license. If the Department finds that water is available and the proposed use will not impair the public interest, a limited license is issued with terms and conditions similar to those of a water use permit. The license includes a condition that specifies when it expires.

5. Transferring Water Rights

Changes to existing rights

The use of water under a water right is restricted to the terms and conditions described in the water right certificate: place of use, point of diversion or appropriation, and type of use. For example, if a water right holder establishes the right to irrigate a particular 20-acre tract of land from a specified water source, the water cannot be diverted from a different point or source, nor can it be used to irrigate other land without permission. It cannot be used for any other purpose than the type of use indicated in the water right.

The water right holder must file a transfer application with the Department to change a point of diversion, point of appropriation, type of use, place of use, or any combination of these.

Gathering streamflow data is an important part of the Department's commitment to protect water rights and Oregon's water

Permanent Transfers

An application for a permanent transfer generally requires a map prepared by a certified water right examiner (CWRE). The applicant must submit a transfer application describing: the current water right, the proposed changes, evidence of water use, land ownership or consent by the landowner, and, in most cases, compliance with local land use plans. The water may continue to be used in accordance with the current water right until the transfer is approved. The proposed use may only occur once the transfer order approving the change is issued.

To approve a transfer application, the Department must determine that the proposed change will not enlarge the water right and will not injure other water rights. Members of the public are offered a chance to comment and protest a proposed transfer if they believe the right proposed for transfer will be enlarged or an existing water right would be injured. The Department, working with the applicant, may attach conditions to an approval order to eliminate enlargement of the right or potential injury to other water rights. If conditional approval will not eliminate injury or enlargement, the application is denied.

For more information, refer to ORS 540.510 and ORS 540.520.

After the transfer is approved, the applicant must make the change. In the case of a change in the type of use or place of use, any portion of the water right involved in the transfer that is not changed is lost. Following completion of the change, a CWRE must prepare a final proof map and site report to be submitted with the applicant's claim of beneficial use. The map and claim of beneficial use describe the completed change and the extent of beneficial water use under the modified water right. A new water right certificate will be issued to confirm the modified water right.

Temporary Transfers

A water user may temporarily change the place of use of a water right to allow a right attached to one parcel of land to be used on another parcel. A temporary transfer may not exceed a period of five years. This type of transfer is typically used for crop rotations or other rotational uses of water. The required application map for a temporary transfer does not have to be prepared by a CWRE.

For more information, refer to ORS 540.523 and OAR 690-380.

A temporary change in point of diversion or appropriation may be made if it is necessary to convey water to the temporary place of use. The Department can revoke a temporary transfer if the change results in injury to other water rights.

Historic Point of Diversion

For more information, refer to ORS 540.532 and OAR 690.380.

If an individual (not a company, government body, or other entity) has been using a diversion point for more than ten years that is not the authorized point of diversion, the individual may request an abbreviated transfer process to change the certificated point of diversion to the current point of diversion. This change may only be made if there have been no complaints about the alternate point of diversion and if the change can take place without causing injury to other water rights.

Drought Transfers

For more information, refer to ORS 536.710 and OAR 690.019.

Upon the Governor's issuance of an Executive Order declaring a drought emergency, the Department is allowed to offer certain tools to water right holders in a drought declared County.

These tools have an expedited review process, reduced fee schedule, and are intended to be short-term emergency authorizations, not permanent solutions to deal with water supply challenges. Water right holders seeking long-term solutions should contact their Watermaster to help identify what options may exist.

Permanent and Temporary District Transfers

For more information, refer to ORS 540.580 OAR 690-385.

Districts organized under ORS Chapter 545, 547, 522, 553, or 554 have the option of applying for a district permanent transfer. Only a place of use within district boundaries may be transferred. In certain circumstances, water use at the proposed place of use may begin when a notice is filed. All noticed lands must be included in a (single) district transfer application due at the end of the year. If certain criteria are met, a district may use the district transfer process to take control and transfer their unused water rights within the district. Districts also have the option of applying for a temporary transfer for one season. Water use may begin as soon as the application is filed. In addition to place of use changes, under temporary district transfers, points of diversion may be transferred to facilitate a place of use change or in emergency situations.

Transfers and Leases for Instream Use

Water rights may be transferred or leased for instream uses. Instream transfers and leases must show that enlargement of the right or injury to other water rights will not occur and that a beneficial use will be made of the water, such as providing flows for fish and wildlife, scenic values, or improved water quality. Instream transfers and leases carry the priority date of the original right.

The water may not be diverted by a junior user while it is an instream right or lease.

Instream Transfers

The instream water right statutes allow a water right to be permanently transferred to instream use or transferred for a specific period of time. At the end of a time-limited instream transfer, the right automatically reverts back to its original place and type of use. Time-limited instream transfers are generally used for periods of time exceeding five years; for five years or less, the instream leasing process is the preferred option.

Instream Leasing

For more information, refer to ORS 537.348, OAR 690-077 and OAR 690-380

The instream leasing program offers water right holders a way to protect water rights that are currently unused, while also providing instream benefits. Leases go through an expedited review process. The term of an instream use lease cannot exceed five years, but it may be renewed.

Split season leasing allows for both instream and existing uses to occur from the same water right, but at different times of the year with appropriate measurement and monitoring to prevent enlargement or injury.

Water rights for surface water use, storage, the use of stored water, and water saved through the conserved water program (see page 36) may be leased instream.

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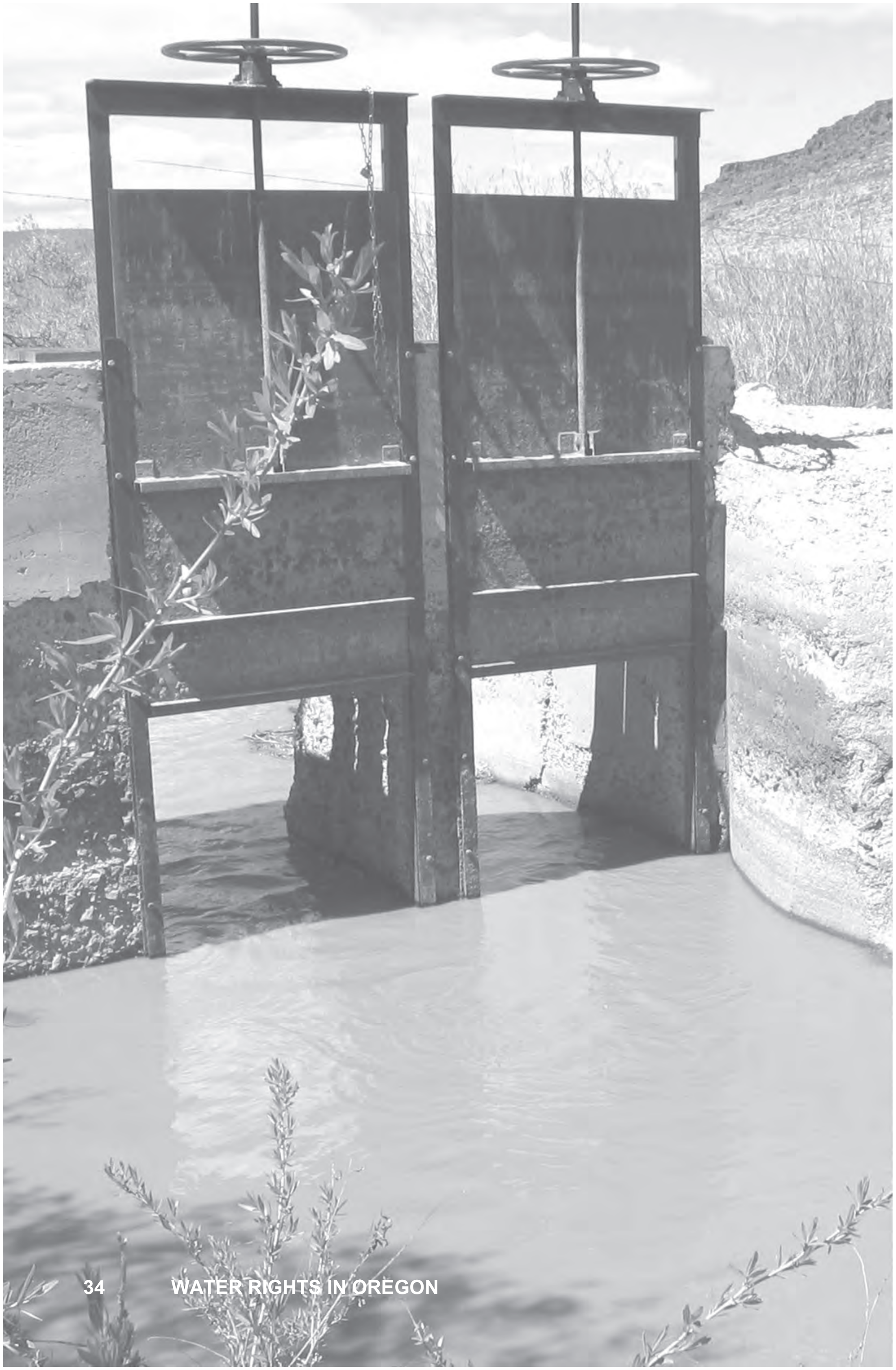
Groundwater Registration Modifications

For more information, refer to ORS 537.585 to 537.610 and OAR 690-382.

Groundwater registrations are claims for rights to use groundwater established prior to 1955 and for which the Department has issued certificates of registration. The Department may recognize a change in use, place of use, or point of appropriation for a groundwater registration if the Department determines that the change will not injure other water rights, will not result in enlargement and will not state scenic waterway flows.

Recognition of a modification in a groundwater registration does not confirm the right, which can only be confirmed in a future adjudication proceeding. Pending that determination, the holder of a registration may use groundwater as described in the certificate of registration, or as modified by the Department's recognition of changes.



6. Cancelling Water Rights

loss of water rights through non-use

A water right remains valid as long as it is not cancelled and beneficial use of the water is continued without a lapse of five or more consecutive years. According to Oregon law, except for municipal rights and in certain other cases, if any portion of a water right is not used for five or more consecutive years, that portion of the right is presumed to have been forfeited and may be subject to cancellation.

Headgates control the flow of water through ditches and canals that serve water users throughout Oregon.

For example, if a water right is for the irrigation of 40 acres and the water right holder irrigates only 20, the portion of land not irrigated for five consecutive years is subject to cancellation. Diverting less than the full amount of water allowed under the right will not result in forfeiture, as long as the water right holder is ready, willing and able to use the full amount and has a water system capable of handling the entire rate and duty as described in the water right.

Once a water right has been unused for five consecutive years or more, it is subject to cancellation even if the property owner begins to use the water again, unless the non-use occurred more than 15 years prior. Under the law, the right is presumed to be forfeited and reuse does not reinstate the right. This is true even if the current owner did not own the property when use was discontinued. Under certain conditions, such non-use may exceed five consecutive years without forfeiture of the right. See ORS 540.610 for more information.

Cancellation of a forfeited water right is not automatic. Cancellation requires a legal proceeding to determine whether or not the period of non-use has occurred. A legal proceeding is not necessary if the landowner voluntarily authorizes cancellation.

For more information, refer to ORS 540.610.

Administrative proceedings to determine the validity of a water right may be initiated by the Department. This usually happens when individuals with firsthand knowledge of non-use come forward and provide sworn affidavits asserting non-use.

Once a water right is cancelled, a landowner must apply for and obtain a new water right permit before using water. A new application for a water right permit is subject to current laws and rules.

7. Conservation
encouraging efficient water use

The Department encourages the efficient use of water and practices that conserve water resources. Oregon law requires that all water that is diverted by water right holders be used beneficially and without waste. This means that a right holder is required by law to use only the amount necessary for the intended purpose and no more, up to the limits of the water right.

Allocation of Conserved Water

For more information, refer to ORS 537.465 and OAR 690-018.

With improved technology and distribution methods, water users are now able to do the same work with much less water than was required in the past. Oregon law provides an opportunity for a water right holder to save water and utilize it on new lands or for other purposes beyond those specified in the water right. For example, if the installation of an improved irrigation system reduces the water use from six acre-feet per year to only two acre-feet per year, under the Allocation of Conserved Water program, the remaining four acre-feet of saved water may be used for a new purpose or on new lands with approval.

State law allows a water right holder who conserves water to submit an application and receive authorization to use a portion of the saved water on additional lands, lease or sell the water, or dedicate the water to instream use. The percentage of saved water that may be applied to new uses or lands depends on the amount of state or federal funding contributed to the conservation project. The law requires a minimum of 25 percent of the saved water be returned to the stream for improving streamflows. The Department will issue an order allocating the saved water for use by the water right holder and for the required instream use. In addition, the Department will issue a superseding certificate for the original water right to reflect the reduced quantity of water now being used with improved technology. The priority date stays the same.

The Department will also issue a certificate for the instream flow. The saved water allocated for the instream flow and new uses will have the same priority date or a priority date of one minute after the original water right.

Water Management and Conservation Planning

Some agricultural and municipal water suppliers are required to prepare water management and conservation plans. Development of these plans involves a step-by-step evaluation of the water supply alternatives available to the supplier and an evaluation of the role that water conservation can have in meeting the supplier's water needs. Department staff provide workshops and other technical assistance to water suppliers preparing water management and conservation plans.

Funding Feasibility Studies

Local communities often find it difficult to secure feasibility study funding as part of their project development. Such studies help determine the environmental, engineering, economic, and social implications of proposed water supply projects. One way Oregon helps with costs is to bridge the existing funding gap for feasibility studies of water conservation, reuse, and storage projects. From 2008 to 2017, the Water Resources Commission awarded 84 grants totalling approximately $4.9 million. The Department continues to offer Feasibility Study Grants with applications typically due in the fall of each year. For more information please visit the Department's website: *www.oregon.gov/OWRD*.

Funding Water Supply Projects

The Water Resources Department also offers funding to implement water supply projects. Water Project Grants and Loans provides funding for water projects that meet instream and out-of-stream water needs, while producing economic, environmental, and social/cultural benefits. In its first two years awarding funds, the Water Resources Commission awarded more than $15 million to thirteen projects. The Department continues to offer this competitive funding opportunity with applications generally due in the spring of each year. For more information please visit our website: *www.oregon.gov/OWRD*.

8. Finding Water Rights

determining if you have a water right

All legally established water rights are on record in the Salem office of the Water Resources Department. Records of water rights are also maintained in the local watermasters' offices. Contact the Department or your watermaster to determine if there are water rights of record for property you own or want to purchase. You may need to pay a fee if you want the Department to research and copy water right files. Please contact the Department to obtain a current fee schedule or look on the web at *www.oregon.gov/OWRD*.

To find out if a water right exists, you will need to provide a copy of the legal description or a current county assessor's tax lot map of the property. If the property lies within a platted and recorded subdivision, a copy of the recorded plat should accompany the legal description. Any maps submitted need to include the township, range, and section of the property involved and have a reference corner such as a section corner.

For more information, refer to ORS 537.330.

You might also find the Department's online interactive mapping utility to be helpful in locating water rights. Step by step instructions detailing how to determine whether a water right exists on a particular piece of property are also available. Both can be found at *www.oregon.gov/OWRD*.

Keep in mind that while the Department or Watermaster can tell you if there is a water right on file for your tract of land, they cannot guarantee that the water has been used continuously and that the right is not subject to cancellation.

9. Water Distribution and Enforcement

Watermasters and Field Staff protect rights and resources

In order to protect the rights of water users, and to ensure compliance with water laws, personnel from the Water Resources Department, in cooperation with landowners, inspect wells and water diversion systems. Inspections are usually conducted by watermasters and well inspectors who are employees of the Department.

Watermasters respond to calls from water users and determine in times of water shortage - which generally occur every year - who has the right to use water. Each summer as streamflows drop, watermasters regulate junior users to provide water to more senior users. On some streams, by the end of summer, there is only enough water to supply users with rights established in the 1800s. Watermasters work with all of the water users on a given water system to ensure that the users voluntarily comply with the needs of more senior users. Occasionally, watermasters take more formal actions to obtain compliance from unlawful water users or those who are engaged in practices that "waste" water. The waste of water means the continued diversion of more water than is needed to satisfy the specific beneficial use for which the right was granted.

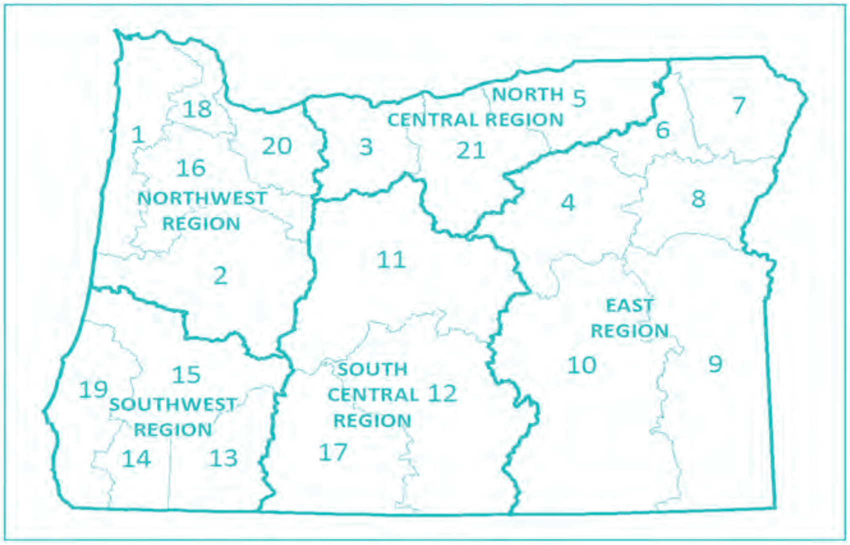
In order to protect the groundwater resources of the state, the Department also regulates the construction, maintenance, and abandonment of wells. In order to accomplish this, the Department tests, licenses, and provides continuing education credit to well constructors. The Department also has well inspectors stationed around the state to inspect wells and ensure that they are constructed, maintained, or formally abandoned (i.e. decommissioned) in a manner that is consistent with Oregon's minimum well construction standards. Wells that do not meet the minimum requirements are normally addressed through voluntary compliance, but there are also other formal actions available if necessary.

Watermasters and field staff also provide general information to the public, oversee enforcement of instream water rights, inspect the conditions of dams, and measure and monitor streamflows for management and planning needs.

See the Water Well Owners' Handbook:
A Guide to Water Wells in Oregon
for more information.

10. Region Offices and Watermaster Districts

Region Offices	Watermasters by District	
NORTHWEST **Region Office** 725 Summer St NE Suite A Salem, OR 97301 Phone: (503) 986-0893 Email: region_manager_w@ wrd.state.or.us	DISTRICT 1 **Watermaster Office** OWRD 4000 Blimp Blvd Ste 400 Tillamook, OR 97141 Phone: (503) 815-1967 Email: watermaster_district1@ wrd.state.or.us	DISTRICT 6 **Watermaster Office** 10507 N McAlister Rd #6 La Grande, OR 97850 Phone: (541) 963-1031 Email: watermaster_district6@ wrd.state.or.us
NORTH CENTRAL **Region Office** 116 SE Dorion Ave Pendleton, OR 97801 Phone: (541) 278-5456 Email: region_manager_nc@ wrd.state.or.us	DISTRICT 2 **Watermaster Office** Lane County Courthouse 125 East 8th Avenue Eugene, OR 97401-2926 Phone: 541-682-3620 Email: watermaster_district2@ wrd.state.or.us	DISTRICT 7 **Watermaster Office** 401 NE First St., Ste 11 Enterprise, OR 97828 Phone: (541) 398-8172 Email: watermaster_district7@ wrd.state.or.us
EASTERN **Region Office** Baker County Courthouse 1995 3rd St, Ste 180 Baker City, OR 97814 Phone: (541) 523-8224 x224 Email: region_manager_e@ wrd.state.or.us	DISTRICT 3 **Watermaster Office** 2705 E 2nd St The Dalles, OR 97058 Phone: (541) 506-2652 Email: watermaster_district3@ wrd.state.or.us	DISTRICT 8 **Watermaster Office** Baker County Courthouse 1995 3rd St, Ste 180 Baker City, OR 97814 Phone: (541) 523-8224 x231 Email: watermaster_district8@ wrd.state.or.us
SOUTH CENTRAL **Region Office** 231 Scalehouse Loop Suite 103 Bend, OR 97702 Phone: (541) 306-6885 Email: region_manager_sc@ wrd.state.or.us	DISTRICT 4 **Watermaster Office** Grant County Courthouse 201 S Humbolt St, Ste 180 Canyon City, OR 97820 Phone: (541) 575-0119 Email: watermaster_district4@ wrd.state.or.us	DISTRICT 9 **Watermaster Office** Malheur County Courthouse #4 251 B St W Vale, OR 97918 Phone: (541) 473-5130 Email: watermaster_district9@ wrd.state.or.us
SOUTHWEST **Region Office** 10 S Oakdale, Rm 309A Medford, Oregon 97501 Phone: 541-774-6884 Email: region_manager_swr@ wrd.state.or.us	DISTRICT 5 **Watermaster Office** 116 SE Dorion Ave Pendleton, OR 97801 Phone: (541) 278-5456 Email: watermaster_district5@ wrd.state.or.us	DISTRICT 10 **Watermaster Office** Harney County Courthouse 450 N Buena Vista #3 Burns, OR 97720 Phone: (541) 573-2764 Email: watermaster_district10@ wrd.state.or.us



DISTRICT 11
Watermaster Office
231 Scalehouse Loop, Ste 103
Bend, OR 97702
Phone: (541) 306-4808
Email: watermaster_district11
@wrd.state.or.us

DISTRICT 12
Watermaster Office
513 Center St
Lakeview, OR 97630
Phone: (541) 947-6038
Email: watermaster_district12
@wrd.state.or.us

DISTRICT 13
Watermaster Office
10 S Oakdale, Rm 309
Medford, OR 97501
Phone: (541) 774-6883
Email: watermaster_district13
@wrd.state.or.us

DISTRICT 14
Watermaster Office
700 NW Dimmick St
Grants Pass, OR 97526
Phone: (541) 261-2213
Email: watermaster_district14
@wrd.state.or.us

DISTRICT 15
Watermaster Office
Douglas County Courthouse
1036 SE Douglas, Rm 306
Roseburg, OR 97470
Phone: (541) 440-4255
Email: watermaster_district15
@wrd.state.or.us

DISTRICT 16
Watermaster Office
725 Summer St NE, Ste. A
Salem, OR 97301
Phone: (503) 986-0889
Email: watermaster_district16
@wrd.state.or.us

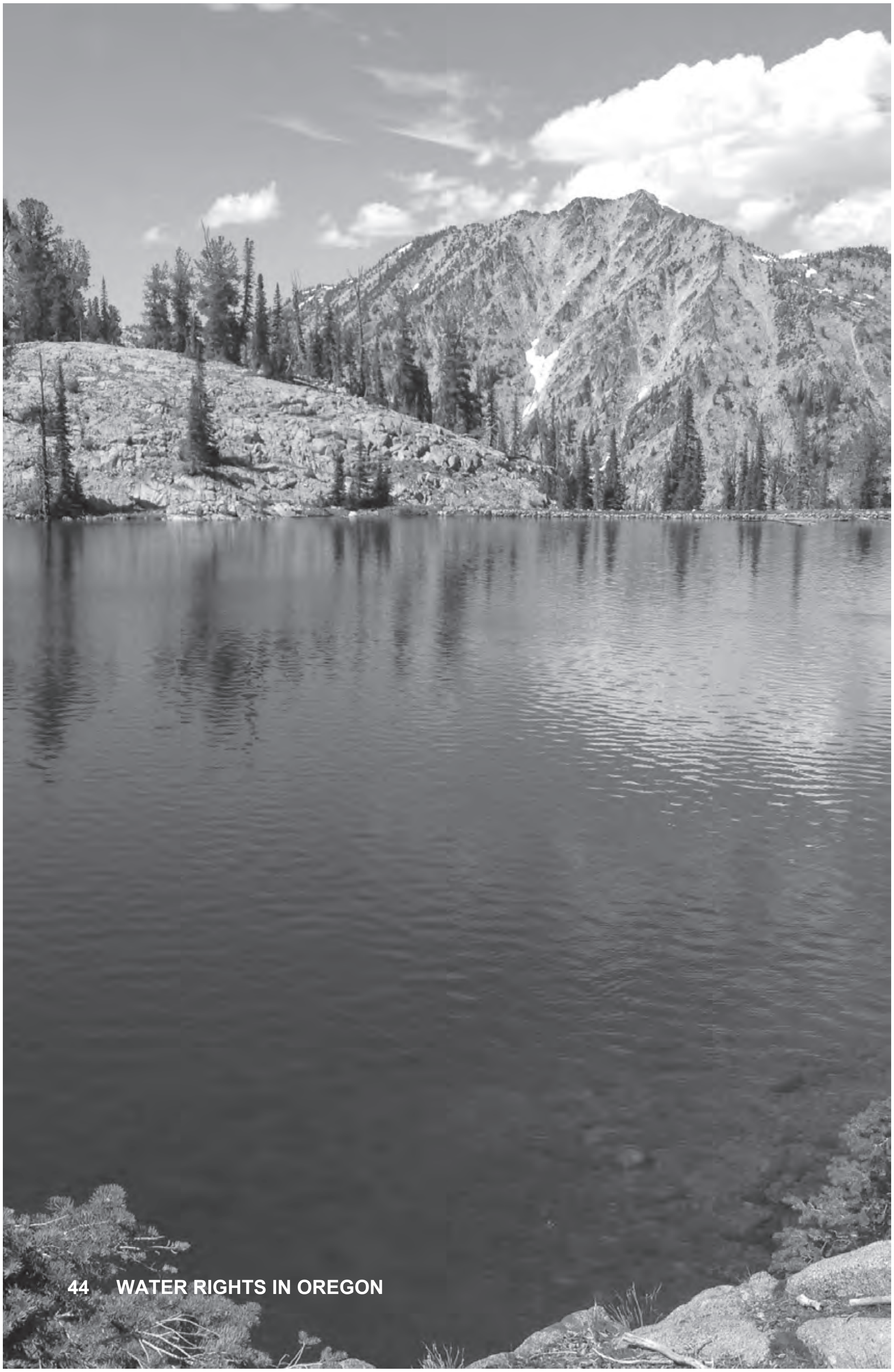
DISTRICT 17
Watermaster Office
305 Main Street, First Floor
Klamath Falls, OR 97601
Phone: (541) 883-4182
Email: watermaster_district17
@wrd.state.or.us

DISTRICT 18
Watermaster Office
1400 SW Walnut St, Ste 240,
MS 49
Hillsboro, OR 97123
Phone: (503) 846-7780
Email: watermaster_district18
@wrd.state.or.us

DISTRICT 19
Watermaster Office
Coos Co. Courthouse Annex
225 N Adams
Coquille, OR 97423
Phone: (541) 297-6157
Email: watermaster_district19
@wrd.state.or.us

DISTRICT 20
Watermaster Office
10722 SE Highway 212
Clackamas, OR 97015
Phone: (503) 722-1410
Email: watermaster_district20
@wrd.state.or.us

DISTRICT 21
Watermaster Office
221 S Oregon St
PO Box 427
Condon, OR 97823
Phone: (541) 384-4207
Email: watermaster_district21
@wrd.state.or.us



11. Fees

For more information, refer to ORS 536.050.

The Department requires a fee for most water use transactions and some administrative services. For information regarding specific fees, please contact the Department's Customer Service Representatives at (503) 986-0900 or call your local watermaster. An explanation, schedule of fees, and online calculator can also be found on the Department's website at www.oregon.gov/OWRD.

Appendix A

other development permits

Developing a water right often entails grading, trenching, or other types of construction in waterways, riparian areas, and wetlands. In addition to a water use permit, other permits from local, state, or federal agencies may be required. Check first with your local city or county planning office.

Activities in Wetlands and Waterways are Regulated by:

See *An Introduction to Water Related Permits And Reviews* issued by Oregon State Agencies (2012) for more information

- *Department of State Lands (*DSL) https://www.oregon.gov/dsl/WW/Pages/WetlandConservation.aspx
- *U.S. Army Corps of Engineers* (Corps) under the federal Clean Water Act and Rivers and Harbors Act https://www.epa.gov/cwa-404/section-404-clean-water-act-how-wetlands-are-defined-and-identified
- *Oregon Department of Forestry* under the Forest Practices Act https://www.oregon.gov/ODF/Working/Pages/FPA.aspx
- *U.S.D.A. Natural Resource Conservation Service* (NRCS) under the Food, Agriculture, Conservation and Trade Act - Check government listings.
- Some city and county land use ordinances

What Areas are Regulated?

- Rivers, streams, and most creeks
- Estuaries and tidal marshes
- Lakes and some ponds
- Permanent and seasonal wetlands

Regulations apply to all lands, public or private. A wetland does not have to be mapped by the state or otherwise "designated" to fall under the regulations. If you are uncertain if there are regulated wetlands on your property, contact Department of State Lands (DLS) for assistance.

What Activities are Regulated?

- Placement of fill material
- Alteration of stream bank or stream course
- Ditching and draining
- Plowing/disking non-farmed wetlands
- Excavation or dredging of material
- In-water construction (may also require a DSL lease)
- For some activities, joint application forms can be obtained from DSL or the Corps

What Activities are Exempt?

- Some routine maintenance activities
- Established, ongoing agricultural activities and grazing
- Some minor projects involving small amounts of fill or removal

How are Laws Enforced?

The best enforcement is to prevent illegal wetland alterations through information and education. However, when violations do occur, a variety of enforcement tools may be used, including restoration orders, fines, civil and/or criminal charges.

Contact your local city or county planning office, Department of State Lands or the Corps for details and clearance to proceed with your project and to determine if you are affecting an area that is regulated.

A list of licenses, permits, and registrations in Oregon can be found on the web at *https://apps.oregon.gov/SOS/LicenseDirectory/*.

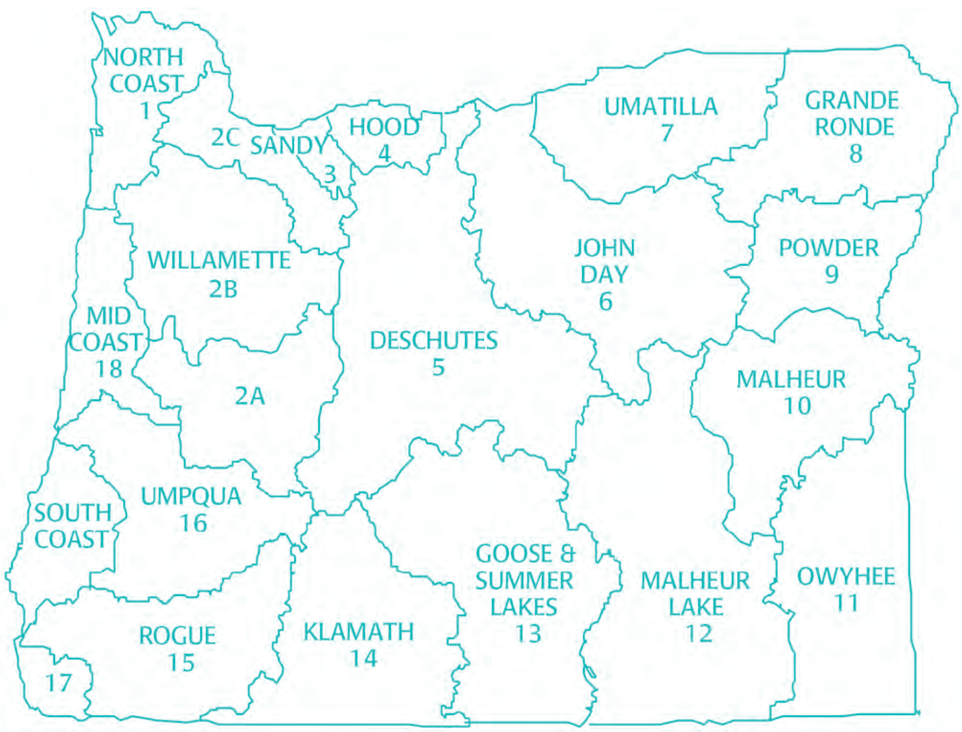
You can also access the state's water permit guide at http://www.oregon.gov/dsl/WW/Pages/Permits.aspx.

Appendix B
Dam Safety in Oregon

Oregon's Dam Safety Program was established in 1929 to protect lives, property, and infrastructure below dams. The program provides construction standards and inspection protocols for dams 10 or more feet in height and storing 3,000,000 or more gallons (9.2 acre feet). Dam owners have responsibility to maintain their structures, and the Department can provide information and technical support to help.

For more information you can access the Department's Dam Safety website at: www.oregon.gov/OWRD.

Oregon's Administrative Basins



Oregon has 18 designated administrative basins that are managed by the Department under the guidance of the Water Resources Commission. These are noted on the map above. Bordering Oregon are the Columbia River and Middle Snake River, which are shared with other states.

Exhibit 27
Page 51 of 52

OREGON
WATER RESOURCES DEPARTMENT

State of Oregon
Water Resources Department
725 Summer St NE, Suite A
Salem, OR 97301-1266
(503) 986-0900
www.oregon.gov/OWRD

Deschutes County Official Records 2020-26401
Nancy Blankenship, County Clerk
01294432202000264010030036
06/08/2020 01:21 PM
D-EAS Cnt=1 Stn=3 AS
$15.00 $11.00 $61.00 $10.00 $6.00 $103.00

EASEMENT

Between

Miller Pit, LLC
an Oregon Limited Liability Company

And

Avion Water Company, Inc.

After recording, return to:

AVION WATER COMPANY, INC
60813 PARRELL RD
BEND, OR 97702

Space Reserved for Recorder's Use

vas , at in and/or as fee/file/instrument/microfilm/reception No. ________, Records of this County.

Witness my hand and seal of County affixed.

Name Title

By: ________________________________, Deputy.

THIS AGREEMENT made and entered into on June 4th, 2020, by and between Miller Pit, LLC an Oregon Limited Liability Company, hereinafter called the first party, and Avion Water Company, Inc. hereinafter called the second party, WITNESSETH:

WHEREAS: The first party is the record owner of the following described real property in Deschutes County, State of Oregon, to-wit:

A tract of land situated in the Northeast Quarter (NE1/4) of Section Twenty-one (21), Township Eighteen (18) South, Range Twelve (12), East of the Willamette Meridian, Deschutes County, Oregon, more particularly described as follows:

Beginning at a point on the North line of said Section Twenty-one (21) which point is located South 89°50' West 450 feet from the Northeast corner of said Section 21; thence South 0°14' West on a line parallel to the East line of said section 21, a distance of 2235 feet; thence West, a distance of 1300 feet; thence North 0°14' East, a distance of 2231.17 feet to the North line of said Section 21; thence North 89°50' East along the North line of said Section 21, a distance of 1300 feet to the point of beginning.

EXCEPTING THEREFROM:

Commencing at the Northeast corner of said Section Twenty-one (21); thence South 89°50' West along the North line of said section 21, 450.00 feet; thence South 00°14' West on a line parallel with the East line of said Section 21, a distance of 20.00 feet to a point the Southerly right of way line of Knott Road, being the point of beginning; thence South 00°14' West on a line parallel with the East line of said Section 21, 10.00 feet; thence North 88°15' West 300.10 feet, to a point on the Southerly right of way line of Knott Road; thence North 89°50' East along the Southerly right of way line of Knott Road a distance of 300.00 feet to the point of beginning.

Also know as tax lot: 1812210000200

NOW, THEREFORE, in view of the premises and in consideration of $25,000.00 cash. A future hot tapped 8-inch valve connection point along Knott Rd. that includes all of the excavation and materials necessary to supply domestic water to the above described property. All of the connection fees waived for seven residential domestic water service connections by the second party to the first party paid, the receipt of which is acknowledged by the first party, it is agreed:

The first party hereby grants, assigns and sets over to the second party and easement, to-wit:

Being 15 Feet in width for the purpose of constructing, operating, maintaining, repairing, replacing and reconstructing underground waterlines together with all necessary appurtenances. Said easement is more particularly described as follows: Commencing at the Northeast property corner of the above described property; thence South along the East property line for a distance of 17.5 feet to the Centerline and TRUE POINT OF BEGINNGING of said easement; thence West and paralleling the North property line for the entire length of the property and then terminating. Said easement is abutting an existing Avion Water Company, Inc. easement of record. Vol:1999 Page:12943 in Deschutes County records. Said easement will be 35 feet in width as a temporary construction easement during construction. After construction said easement will revert back to 15 feet in width as a permanent easement. Said permanent easement is depicted in Exhibit "A". Future utility crossings shall be permitted within this easement and other existing Avion Water Company, Inc. easements on the property with the appropriate amount of separation.

The second party agrees to haul off site all excavated trenching material including rocks, stumps, trees and brush. The second party agrees to backfill with clean material within the pipe zone and top soil for the top 18 inches. The second party agrees to remove only the trees that are necessary to complete construction. The second party also agrees to restore all other disturbed areas with top soil and reconstruct any fences that are removed or disturbed during construction.

(OVER)

The second party shall have all rights of ingress and egress to and from the real estate (including the right from time to time, except as hereinafter provided, to cut, trim and remove trees, brush, overhanging branches and other obstructions) necessary for the second party's use, enjoyment, operation and maintenance of the easement hereby granted and all rights and privileges incident there to, except as to the rights herein granted, the first party shall have the full use and control of the above described real estate. The first party agrees to not constructing any permanent structures within the easement area.

The second party agrees to save and hold the first party harmless from any and all claims of third parties arising from the second party's use of the rights herein granted.

The period of this easement shall be perpetual.

During the existence of this easement, maintenance of the easement and costs of repair of the easement, if damaged by natural disasters or other events for which all holders of an interest in the easement are blameless, shall be the responsibility of (check one): ☐ the first party; ☑ the second party; ☐ both parties, share and share alike; ☐ both parties, with the first party responsible for __________% and the second party responsible for __________%. (If the last alternative is selected, the percentages allocated to each party should total 100)

During the existence of this easement, holders of an interest in the easement who are responsible for damage to the easement because of negligence or abnormal use shall repair the damage at their sole expense.

This agreement shall bind and inure to the benefit of, as the circumstances may require, not only the parties hereto but also their respective heirs, executors, administrators, assigns, and successors in interest.

In construing this agreement, where the context so requires, the singular includes the plural and all grammatical changes shall be made so that this agreement shall apply equally to individuals and to corporations. If the undersigned is a corporation, it has caused its name to be signed and its seal, if any, affixed by an officer or other person duly authorized to do so by its board of directors.

IN WITNESS WHEREOF, the parties have hereunto set their hands in duplicate on the day and year first written above.

Ronald J. Robinson Jr

Ronald J. Robinson, Jr., Manager

STATE OF OREGON, County of Deschutes) ss.

This instrument was acknowledged before me on June 4th, 2020,

by Ronald J. Robinson, Jr., as Manager of Miller Pit, LLC, an Oregon limited liability company.

Mike Heffernan

Notary Public of Oregon

My commission expires October 16th, 2021

OFFICIAL STAMP
MICHAEL JOSEPH HEFFERNAN
NOTARY PUBLIC-OREGON
COMMISSION NO. 967914
MY COMMISSION EXPIRES OCTOBER 16, 2021

Jason Wick

Jason Wick, President

STATE OF OREGON, County of Deschutes) ss.

This instrument was acknowledged before me on June 4th, 2020,

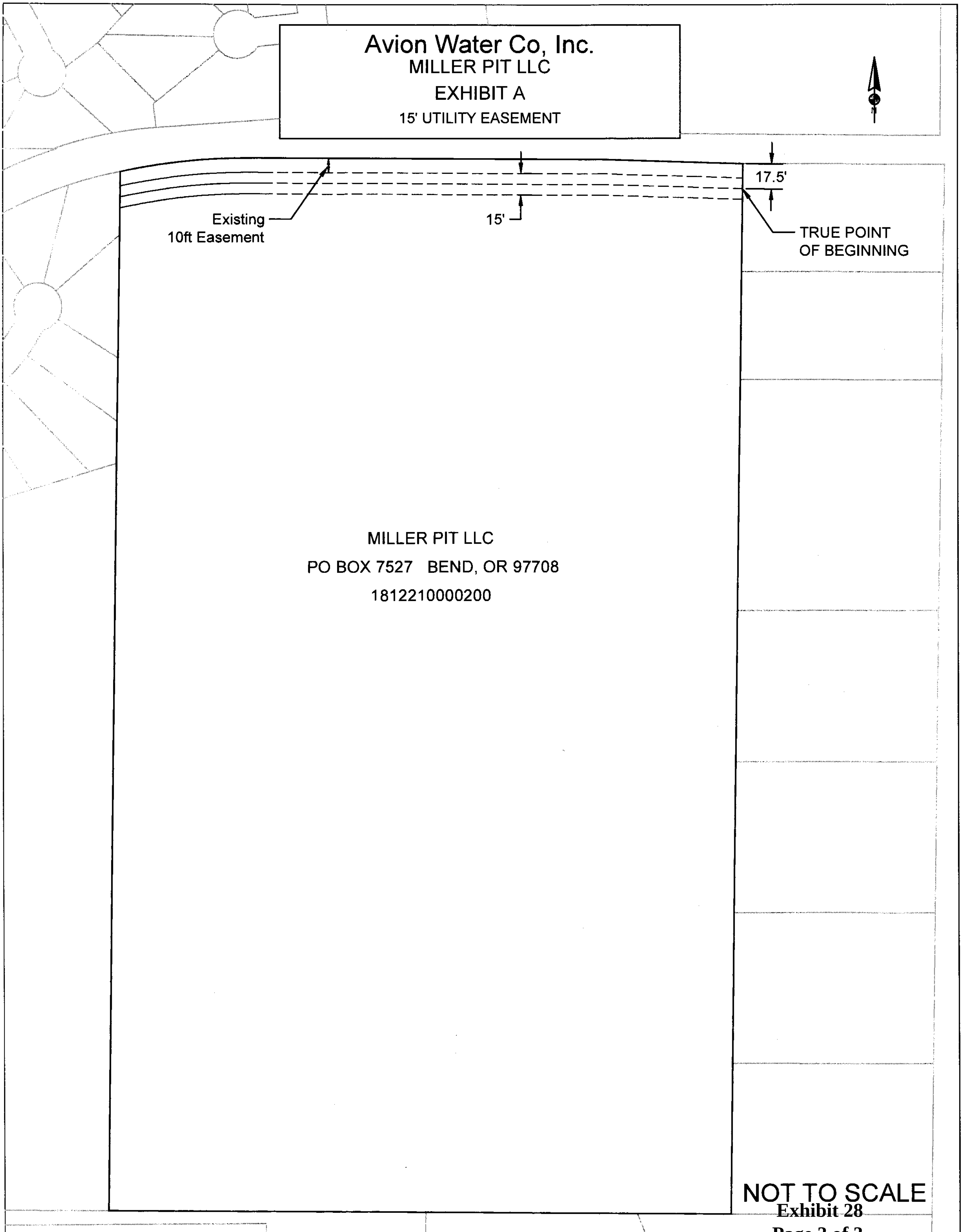
by Jason Wick, as President of Avion Water Company, Inc.

Mike Heffernan

Notary Public of Oregon

My commission expires October 16th, 2021

OFFICIAL STAMP
MICHAEL JOSEPH HEFFERNAN
NOTARY PUBLIC-OREGON
COMMISSION NO. 967914
MY COMMISSION EXPIRES OCTOBER 16, 2021


Avion Water Co, Inc.
MILLER PIT LLC
EXHIBIT A
15' UTILITY EASEMENT
17.5'
Existing 10ft Easement
15'
TRUE POINT OF BEGINNING
MILLER PIT LLC
PO BOX 7527 BEND, OR 97708
1812210000200
NOT TO SCALE

Digital Research Room

771 Results Found Displaying results 1 - 50

Search Criteria: Last Name: Avion Water%

View By: Summary Party Map

Sort By: Document Numbe

More Options

Back | New Search | Previous 50 | Next 50 | Show 500 | **Jump to Result #** | Go

2023-014470 **Date Recorded:** 06/16/2023 12:48 PM **Doc Type:** Easement

DIRECT: RODGERS, BRIAN S **INDIRECT:** AVION WATER COMPNANY INC
DIRECT: RODGERS, CAROLYN G
Twn 17 **Rng** 12 **Sct** 23

2023-014469 **Date Recorded:** 06/16/2023 12:48 PM **Doc Type:** Deed

DIRECT: AVION WATER COMPANY **INDIRECT:** RODGERS, BRIAN S
INDIRECT: RODGERS, CAROLYN G
Twn 17 **Rng** 12 **Sct** 23

2023-014468 **Date Recorded:** 06/16/2023 12:48 PM **Doc Type:** Easement

DIRECT: RODGERS, BRIAN S **INDIRECT:** AVION WATER COMPNANY INC
DIRECT: RODGERS, CAROLYN G
Twn 17 **Rng** 12 **Sct** 23

2023-012451 **Date Recorded:** 05/24/2023 03:52 PM **Doc Type:** Easement
References: 2020-067865 , 2021-023345 , 2021-023985

DIRECT: JACK ROBINSON & SONS INC **INDIRECT:** AVION WATER COMPANY
DIRECT: JCT 97 STORAGE LLC
Twn 16 **Rng** 12 **Sct** 26

2023-009829 **Date Recorded:** 04/27/2023 02:26 PM **Doc Type:** Easement Release
References: 2021-045341

DIRECT: AVION WATER COMPANY INC **INDIRECT:** KOR LAND TRUST

Sub WAYWEST PROPERTIES **Lot** 4

2023-008699 **Date Recorded:** 04/17/2023 08:41 AM **Doc Type:** Easement

DIRECT: PRENTICE, PATRICK **INDIRECT:** AVION WATER COMPANY INC
DIRECT: FINNIGAN, KELLI K

Sub GOLDEN MANTLE **Lot** 7

2023-001662 **Date Recorded:** 01/23/2023 01:34 PM

Doc Type: Instrument Presented by a Political Subdivision - Satisfaction / Release

References: 2021-039169

DIRECT: CITY OF BEND **INDIRECT:** AVION WATER CO INC

2022-042885 **Date Recorded:** 12/09/2022 10:30 AM **Doc Type:** Deed

References: 2020-034352

DIRECT: AVION WATER COMPANY **INDIRECT:** PAHLISCH HOMES AT PETROSA LP

Twn 17 **Rng** 12 **Sct** 23

2022-042884 **Date Recorded:** 12/09/2022 10:30 AM **Doc Type:** Deed

References: 2021-036791

DIRECT: AVION WATER COMPANY **INDIRECT:** PAHLISCH HOMES AT PETROSA LP

Sub PETROSA PHASE 2 **Lot** BB **Sub** PETROSA PHASE 2 **Lot** CC

Sub PETROSA PHASE 2 **Lot** DD

2022-039659 **Date Recorded:** 11/03/2022 08:47 AM **Doc Type:** Easement Release

References: 2005-073106

DIRECT: AVION WATER COMPANY INC **INDIRECT:** VIEW LANE LLC

2022-037084 **Date Recorded:** 10/10/2022 03:57 PM **Doc Type:** Deed

References: 2021-051924

DIRECT: AVION WATER COMPANY INC **INDIRECT:** STATE OF OREGON
INDIRECT: DEPARTMENT OF TRANSPORTATION

Twn 17 **Rng** 12 **Sct** 08

2022-037083 **Date Recorded:** 10/10/2022 03:57 PM **Doc Type:** Deed

DIRECT: AVION WATER COMPANY INC **INDIRECT:** STATE OF OREGON
INDIRECT: DEPARTMENT OF TRANSPORTATION

Twn 17 **Rng** 12 **Sct** 08

Exhibit 29
Page 2 of 8

2022-034248 **Date Recorded:** 09/12/2022 02:03 PM

Doc Type: Deed of Trust / Mortgage-Reconveyance / Release / Satisfaction

References: 2021-032014

DIRECT: WILLIAMS, BRAD L TRUSTEE **INDIRECT:** AVION WATER COMPANY INC

2022-034247 **Date Recorded:** 09/12/2022 02:02 PM

Doc Type: Deed of Trust / Mortgage-Reconveyance / Release / Satisfaction

References: 2021-032015

DIRECT: WILLIAMS, BRAD L TRUSTEE **INDIRECT:** AVION WATER COMPANY INC

2022-033363 **Date Recorded:** 09/02/2022 08:16 AM

Doc Type: Deed of Trust / Mortgage - Modification / Amendment

References: 2013-038023

DIRECT: AVION WATER COMPANY INC **INDIRECT:** FIRST INTERSTATE BANK

2022-031518 **Date Recorded:** 08/17/2022 12:53 PM **Doc Type:** Release of Assignment of Rents

References: 2021-032004

DIRECT: FIRST INTERSTATE BANK **INDIRECT:** AVION WATER COMPANY INC

2022-030875 **Date Recorded:** 08/11/2022 01:32 PM

Doc Type: Deed of Trust / Mortgage-Reconveyance / Release / Satisfaction

References: 2021-032003

DIRECT: WILLIAMS, BRAD L TRUSTEE **INDIRECT:** AVION WATER COMPANY INC

2022-030325 **Date Recorded:** 08/05/2022 11:20 AM **Doc Type:** Easement

DIRECT: BCL LLC **INDIRECT:** AVION WATER COMPANY INC

Sub DALY ESTATES **Lot** 11 **Blk** 1 **Sub** DALEY ESTATES **Lot** 18 **Blk** 1 **Desc** REPLAT OF LOT 14

2022-029458 **Date Recorded:** 07/29/2022 10:02 AM **Doc Type:** Easement Partial Release

References: 1989-014178

DIRECT: AVION WATER CO **INDIRECT:** JOHNSON, KENNETH
INDIRECT: JOHNSON, LINDA

Twn 17 **Rng** 12 **Sct** 23

2022-022570 **Date Recorded:** 06/06/2022 08:17 AM **Doc Type:** Deed of Trust / Mortgage

DIRECT: AVION WATER COMPANY INC **INDIRECT:** FIRST INTERSTATE BANK

Twn 18 **Rng** 12 **Sct** 29

2022-022569 **Date Recorded:** 06/06/2022 08:16 AM **Doc Type:** Deed of Trust / Mortgage

DIRECT: AVION WATER COMPANY INC **INDIRECT:** FIRST INTERSTATE BANK

Twn 18 **Rng** 12 **Sct** 17

2022-016044 **Date Recorded:** 04/18/2022 11:58 AM **Doc Type:** Deed

DIRECT: AVION WATER COMPANY INC **INDIRECT:** KOR COMMUNITY LAND TRUST

Sub WAYWEST PROPERTIES **Lot** 4

2022-009548 **Date Recorded:** 03/08/2022 09:34 AM

Doc Type: Instrument Presented by a Political Subdivision

DIRECT: AVION WATER COMPANY **INDIRECT:** CITY OF BEND
DIRECT: WICK, JASON

Twn 18 **Rng** 12 **Sct** 17

2022-008470 **Date Recorded:** 03/01/2022 08:46 AM

Doc Types: Deed, Agreement / License/Permit - Satisfaction / Release

References: 1976-2410042

Title 1: Deed **DIRECT:** AVION WATER COMPANY INC **INDIRECT:** K&R DEVELOPMENT LLC
DIRECT: AVION WATER COMPANY **INDIRECT:** K&R DEVELOPMENT

Twn 17 **Rng** 12 **Sct** 16 **Twn** 17 **Rng** 12 **Sct** 21

Title 2: Agreement / License/Permit - Satisfaction / Release **DIRECT:** AVION WATER COMPANY INC
DIRECT: AVION WATER COMPANY
INDIRECT: K&R DEVELOPMENT LLC
INDIRECT: K&R DEVELOPMENT

Twn 17 **Rng** 12 **Sct** 16 **Twn** 17 **Rng** 12 **Sct** 21

2021-071082 **Date Recorded:** 12/28/2021 03:46 PM **Doc Type:** Easement Release

References: 1977-2450658 , 1977-2450660 , 2021-039557

DIRECT: AVION WATER COMPANY INC **INDIRECT:** RHINE SPENCER LLC

2021-063143 **Date Recorded:** 11/10/2021 08:31 AM **Doc Type:** Easement Release

References: 1981-3350889

DIRECT: AVION WATER COMPANY INC **INDIRECT:** MICHAEL TORVIK

2021-052739 **Date Recorded:** 09/14/2021 10:28 AM **Doc Type:** Easement

DIRECT: AVION WATER COMPANY INC **INDIRECT:** PACIFRICORP

Twn 18 **Rng** 12 **Sct** 17

2021-051924 **Date Recorded:** 09/09/2021 12:14 PM **Doc Type:** Easement

DIRECT: AVION WATER COMPANY INC **INDIRECT:** AVION WATER COMPANY INC

Sub SUNSET WEST SUBDIVISION FIRST ADDITION **Lot** 1 **Blk** 5

2021-048740 **Date Recorded:** 08/23/2021 08:15 AM

Doc Types: Appointment/Substitution of Successor Trustee, Deed of Trust / Mortgage-Reconveyance / Release / Satisfaction

References: 2019-010616

Title 1: Appointment/Substitution of Successor Trustee **DIRECT:** FIRST INTERSTATE BANK
INDIRECT: WILLIAMS, BRAD L TRUSTEE

Title 2: Deed of Trust / Mortgage-Reconveyance / Release / Satisfaction **DIRECT:** WILLIAMS, BRAD L TRUSTEE
INDIRECT: AVION WATER COMPANY INC

2021-046990 **Date Recorded:** 08/12/2021 11:20 AM **Doc Type:** Deed of Trust / Mortgage

References: 2021-032015

DIRECT: AVION WATER COMPANY INC **INDIRECT:** FIRST INTERSTATE BANK

Twn 18 **Rng** 12 **Sct** 17

2021-046989 **Date Recorded:** 08/12/2021 11:20 AM **Doc Type:** Assignment of Rents

References: 2021-032004

DIRECT: AVION WATER COMPANY INC **INDIRECT:** FIRST INTERSTATE BANK

Twn 18 **Rng** 12 **Sct** 17

2021-046988 **Date Recorded:** 08/12/2021 11:20 AM **Doc Type:** Deed of Trust / Mortgage

References: 2021-032003

DIRECT: AVION WATER COMPANY INC **INDIRECT:** FIRST INTERSTATE BANK

Twn 18 **Rng** 12 **Sct** 17

2021-045341 **Date Recorded:** 08/03/2021 02:27 PM **Doc Type:** Easement

DIRECT: AVION WATER COMPANY **INDIRECT:** AVION WATER COMPANY

Sub WAYWEST PROPERTIES **Lot** 4

2021-043139 **Date Recorded:** 07/22/2021 09:32 AM **Doc Type:** Easement

DIRECT: STILLWATER HOUSING ASSOCIATES LIMITED PARTNERSHIP **INDIRECT:** AVION WATER COMPANY INC

Twn 18 **Rng** 12 **Sct** 17 **Twn** 18 **Rng** 12 **Sct** 18

Exhibit 29
Page 5 of 8

2021-040541 **Date Recorded:** 07/08/2021 08:40 AM

Doc Types: Appointment/Substitution of Successor Trustee, Deed of Trust / Mortgage-Reconveyance / Release / Satisfaction

References: 2013-037932

Title 1: Appointment/Substitution of Successor Trustee **DIRECT:** FIRST INTERSTATE BANK SUCCESSOR IN INTEREST **DIRECT:** HOME FEDERAL BANK

INDIRECT: WILLIAMS, BRAD L TRUSTEE

Title 2: Deed of Trust / Mortgage-Reconveyance / Release / Satisfaction **DIRECT:** WILLIAMS, BRAD L TRUSTEE

INDIRECT: AVION WATER COMPANY INC

2021-040409 **Date Recorded:** 07/07/2021 01:47 PM **Doc Type:** Easement

DIRECT: WILLAMETTE GRAYSTONE LLC **INDIRECT:** AVION WATER COMPANY INC

Twn 16 **Rng** 12 **Sct** 26

2021-039169 **Date Recorded:** 06/30/2021 08:26 AM

Doc Type: Instrument Presented by a Political Subdivision

DIRECT: AVION WATER CO INC **INDIRECT:** CITY OF BEND

Twn 18 **Rng** 12 **Sct** 17

2021-037574 **Date Recorded:** 06/23/2021 12:22 PM **Doc Type:** Easement

DIRECT: THREE SISTERS HOLDINGS LLC **INDIRECT:** AVION WATER COMPANY INC

DIRECT: RHINE FAMILY VENTURES LLC

Twn 18 **Rng** 12 **Sct** 10 **Sub** VINTAGE FAIRE **Lot** 1 **Blk** 3 **Desc** BEGINNING AT

2021-032015 **Date Recorded:** 05/25/2021 01:07 PM **Doc Type:** Deed of Trust / Mortgage

DIRECT: AVION WATER COMPANY INC **INDIRECT:** FIRST INTERSTATE BANK

Twn 18 **Rng** 12 **Sct** 17

2021-032014 **Date Recorded:** 05/25/2021 01:07 PM **Doc Type:** Deed of Trust / Mortgage

DIRECT: AVION WATER COMPANY INC **INDIRECT:** FIRST INTERSTATE BANK

Twn 18 **Rng** 12 **Sct** 29

2021-032003 **Date Recorded:** 05/25/2021 12:37 PM **Doc Type:** Deed of Trust / Mortgage

DIRECT: AVION WATER COMPANY INC **INDIRECT:** FIRST INTERSTATE BANK

Twn 18 **Rng** 12 **Sct** 17

2021-028705 **Date Recorded:** 05/07/2021 11:39 AM **Doc Type:** Deed

DIRECT: AVION WATER COMPANY INC **INDIRECT:** AVION WATER COMPANY INC

Twn 18 **Rng** 12 **Sct** 17 **Twn** 18 **Rng** 12 **Sct** 20

2021-028704 **Date Recorded:** 05/07/2021 11:39 AM **Doc Type:** Deed

DIRECT: AVION WATATT COMPANY INC **INDIRECT:** AVION WATER COMPANY INC

Twn 18 **Rng** 12 **Sct** 17

2021-028703 **Date Recorded:** 05/07/2021 11:39 AM **Doc Type:** Deed

DIRECT: AVION WATER COMPANY INC **INDIRECT:** AVION WATER COMPANY INC

Twn 18 **Rng** 12 **Sct** 17

2021-022093 **Date Recorded:** 04/08/2021 11:33 AM **Doc Type:** Deed of Dedication

DIRECT: AVION WATER COMPANY **INDIRECT:** CITY OF BEND

Twn 18 **Rng** 12 **Sct** 17 **Twn** 18 **Rng** 12 **Sct** 20

2021-016411 **Date Recorded:** 03/15/2021 02:05 PM **Doc Type:** Easement

DIRECT: WILD RIVER ASSOC INC **INDIRECT:** AVION WATER COMPANY INC

Sub WILD RIVER PHASE I **Desc** ALL COMMON LAND

2021-009201 **Date Recorded:** 02/11/2021 02:20 PM **Doc Type:** Easement

DIRECT: SUNSET VIEW ESTATES HOMEOWNERS ASSOC INC **INDIRECT:** AVION WATER COMPANCY INC

Twn 18 **Rng** 12 **Sct** 29

2021-009200 **Date Recorded:** 02/11/2021 02:19 PM **Doc Type:** Easement

DIRECT: JOHNSON, MITCHELL B **INDIRECT:** AVION WATER COMPANCY INC
DIRECT: HIRSCH-JOHNSON, CONSTANCE M

Twn 17 **Rng** 13 **Sct** 31

2021-005963 **Date Recorded:** 01/28/2021 01:38 PM **Doc Type:** Deed

DIRECT: AVION WATER COMPANY INC **INDIRECT:** PAHLISCH HOMES AT PETROSA LIMITED PARTNERSHIP

Twn 17 **Rng** 12 **Sct** 23

2020-062403 **Date Recorded:** 11/19/2020 01:36 PM **Doc Type:** Easement

DIRECT: ADMINISTRATIVE SCHOOL DISTRICT **INDIRECT:** AVION WATER COMPANY INC

Twn 18 **Rng** 12 **Sct** 16

View By: ◉ **Summary** ○ **Party** ○ **Map**

Sort By: Document Numbe

More Options

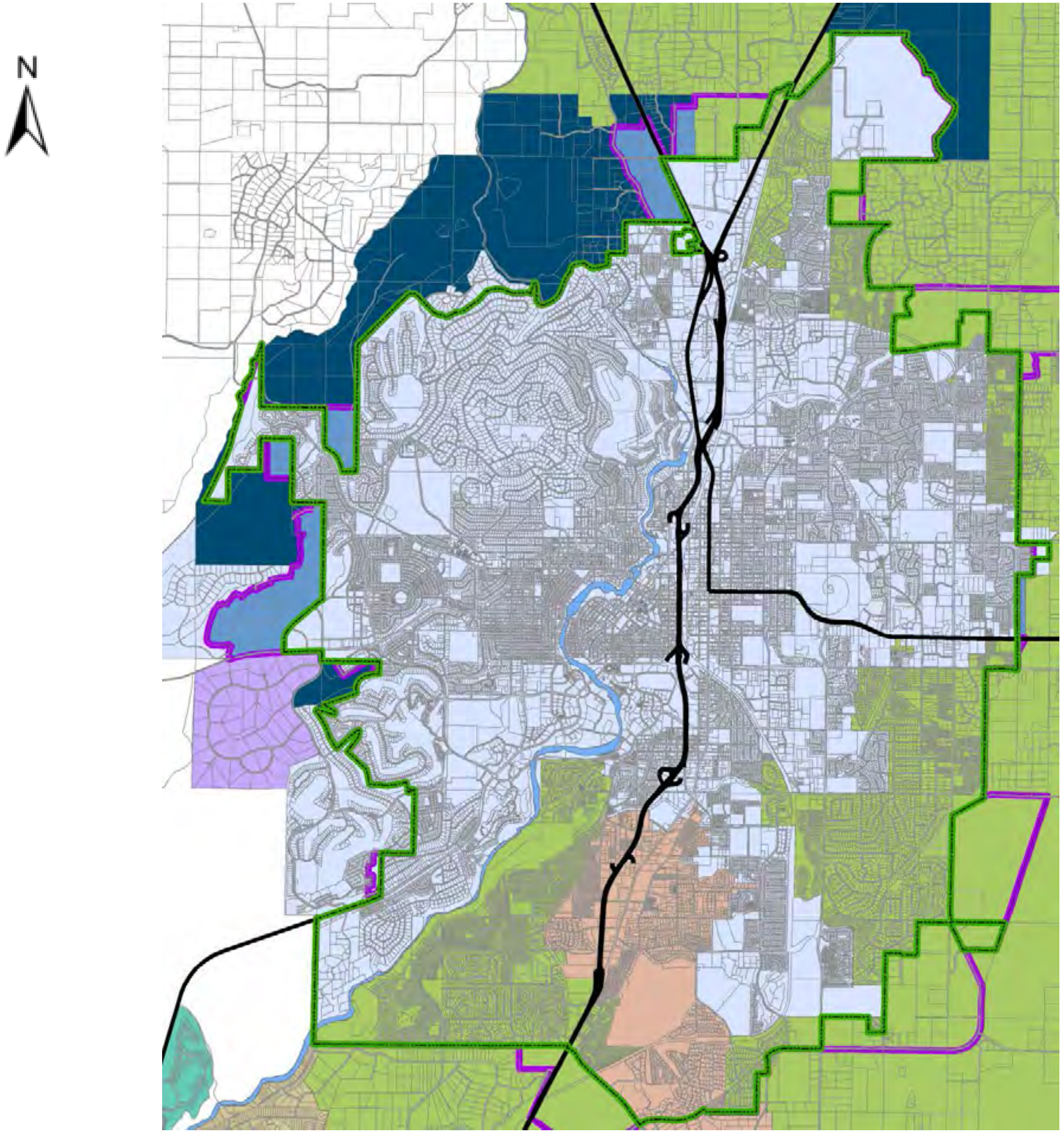
Exhibit 29
Page 7 of 8

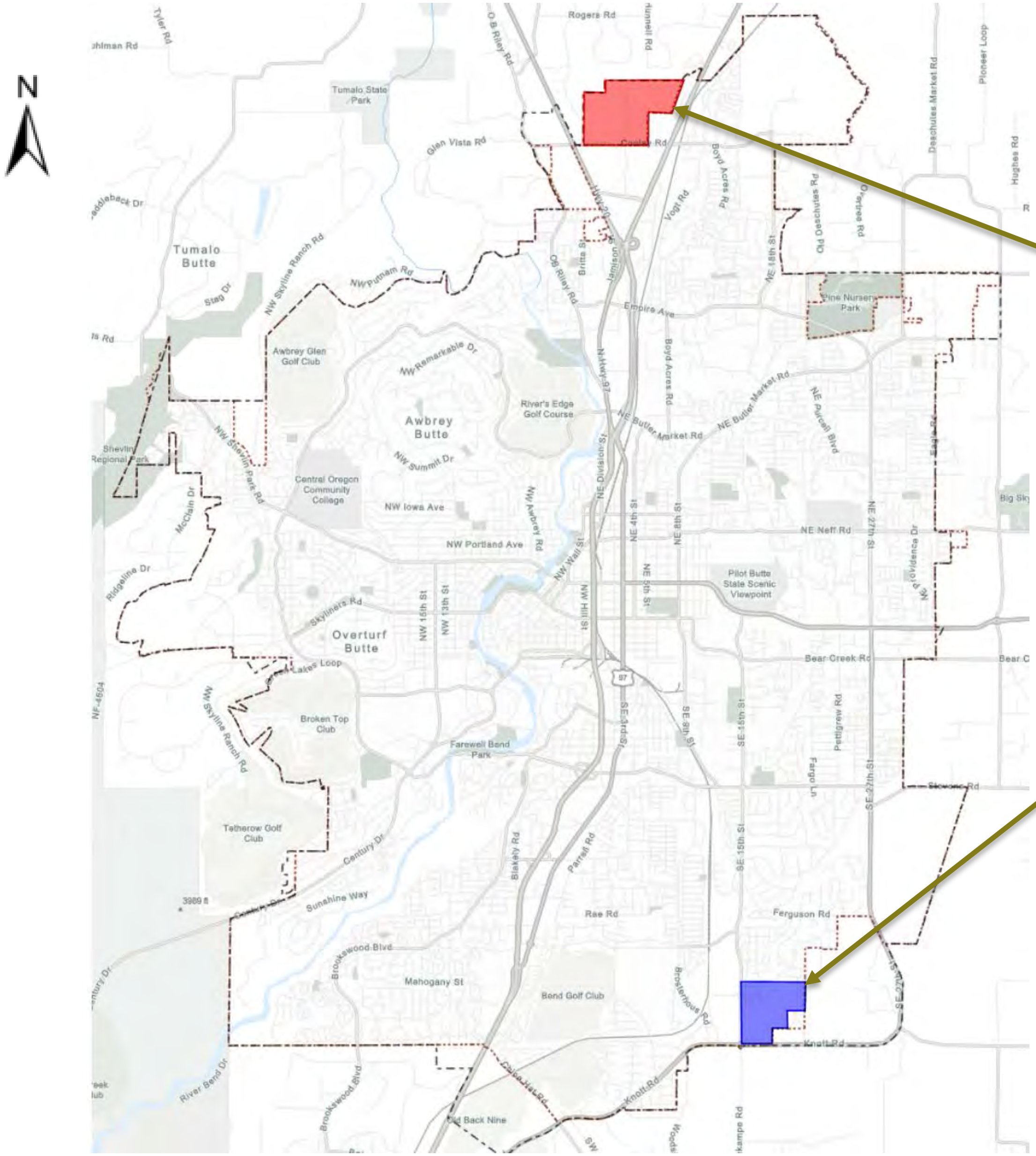
Back New Search Previous 50 Next 50 Show 500 **Jump to Result #** Go

AVION SERVICE AREA ADJUSTMENT

AUGUST 3, 2022

WATER SERVICE AREAS





AFFECTED SERVICE AREAS

North Triangle Expansion Area

Avion service area

- Limited capacity to serve
- Stalled development

Easton Master Plan Area

City of Bend service area

- Boundary of service area
- Under construction

City of Bend

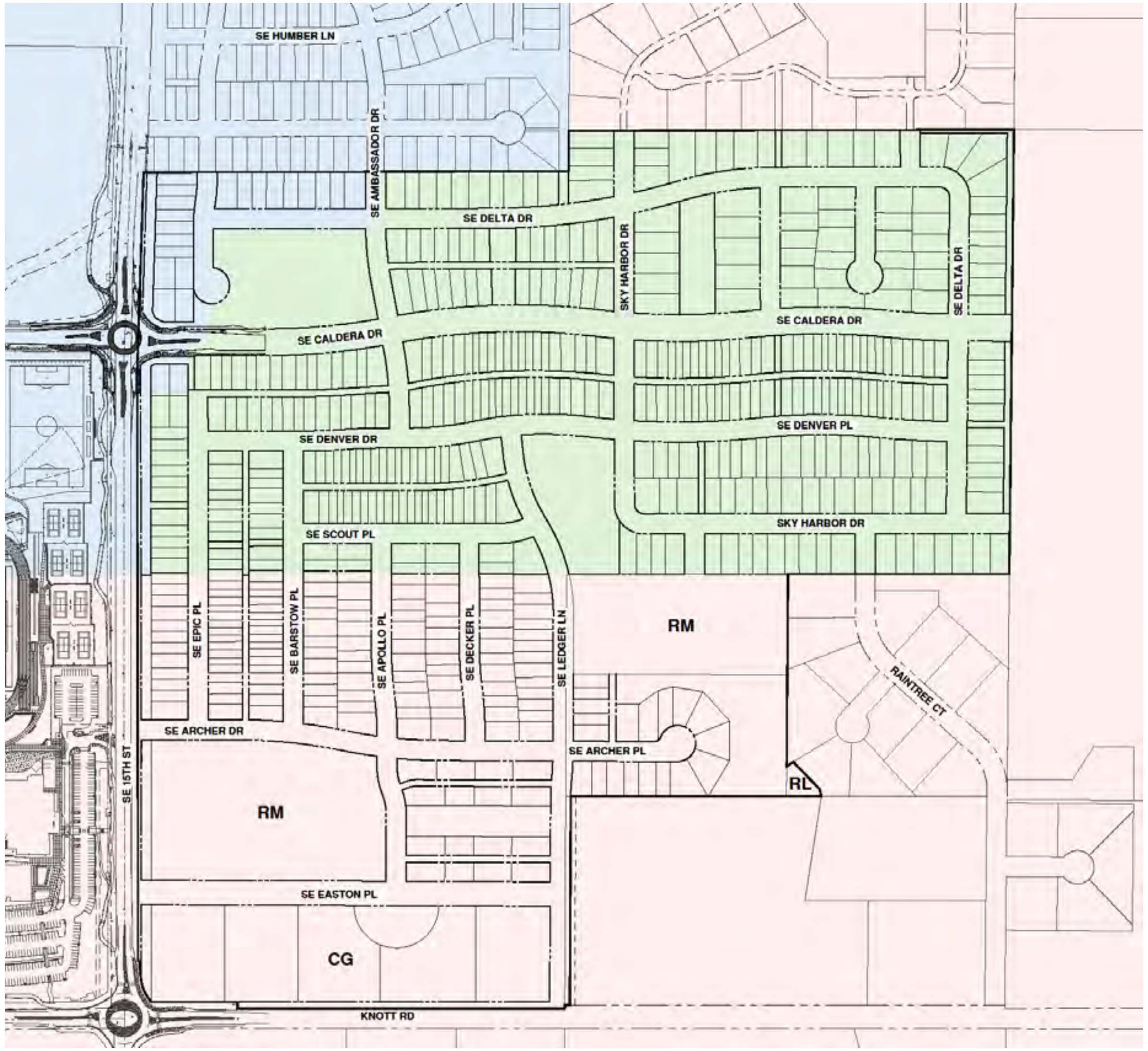
- Receiving Avion service area in North Triangle Expansion Area.

Avion Water Company

- Receiving City of Bend service area in the Easton Master Plan.

Zoning Changes			
Zoning	Unit	Bend	Avion
Residential Standard (RS) and Medium (RM) Density	Dwellings	-47	47
Mixed Employment (ME)	Acres	20.3	-20.3
Commercial Limited (CL)	Acres	6.8	-6.8
Commercial General (CG)	Acres	21.8	-21.8
Light Industrial (IL)	Acres	0	0

SERVICE AREA MAP UPDATE: EASTON

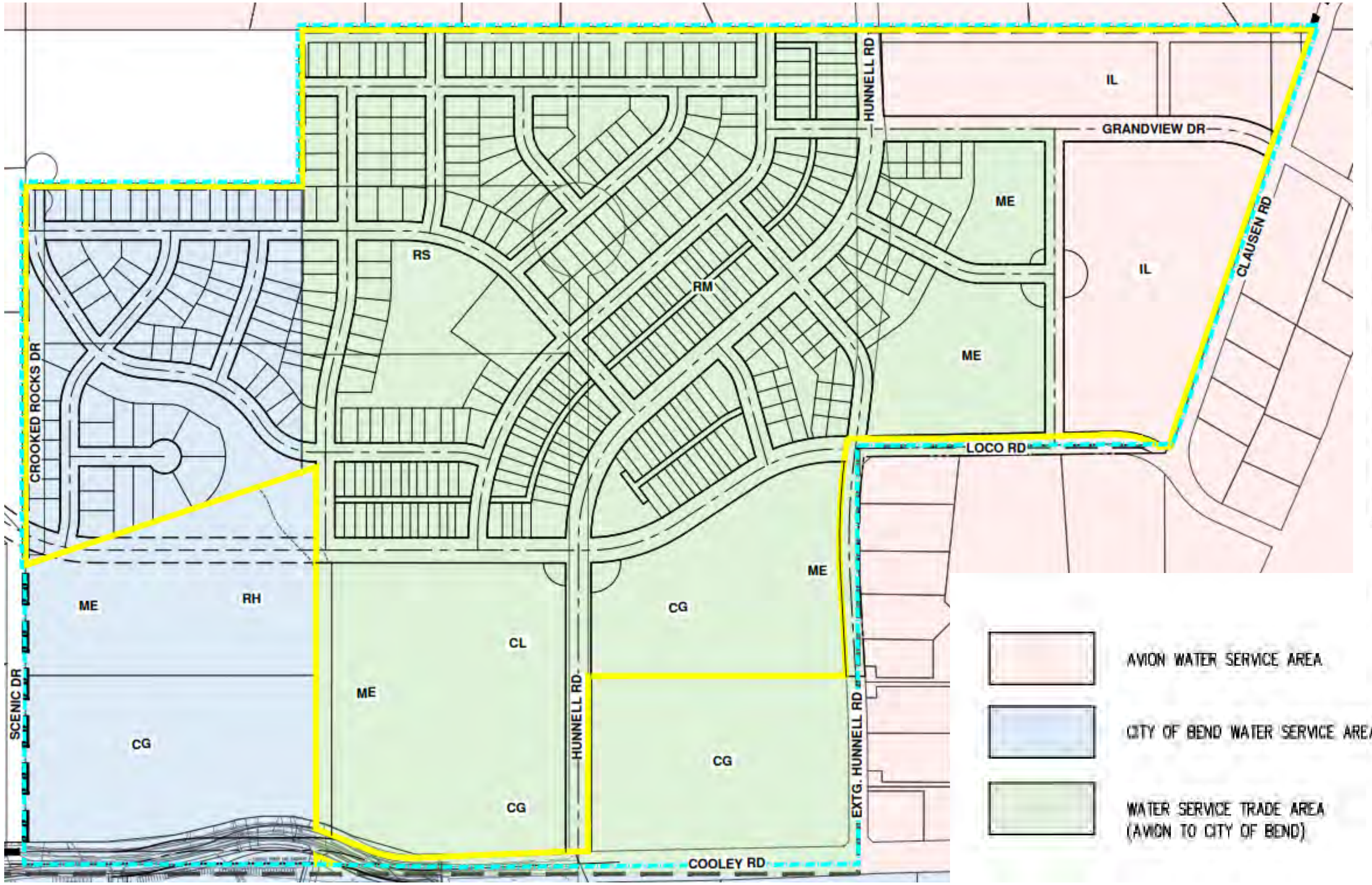


WATER SERVICE AREA COUNT				
	PRIOR TO TRADE		AFTER TRADE	
ZONES	CITY OF BEND	AVION	CITY OF BEND	AVION
RESIDENTIAL LOW DENSITY (RL) ACRES	–	0.2	–	0.2
RESIDENTIAL STANDARD DENSITY (RS) UNITS	416	138	22	532
RESIDENTIAL MEDIUM DENSITY (RM) ACRES	–	17.6	–	17.6
COMMERCIAL GENERAL (CG) ACRES	–	10.1	–	10.1

LEGEND

- AVION WATER SERVICE AREA
- CITY OF BEND WATER SERVICE AREA
- WATER SERVICE TRADE AREA (CITY OF BEND TO AVION)

SERVICE AREA MAP UPDATE: NORTH TRIANGLE



WATER SERVICE UNIT/AREA COUNT (WITHIN EXPANSION AREA)				
	PRIOR TO TRADE		AFTER TRADE	
ZONES	CITY OF BEND	AVION	CITY OF BEND	AVION
RESIDENTIAL (RS & RM) (UNITS)	69	347	416	-
HIGH DENSITY RESIDENTIAL (RH) ACRES	5	-	5	-
MIXED EMPLOYMENT (ME) (ACRES)	5.7	20.3	26	-
COMMERCIAL LIMITED (CL) (ACRES)	-	6.8	6.8	-
COMMERCIAL GENERAL (CG) (ACRES)	11.4	21.8	33.2	-
LIGHT INDUSTRIAL (IL) (ACRES)	-	21.5	-	21.5

LEGEND

- AVION WATER SERVICE AREA
- CITY OF BEND WATER SERVICE AREA
- WATER SERVICE TRADE AREA (AVION TO CITY OF BEND)
- MASTER PLAN BOUNDARY
- NORTH TRIANGLE EXPANSION AREA BOUNDARY
- URBAN GROWTH BOUNDARY
- CITY LIMITS

Prevent need for Avion to construct major assets in the North Triangle Expansion area.

- Avion infrastructure needs
- City services can allow connections

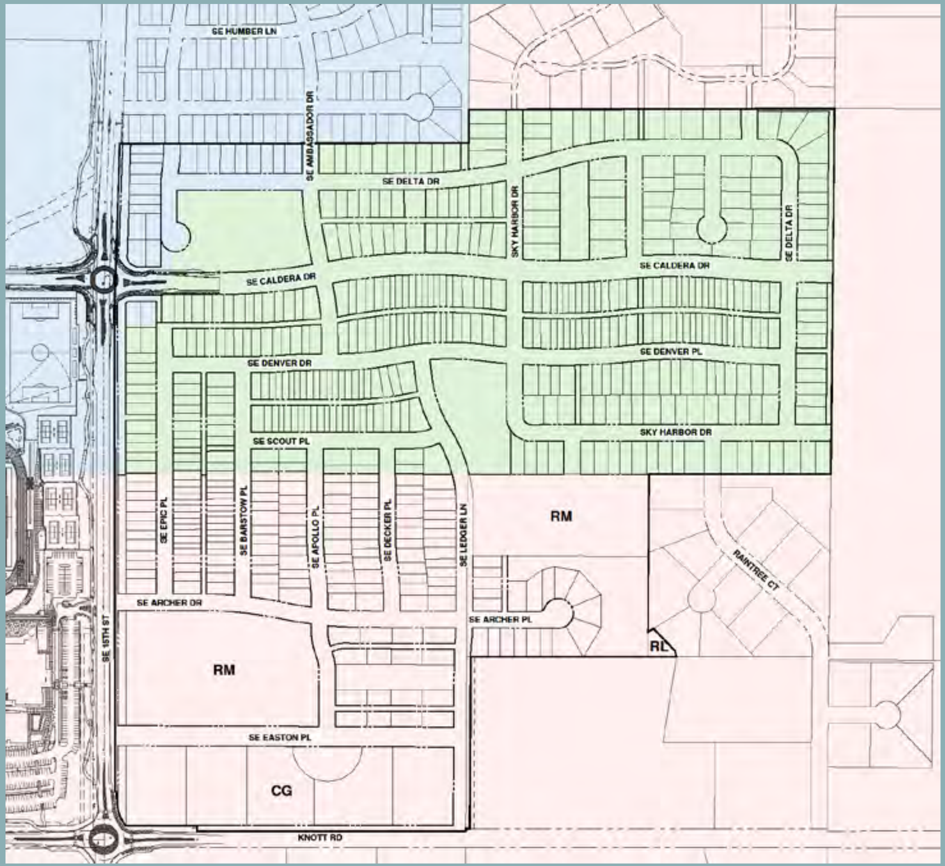
Promote development in the North Triangle Expansion area.

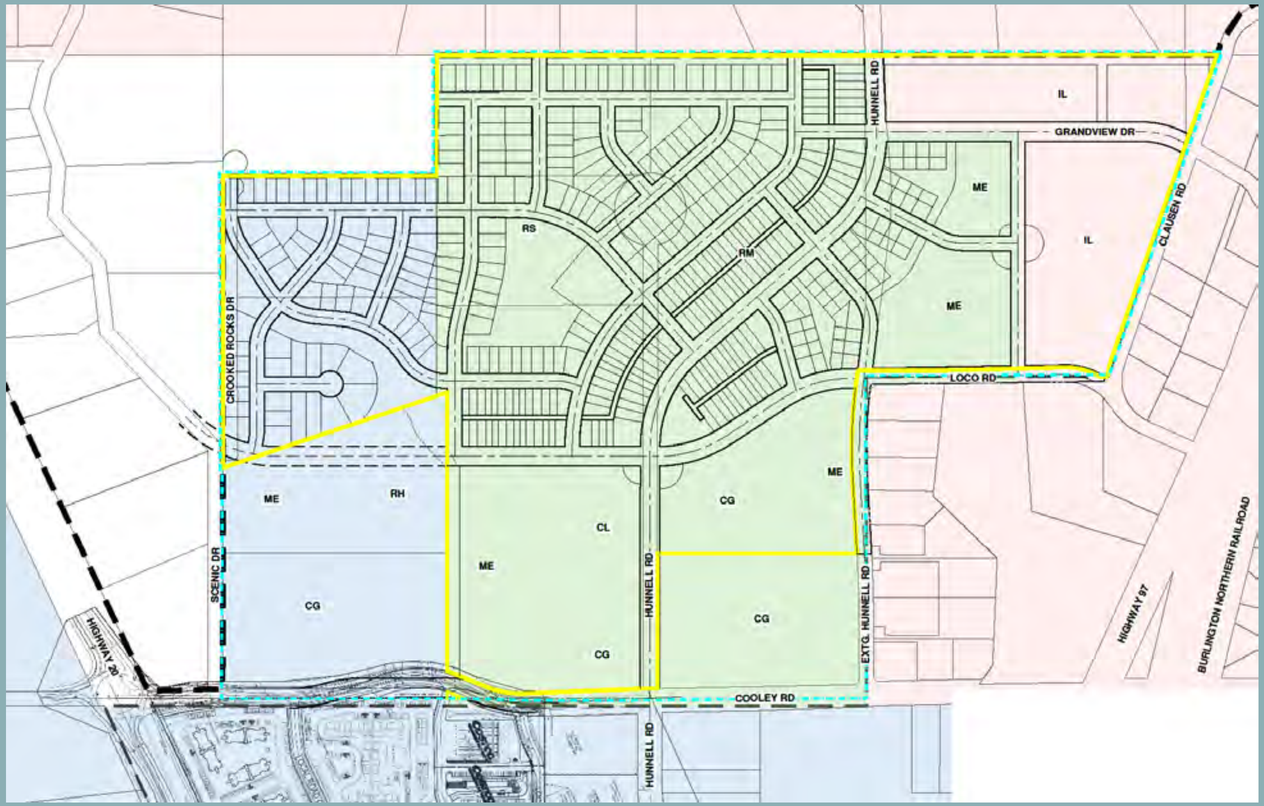
- Development is stalled
- Service area adjustment will expedite development
- Achieve Council goals

Improve water systems for both service areas.

- City fire pressure concerns
- Additional systems loops
- Infrastructure cost savings

QUESTIONS


SE HUMBER LN
SE AMBASSADOR DR
SE DELTA DR
SKY HARBOR DR
SE CALDERA DR
SE DENVER DR
SE DENVER PL
SKY HARBOR DR
SE SCOUT PL
SE EPIC PL
SE BARSTOW PL
SE APOLLO PL
SE DECKER PL
SE LEDGER LN
RM
RAINTREE CT
SE ARCHER DR
SE ARCHER PL
RL
SE 15TH ST
RM
SE EASTON PL
CG
KNOTT RD


HUNNELL RD
IL
GRANDVIEW DR
ME
RS
IL
RM
CLAUSEN RD
ME
CROOKED ROCKS DR
LOCO RD
ME
ME
RH
CG
CL
ME
SCENIC DR
HUNNELL RD
CG
CG
CG
EXTG. HUNNELL RD
HIGHWAY 97
BURLINGTON NORTHERN RAILROAD
HIGHWAY 20
COOLEY RD
HUNNELL RD

WATER SERVICE AGREEMENT

THIS AGREEMENT is made this ____ day of ______________, 2008 by and between AVION WATER COMPANY, INC., an Oregon corporation ("Avion") and the CITY OF BEND, a municipality of the State of Oregon ("City").

RECITALS:

A. Avion is a private water company, regulated by the Oregon Public Utility Commission ("PUC") and the Oregon Health Division, with vested groundwater rights under permits issued by the Oregon Water Resources Department ("OWRD"). Avion provides both domestic and irrigation water in Crook and Deschutes Counties, Oregon.

B. City is a municipality of the State of Oregon and owns a municipal airport known as the "Bend Airport" in Bend, Deschutes County, Oregon.

AGREEMENT:

NOW THEREFORE, Avion hereby agrees to provide water service to the City and its Bend Municipal Airport and the City agrees to fund construction of the water systems and any necessary improvements and pay all appropriate fees for the water service as follows:

1. <u>Water Service Commitment; Required Water Pressure</u>. Avion shall provide domestic water, commercial water, water for dust control, fire protection, restoration, construction, landscaping, and limited irrigation water and other uses typical and usual for a municipality to the Bend Municipal Airport.

1.1 All water service fees shall be charged at a rate equal to 73% of the prevailing commodity rate otherwise allowed by the Avion Water Company Tariff, as the same may be modified from time to time. Avion shall provide a copy of the Tariff within ten

(10) days of written request by any party to this Agreement. The City will reciprocate by selling Avion water at 73% of its commodity rate if the need arises at a future date.

1.2 The water service shall be provided at a minimum of 1,000 gallons per minute.

Commented [Jim Forbes1]: Bob, Jason says we already have fire flows at the airport. Tom, is that accurate?

2. Water System Improvements. The Water System Improvements to be constructed by Avion shall include, but not be limited to, the following:

2.1 Based upon preliminary engineering and design calculations, Avion shall construct an extension of a water transmission main from an existing main line to the City's Municipal Airport (the "Transmission Main") as follows:

2.1.1 The Transmission Main shall be a twelve inch (12") diameter PVC pipe, approximately 7,000 feet in length;

Commented [Jim Forbes2]: Bob, Jason contends this doesn't violate city standards/specs

2.1.2 Avion shall install the Transmission Main within the following approximate route: See Exhibit "A", which is attached hereto and incorporated herein by reference. At this juncture, the Transmission Main shall end and terminate and the water distribution lines for the City's Municipal Airport shall begin.

2.1.3 The estimated cost of the Transmission Main is attached hereto as Exhibit "B" and incorporated herein by reference. It is the intent of the parties that the City will not be obligated to pay more than the actual cost of construction of the water transmission line.

3. Systems Development Charges; Reimbursement Area; Service Connection Fees. Avion shall waive all systems development charges ("SDCs"), as defined in OAR 860-036-0010(27), for the City's Municipal Airport.

4. Initiation of Construction of Water Supply Improvements. Within twenty (20) days of the date of PUC approval of this Agreement, Avion shall initiate construction of the Water Transmission Main.

5. City's Financial Responsibilities for Water System Improvements. City shall pay the entire cost of construction and installation of the Water Transmission Main. City shall make an initial payment of $~~160,887~~148,411 for materials, within ten (10) days of receipt of invoice. Once Avion commences construction of the Water Transmission Main, Avion shall transmit a written invoice to City on a monthly basis for the cost of the portion of the Water Transmission Main completed during the subject month. The invoice shall include a detailed description of the work completed during the subject month. Following inspection and approval of the completed work by a professional engineer chosen by City, City shall pay the subject invoices, minus a retention of five percent (5%) labor costs, within thirty (30) days of receipt of the invoice to ensure continuation of construction of the Water Transmission Main by Avion. The total price for the project is not to exceed $~~414,000.00~~415,292 unless excavation conditions merit an increase. City shall have the right in reasonable notice to inspect and audit Avion's costs for constructing this water transmission main.

6. Avion's Representations and Warranties. Avion makes the following representations and warranties, with full knowledge that the City is entering into this Agreement in reliance upon these representations and warranties:

6.1 Avion has obtained or will obtain, prior to completion of construction of the Water System Improvements, all permits or other governmental approvals necessary to carry out its obligations hereunder.

6.2 All water provided pursuant to this Agreement for domestic and commercial use shall be potable and shall meet all applicable standards for drinking water established by federal, state and local government authorities.

6.3 Avion will maintain and repair all Water System Improvements constructed pursuant to this Agreement in good and operable condition.

7. Miscellaneous.

7.1 Insurance. At all times, Avion shall maintain commercial general liability insurance, naming the city as an additional insured. ~~in commercially reasonable amounts~~The insurance policy limits shall be not less than $1,000,000 per occurrence and $2,000,000 aggregate, covering construction of all improvements under this Agreement and all operations. Such insurance shall cover all risks arising out of Avion's construction, maintenance and operation of such improvements, and Avion's provision of services under this Agreement.

7.2 Further Assurances. The parties hereto agree to cooperate with each other in good faith to effect the purposes of this Agreement, including by executing such further instruments as may be reasonably necessary.

7.3 Entire Agreement. Except as expressly provided herein, this Agreement constitutes the entire understanding and agreement of the parties with respect to the subject matter of this Agreement.

7.4 Arbitration. If any dispute arises between the parties, any party may request arbitration in accordance with the rules established by the Arbitration Service of Portland, in Portland, Oregon. The arbitration shall proceed according to the rules of the Arbitration Service of Portland, and the Oregon statutes governing arbitration, and the award of the arbitrator shall have the effect therein provided. The arbitration shall take place in Deschutes County, Oregon. Costs of the arbitration shall be shared equally by the parties, but each party shall pay its own attorney's fees incurred in connection with the arbitration.

7.5 Legal Action. In the event suit or action is instituted to enforce any of the terms of this Agreement, including arbitration, the losing party shall pay to the prevailing party, in addition to costs and disbursements allowed by law, such sum as the court may adjudge reasonable as attorney fees in such suit or action, at both the trial and appellate courts.

7.6 Heirs, Successors and Assigns. Each and all of the covenants, terms, provisions and agreements herein contained shall be binding upon and inure to the benefit of the parties hereto and, to the extent permitted by this Agreement, their respective heirs, legal representatives, successors and assigns.

7.7 Assignment. This Agreement may not be assigned or otherwise transferred without the prior written consent of each party. Said consent shall not be unreasonably withheld, conditioned or delayed.

7.8 Waivers and Consents; Amendment. No waivers of any provision of this Agreement or consents to action under this Agreement shall be effective unless in writing signed by the party to be bound. This Agreement may not be modified or amended except by the written agreement of the parties. Failure of any party at any time to require performance of any provision of this Agreement shall not limit such party's right to enforce such provision, nor shall any waiver of any breach of any provision of this Agreement constitute a waiver of any succeeding breach of such provision or a waiver of such provision itself.

7.9 Notices. Any notice, demand or communication required or permitted to be given by any provision of this Agreement shall be deemed to have been sufficiently given or served for all purposes if delivered personally to the party or, if sent by registered or certified mail, postage and charges prepaid, addressed to the party's address, as shown below. Except as otherwise provided herein, any such notice shall be deemed to be given two (2) business days after the date on which the same was deposited in the United States mails, addressed as aforesaid.

7.10 Indemnification and Hold Harmless. Avion shall be responsible for any and all injury to any and all persons or property caused directly or indirectly by reason of any and all activities by Avion in the performance of this Agreement. Avion further agrees to indemnify, save harmless and defend City, its officers, agents and employees from and against all claims, suits, actions, damages, costs, losses and expenses in any manner resulting from, arising out of, or connected with any such injury.

7.11 Non-Discrimination. Avion agrees that no person shall, on the grounds of race, color, creed, national origin, sex, marital status, or age, suffer discrimination in the performance of this Agreement when employed by Avion. Avion agrees that comply with Title VI of the Civil Rights Act of 1964, with Section V of the Rehabilitation Act of 1973, and with all applicable requirements of federal and state devil rights and rehabilitation statues, rules and regulations. Additionally, each party shall comply with the Americans with Disabilities Act of 1990, ORS 659.425 and all regulations and administrative rules established pursuant to those laws.

7.12 Franchise Agreement. Except as specifically provided herein to the contrary, all provisions of Avion's Franchise Agreement with the City shall apply to this Agreement.

IN WITNESS WHEREOF, this Agreement was executed on the ____ day of ______________________, 2008.

AVION WATER COMPANY, INC.	CITY OF BEND
By: _______________________________ Its: _______________________________	By: _____________________________ Its: _____________________________

Address for Notices:

60813 Parrell Rd. Bend, OR 97702	c/o Public Works Dept. 575 NE 15th St. Bend, OR 97701

Exhibits:

Exhibit "A" - Transmission Main Route
Exhibit "B" - Estimated Cost of Water Transmission Line

Oregon Public Utility Commission

e-FILING REPORT COVER SHEET

COMPANY NAME: Avion Water Company, Inc.

DOES REPORT CONTAIN CONFIDENTIAL INFORMATION? ☒ No ☐ Yes If yes, submit a redacted public version (or a cover letter) by email. Submit the confidential information as directed in OAR 860-001-0070 or the terms of an applicable protective order.

Select report type: ☐ RE (Electric) ☐ RG (Gas) ☒ RW (Water) ☐ RT (Telecommunications)
☐ RO (Other, for example, industry safety information)

Did you previously file a similar report? ☒ No ☐ Yes, report docket number:

Report is required by: ☐ OAR
☒ Statute 757.125 and 757.135
☐ Order
Note: A one-time submission required by an order is a compliance filing and not a report (file compliance in the applicable docket)
☐ Other
(For example, federal regulations, or requested by Staff)

Is this report associated with a specific docket/case? ☒ No ☐ Yes, docket number:

List Key Words for this report. We use these to improve search results.

Send the completed Cover Sheet and the Report in an email addressed to PUC.FilingCenter@puc.oregon.gov

Send confidential information, voluminous reports, or energy utility Results of Operations Reports to PUC Filing Center, PO Box 1088, Salem, OR 97308-1088 or by delivery service to 201 High Street SE Suite 100, Salem, OR 97301.

Print

ANNUAL RESULTS OF OPERATIONS REPORT

COMPANY SIZE (based on Annual Revenue)

Class A Water Utility
(Annual Gross Revenue of $1,000,000 or more)

FOR THE CALENDAR YEAR

2022

COMPANY NAME

Avion Water Company, Inc.

OREGON PUBLIC UTILITY COMMISSION
PO BOX 1088
SALEM OR 97308-1088

FM763 - revised 12/22/2021

Avion Water Company, Inc.

The Annual Results of Operations Report, required by the Public Utility Commission (PUC or Commission) under the authority of the Oregon Revised Statutes (ORS) 757.125 and 757.135, is based on the utility's operations for a calendar or fiscal year and is a convenient method for the Commission's staff to monitor the utility's results of operations. It must be filed electronically with the PUC on or before April 1st of the year following that for which the report is made. Attach the completed report in Excel ONLY with formulae intact and any supplementary pages to an email addressed to the following address: puc.filingcenter@puc.oregon.gov

- Interpret all accounting words and phrases in accordance with the USOA.

- Special or unusual entries and all discrepancies must be fully explained. Describe fully any unusual entries and discrepancies in a narrative explanation in the tab titled "Notes."

- If the utility has filed, or intends to file, a separate rate schedule in its tariff for non-contiguous portions of its water system, separate accounting for Operating Revenues, Operating Expense, Plant Investments, and related Reserve for Depreciation must be maintained by the utility for each portion of the water system relating to each separate rate schedule. This annual report, however, should include the combined financial data for the utility.

- Each incorporated utility is requested to file with this report a copy of its most recent annual report to stockholders, if one is prepared.

- All schedules that call for the balance at the beginning of the year should reflect the same end of year balance **exactly** as shown in the prior year's annual report. Any adjustments to the ending balances shown in the report for the previous year should be reflected in the current year's activity and reported along with an explanation in the annual report.

FOR QUESTIONS CONTACT RUSS BEITZEL AT 971-209-0533 OR EMAIL AT RUSSELL.BEITZEL@PUC.OREGON.GOV

Avion Water Company, Inc.

Complete Address of Reporting Utility

Line 1:	60813 Parrell Road
Line 2:	
City:	Bend
State:	OR
Zip:	97702
phone:	(541) 382-5342
email:	rick@avionwater.com
fax:	(541) 382-5390
website:	www.avionwater.com

Name and title of person responsible for report

Name:	Richard C. Bailey
Title:	Secretary-Treasurer
Phone:	(541) 382-5342
Email:	rick@avionwater.com

Oath & Signature

THIS REPORT, INCLUDING ANY ACCOMPANYING SCHEDULES AND STATEMENTS, HAS BEEN EXAMINED BY ME, AND TO THE BEST OF MY KNOWLEDGE AND BELIEF, IS TRUE, CORRECT AND COMPLETE.

☑ By clicking this box I affirm the above statement.

INFORMATION

Avion Water Company, Inc.

Provide the following information for the contact person regarding this report

Name:	Richard C. Bailey
Address:	60813 Parrell Road, Bend, OR 97702
Phone:	(541) 382-5342
Email:	rick@avionwater.com

Provide the following information for where the utility's books and records are located

Name:	Richard C. Bailey
Address:	60813 Parrell Road, Bend, OR 97702
Phone:	(541) 382-5342
Email:	rick@avionwater.com

Provide the following information of any audit group reviewing records and/or operations

Name:	Price/Fronk & Co.
Address:	2796 NW Clearwater Drive, Bend, OR 97703
Phone:	(541) 382-4791
Email:	price@bendcpa.com

Date of original organization of the utility (month, day, year): 1/1/1976

Provide the following information for all utility officers and directors

Name	Title	Phone #	Email
Jason J. Wick	President/Director	(541) 382-5342	jason@avionwater.com
Jan M. Wick	Exec. Vice President	(541) 382-5342	jan@avionwater.com
Richard C. Bailey	Secretary-Treasurer	(541) 382-5342	rick@avionwater.com
Jordan D. Wick	Director	(503) 639-0300	jordan@kywainternational.com
David Anderson	Director	(503) 220-2406	David.Anderson@nwnatural.com
Justin Palfreyman	Director	(503) 220-2406	Justin.Palfreyman@nwnatural.com

Provide the following information for legal counsel, accountants, and others not on utility's general payroll

Name	Title	Phone #	Email
Kyle D. Wuepper	Attorney	(541) 617-1309	kwuepper@brixlaw.com
Wesley B. Price, III	CPA	(541) 382-4791	price@bendcpa.com

ORGANIZATION

Avion Water Company, Inc.

Select business type	Select ownership type	Select accounting method
Private/Investor Owned	Corporation	accrual

INSTRUCTIONS: IF THE UTILITY IS A SOLE PROPRIETORSHIP OR PARTNERSHIP, COMPLETE PART A AND PROVIDE THE NAMES AND ADDRESSES OF ALL PERSONS HAVING ANY INTEREST OR EQUITY IN THE UTILITY AND THE AMOUNT OF SUCH EQUITY. IF THE UTILITY IS A CORPORATION, COMPLETE PARTS B AND C, AND PROVIDE THE NAMES AND ADDRESSES OF THE THREE LARGEST STOCKHOLDERS AND ALL OFFICERS AND DIRECTORS. STATE THE NUMBER OF SHARES HELD BY EACH.

Part A: Sole Proprietorship or Partnership

1	Name of owner or partner	
	Address	
	% interest or equity	
	Principal duty (if employed by company)	
2	Name of owner or partner	
	Address	
	% interest or equity	
	Principal duty (if employed by company)	
3	Name of owner or partner	
	Address	
	% interest or equity	
	Principal duty (if employed by company)	
4	Name of owner or partner	
	Address	
	% interest or equity	
	Principal duty (if employed by company)	

Part B: Corporation

1	Name of stockholder/director/officer	Jan M. Wick
	Title	Stockholder/Executive Vice President
	Address	60813 Parrell Road, Bend, OR 97702
	# shares owned	8,781.00
2	Name of stockholder/director/officer	Christine M. Wick
	Title	Stockholder
	Address	60813 Parrell Road, Bend, OR 97702
	# shares owned	8,895.00
3	Name of stockholder/director/officer	Jordan Wick
	Title	Stockholder/Director
	Address	4000 Kruse Way Place II, suite 210, Lake Oswego, OR 97035
	# shares owned	16,162.00
4	Name of stockholder/director/officer	Jason J. Wick
	Title	Stockholder/Director/President
	Address	60813 Parrell Road, Bend, OR 97702
	# shares owned	18,190.00

Part C: Corporation - Shares Outstanding

	Common Stock	Preferred Stock
# shares authorized	1000000	
# shares issued at year end	95901	
Par or stated value per share:	$ 10.8806	
Dividends declared per share during the year:	$ (9)	

Avion Water Company, Inc.

Part B: Corporation continued

5	Name of stockholder/directory/officer	Megan Wick
	Title	Stockholder
	Address	60813 Parrell Road, Bend, OR 97702
	# shares owned	2222

6	Name of stockholder/directory/officer	Leah E. Wick
	Title	Stockholder
	Address	4000 Kruse Way Place II, suite 210, Lake Oswego, OR 97035
	# shares owned	1000

7	Name of stockholder/directory/officer	Adam Wick
	Title	Stockholder
	Address	4000 Kruse Way Place II, suite 210, Lake Oswego, OR 97035
	# shares owned	1000

8	Name of stockholder/directory/officer	Joseph Wick
	Title	Stockholder
	Address	60813 Parrell Road, Bend, OR 97702
	# shares owned	1000

9	Name of stockholder/directory/officer	NW Natural Water of Oregon, LLC
	Title	Stockholder
	Address	250 SW Taylor Street, Portland, OR 97204
	# shares owned	38651

10	Name of stockholder/directory/officer	Richard C. Bailey
	Title	Secretary-Treasurer
	Address	60813 Parrell Road, Bend, OR 97702
	# shares owned	0

AFFILIATED INTERESTS

List each contract, agreement, or other business transaction exceeding a cumulative amount of $500.00 in any one year, entered into between the company and an affiliated business or financial organization, firm, partnership, or individual. An Affiliated Interest is defined, in part, as every corporation and/or person owning or holding directly or indirectly **5 percent** or more of the voting securities of the utility. For a complete definition of affiliated interest, see ORS 757.015.

Products or Services SOLD to Affiliated Interests

Name of Affiliate	Description of product or service	Contract or Agreement effective date	Revenue
			$ -

Products or Services PURCHASED from Affiliated Interests

Name of Affiliate	Description of product or service	Contract or Agreement effective date	Cost
Jan M. Wick	Salary & Benefits	Order No. 22-196	$ 86,410
Jason J. Wick	Salary & Benefits	Order No. 22-203	$ 196,194
			$ 282,604
		TOTAL	$ (282,604)

Explanations or Notes

REVENUES

Avion Water Company, Inc.

gal or cf: **cf**

Consumption and Revenue

	Act #	# customers at year beginning	# customers at year end	Total Quantity water sold	revenues
Unmetered (flat rate) water sales	460				
Metered sales to RESIDENTIAL customers	461.1	14,135	14,287	300,470,804	$ 7,563,357
Metered sales to COMMERCIAL customers	461.2	379	579	87,772,992	$ 1,154,470
Metered sales to INDUSTRIAL customers	461.3				
Other metered sales to public authorities	461.4				
Metered sales to multiple family dwellings	461.5				
Public fire protection revenue	462.1				$ 69,070
Private fire protection revenue	462.2				
Other Sales to public authorities	464				
Sales to irrigation customers	465	777	951		$ 553,673
Sales for resale	466				$ 81,396
Water Sales to golf course/recreation revenue	467				
Special contract/agreement revenue	468				
TOTAL		15,291	15,817	388,243,796	$ 9,421,966

Revenue other than water sales

	Act #	revenues
Forfeited discounts	470	
Miscellaneous service revenues	471	$ 207,635
Rents from water property	472	
Interdepartmental rents	473	
Other	474	$ 314,254
Cross Connection sales & services revenues	475	$ 246,087
Total		$ 767,976

Total Operating Revenue

$ 10,189,942

Average Monthly Consumption and Bill

	Act #	Average Monthly Consumption per customer	Average Monthly Revenue per customer
Unmetered (flat rate) water sales	460		
Metered sales to RESIDENTIAL customers	461.1	1761.961415	44.35154106
Metered sales to COMMERCIAL customers	461.2	15270.17954	200.8472512
Metered sales to INDUSTRIAL customers	461.3		
Other metered sales to public authorities	461.4		
Metered sales to multiple family dwellings	461.5		
Public fire protection revenue	462.1		
Private fire protection revenue	462.2		
Other Sales to public authorities	464		
Sales to irrigation customers	465		53.40210262
Sales for resale	466		
Water Sales to golf course/recreation revenue	467		
Special contract/agreement revenue	468		

Act #	TAXES OTHER THAN INCOME TAX		
408.11	Property Tax	$	440,807
408.12	Payroll Tax	$	218,943
408.13	Other Tax Other Than Income Tax	$	352,270
408.2	Nonutility Taxes Other Than Income Tax		
	TOTAL	$	1,012,020

Act #	INCOME TAXES		
409.1	Federal Income Tax	$	201,619
409.11	State Income Tax	$	68,013
409.13	Other Income Tax		
409.2	Nonutility Income Tax		
	TOTAL	$	269,632

Act #	DEFERRED AND PROVISION FOR DEFERRED INCOME TAXES		
410.1	Deferred Federal Income Taxes – Utility Operations	$	65,343
410.11	Deferred State Income Taxes – Utility Operations	$	22,047
410.2	Provision for Deferred Income Taxes – Other Income and Deductions		
411.1	Provision for Deferred Income Taxes – Credit – Utility Operations		
411.2	Provision for Deferred Income Taxes – Credit – Other income & Deductions		
	TOTAL	$	87,390

GAINS AND LOSSES FROM UTILITY PROPERTY SALE - ACCOUNT 414 (enter losses as negative amounts)

Description	Amount	
Land sale (two sales)	$	546,751
Truck sales (six trucks sold)	$	64,100
Laptop	$	25
Total	$	610,876

EXPENSES

Act #		Expense amount
601	Salaries and Wages - employees	$ 2,312,095
603	Salaries and Wages – officers, directors, and majority stockholders	$ 416,824
604	Employee Pensions & Benefits	$ 900,803
610	Purchased Water	$ 366,822
611	Telephone/Communications	$ 86,170
615	Purchased Power	$ 978,778
616	Fuel for Power Production	$ -
617	Utilities - Other (garbage, natural gas)	$ 16,818
618	Chemicals & testing	$ 498
619	Office Supplies (excluding postage)	$ 9,391
619.1	Postage	$ 3,029
620	Materials & Supplies (O&M)	$ 156,625
621	Repairs of Water Plant	$ 132,636
631	Contractual Services - engineering	$ -
632	Contractual Services - accounting	$ 17,813
633	Contractual Services - legal	$ 53,591
634	Contractual Services - management	$ -
635	Contractual Services – testing / sampling	$ 49,518
636	Contractual Services – labor	$ -
637	Contractual Services - billing/collections	$ 115,966
638	Contractual Services - meter reading	$ 160,243
639	Contractual Services - other	$ 126,882
641	Rental of Building / Real Property	$ 30,271
642	Rental of Equipment	$ 63,718
643	Small Tools	$ 15,484
648	Computer and electronic Expenses	$ 123,584
650	Transportation Expenses	$ 531,539
656	Insurance - Vehicle	$ 28,132
657	Insurance – General Liability	$ 68,234
658	Insurance – Workman's Compensation	$ 23,985
659	Insurance – Other	$ 15,623
660	Public Relation / Advertising Expense	$ 1,073
666	Amortization of Rate Case Expense	$ -
667	Regulatory Commission Fee (Gross Rev Fee)	$ 44,016
668	Conservation Expense	$ 4,288
670	Bad Debt Expense	$ 18,108
671.1	Cross Connection Control Program Expense	
671.2	Cross Connection Testing & Maintenance Services	$ 1,140
673	Training & Certification Expense	$ 49,463
674	Consumer Confidence Report	$ 1,440
675	Miscellaneous Expense	$ 149,938
	TOTAL	$ 7,074,538

PLANT

Avion Water Company, Inc.
NOTE: Do **NOT** include any donated capital or contributions in aid of construction (CIAC) on this page.

Act #		Beg Year Balance	Added during year	Retired during year	Adjustments	End of year balance
301	Organization	$ 211				$ 211
302	Franchises	$ -				$ -
303	Land & land rights	$ 2,792,781	$ 179,114			$ 2,971,895
304	Structures & improvements	$ 1,793,385	$ 2,928,021			$ 4,721,406
305	Collecting & impounding reservoirs	$ 4,769				$ 4,769
306	Lake, river & other intakes	$ 34,925				$ 34,925
307	Wells & springs	$ 3,288,134	$ 64,622			$ 3,352,756
308	Infiltration galleries & tunnels	$ 106				$ 106
309	Supply mains	$ 439,307				$ 439,307
310	Power generation equipment	$ 1,203				$ 1,203
311	Pumping equipment	$ 1,679,612	$ 7,723			$ 1,687,335
320	Water treatment equipment	$ 21,100				$ 21,100
330	Distribution reservoirs & standpipes	$ 3,670,603	$ 6,673			$ 3,677,276
331	Transmission & distribution mains	$ 48,056,232	$ 2,288,295			$ 50,344,527
333	Services	$ 1,435,853				$ 1,435,853
334	Meters & meter installations	$ 2,076,923	$ 214,267	$ 7,507		$ 2,283,683
335	Hydrants	$ 172,036				$ 172,036
336	Backflow prevention devices (utility owned)	$ 417,048	$ 46,023			$ 463,071
339	Other plant & miscellaneous equipment	$ 210,713				$ 210,713
340	Office furniture & equipment	$ 129,963				$ 129,963
341	Transportation equipment	$ 409,619	$ 38,343	$ 220,915		$ 227,047
343	Tools, shop & garage equipment	$ 129,084	$ 18,950			$ 148,034
344	Laboratory equipment	$ -				$ -
345	Power operated equipment	$ 170,192				$ 170,192
346	Communication equipment	$ 263,042				$ 263,042
347	Electronic & computer equipment	$ 363,771	$ 38,411	$ 1,614		$ 400,568
348	Miscellaneous equipment	$ 14,162				$ 14,162
	TOTAL	$ 67,574,774	$ 5,830,442	$ 230,036	$ -	$ 73,175,180

Explanation of unusual changes in utility plant during the year:

CIAC AND ADVANCES

NOTE: Include ALL donated capital or contributions in aid of construction (CIAC) on this page.

Advances for Construction

Beg of year balance	
Additions during year	
Subtractions during year	
End of year balance	$ -

Contributions in Aid of Construction

Beg of year balance	$ 34,126,804
Added during the year:	
Capacity charge	$ 657,624
Main line extension charges	
Customer connection charges	
Developer's property	$ 1,306,317
Other	
Retired during the year	
End of year balance	$ 36,090,745

Accumulated Amortization of CIAC

Beg of year balance	$ 9,400,910
Add CIAC amortized during year	$ 768,455
Subtract effects of CIAC disposals	
+/- other adjustments*	
Change in Accumulated Amortization during the year	$ 768,455
End of year balance	$ 10,169,365

* Explain any adjustments:

CIAC disposal

Avion Water Company, Inc.

NOTE: Do **NOT** include any contributions in aid of construction (CIAC) on this page.

Act #		annual depreciation expense	acc dep balance beg of year	accruals booked to acc dep	plant retired charged to acc dep	Adjustments*	acc dep balance end of year
301	Organization						
302	Franchises						
303	Land & land rights						
304	Structures & improvements	$ 89,638	$ 810,687	$ 89,638			$ 900,325
305	Collecting & impounding reservoirs	$ 102	$ 3,721	$ 102			$ 3,823
306	Lake, river & other intakes	$ 707	$ 23,171	$ 707			$ 23,878
307	Wells & springs	$ 119,623	$ 978,188	$ 119,623			$ 1,097,811
308	Infiltration galleries & tunnels	$ 3	$ 96	$ 3			$ 99
309	Supply mains	$ 8,785	$ 68,386	$ 8,785			$ 77,171
310	Power generation equipment	$ 21	$ 1,116	$ 21			$ 1,137
311	Pumping equipment	$ 37,209	$ 1,468,020	$ 37,209			$ 1,505,229
320	Water treatment equipment	$ 1,055	$ 9,227	$ 1,055			$ 10,282
330	Distribution reservoirs & standpipes	$ 100,138	$ 1,899,790	$ 100,138			$ 1,999,928
331	Transmission & distribution mains	$ 976,977	$ 13,854,266	$ 976,977			$ 14,831,243
333	Services	$ 35,481	$ 813,212	$ 35,481			$ 848,693
334	Meters & meter installations	$ 100,495	$ 821,449	$ 100,495	$ 7,509		$ 914,435
335	Hydrants	$ 3,456	$ 85,219	$ 3,456			$ 88,675
336	Backflow prevention devices (utility owned)	$ 25,480	$ 188,717	$ 25,480			$ 214,197
339	Other plant & miscellaneous equipment	$ 5,245	$ 142,496	$ 5,245			$ 147,741
340	Office furniture & equipment	$ 1,294	$ 113,171	$ 1,294			$ 114,465
341	Transportation equipment	$ 25,000	$ 333,159	$ 25,000	$ 198,781		$ 159,378
343	Tools, shop & garage equipment	$ 5,626	$ 79,561	$ 5,626			$ 85,187
344	Laboratory equipment		$ -	$ -			$ -
345	Power operated equipment	$ 6,767	$ 147,312	$ 6,767			$ 154,079
346	Communication equip	$ 17,178	$ 136,879	$ 17,178			$ 154,057
347	Electronic & computer Equipment	$ 40,397	$ 270,064	$ 40,397	$ 1,614		$ 308,847
348	Miscellaneous Equipment	$ 99	$ 14,062	$ 99			$ 14,161
	TOTAL	$ 1,600,776	$ 22,261,969	$ 1,600,776	$ 207,904	$ -	$ 23,654,841

*Explanation of any adjustments made:

RETAINED EARNINGS

Avion Water Company, Inc.

215	Unappropriated Retained Earnings (beginning of year balance)	$	10,791,775

435	Balance transferred from income	$	1,140,425
436	Appropriations of Retained Earnings	$	-
437	Preferred Stock dividends declared	$	-
438	Common Stock dividends declared	$	(900,000)
439	Adjustments to Retained Earnings*	$	3,199,515

215	Unappropriated Retained Earnings (as of year end)	$	14,231,715

* Explanation of any adjustments made to Retained Earnings

Prior period adjustment for accumulated deferred income taxes

Avion Water Company, Inc.
For account information not already entered, please enter amounts below, if applicable.

Category	Act #	Act Name		
ASSETS AND OTHER DEBITS (101-190)				
Utility Plant				
	101	Utility Plant in Service	$	73,175,180
	102	Utility Plant Leased to Others	$	-
	103	Property Held for Future Use	$	-
	104	Utility Plant Purchased or Sold	$	-
	105	Construction Work in Progress - Commission Approved	$	1,473,173
	108	Accumulated Depreciation of Utility Plant in Service	$	23,654,841
	110	Accumulated Amortization of Utility Plant in Service	$	-
	114	Utility Plant Acquisition Adjustments	$	59,090
	115	Accumulated Amortization of Utility Plant Acquisition Adjustments	$	-
Other Property & Investments				
	121	Nonutility Property	$	-
	122	Accumulated Depreciation and Amortization of Nonutility Property	$	-
	123	Investment in Associated Companies	$	-
	124	Utility Investments	$	-
	125	Other Investments	$	-
	127	Other Special Funds	$	-
Current & Accrued Assets				
	131	Cash	$	859,394
	132	Special Deposits	$	-
	134	Working Funds	$	-
	135	Temporary Cash Investments	$	-
	141	Customer Accounts Receivable	$	351,987
	142	Other Accounts Receivable	$	-
	143	Allowance for Uncollectible Accounts (Enter positive)	$	18,094
	144	Notes Receivable	$	-
	145	Accounts Receivable from Associated Companies	$	-
	146	Notes Receivable from Associated Companies	$	-
	151	Plant Materials and Supplies	$	511,606
	162	Prepayments	$	584,490
	171	Accrued Interest Receivable	$	-
	174	Miscellaneous Current and Accrued Assets	$	-
Deferred Debits				
	181	Unamortized Debt Discount and Expense	$	-
	182	Extraordinary Property Losses	$	-
	186	Miscellaneous Deferred Debits	$	8,565
	190	Accumulated Deferred Income Taxes	$	-
EQUITY, LIABILITIES, AND OTHER CREDITS (201-283)				
Equity				
	201	Common Stock Issued	$	1,043,462
	204	Preferred Stock Issued	$	-
	207	Premium on Capital Stock	$	174,899
	211	Paid in Capital	$	-
	212	Discount on Capital Stock	$	-
	213	Capital Stock Expense	$	-
	214	Appropriated Retained Earnings	$	-
	215	Unappropriated Retained Earnings	$	14,231,715
	216	Reacquired Capital Stock	$	75,000
	218	Proprietary Capital	$	-
Long Term Debt				
	221	Bonds	$	-
	223	Advances from Associated Companies	$	-
	224	Other Long-Term Debt	$	11,076,204
Current and Accrued Liabilities				
	231	Accounts Payable	$	228,675
	232	Notes Payable	$	8,560
	233	Accounts Payable to Associated Companies	$	-
	234	Notes Payable to Associated Companies	$	-
	235	Customer Deposits	$	1,500
	236	Accrued Taxes	$	86,410
	237	Accrued Interest	$	18,778
	238	Accrued Dividends	$	-
	239	Matured Long-Term Debt	$	-
	240	Matured Interest	$	-
	241	Miscellaneous Current and Accrued Liabilities	$	442,279
Deferred Credits				
	251	Unamortized Premium on Debt	$	-
	252	Advances for Construction	$	-
	253	Other Deferred Credits	$	-
Operating Reserves				
	261	Property Insurance Reserve	$	-
	262	Injuries and Damages Reserve	$	-
	263	Pensions and Benefits Reserve	$	-
	265	Miscellaneous Operating Reserves	$	-
Contributions in Aid of Construction				
	271	Contributions in Aid of Construction	$	36,090,745
	272	Accumulated Amortization of CIAC	$	10,169,365
Accumulated Deferred Income Taxes				
	281	Accumulated Deferred Income Taxes - Accelerated Depreciation	$	191,688
	282	Accumulated Deferred Income Taxes - Liberalized Depreciation	$	-
	283	Accumulated Deferred Income Taxes - Other	$	-
WATER UTILITY PLANT ACCOUNTS (301-348)				
	301	Organization	$	211
	302	Franchises	$	-
	303	Land and Land Rights	$	2,971,895
	304	Structures and Improvements	$	4,721,406
	305	Collecting and Impounding Reservoirs	$	4,769
	306	Lakes, River and Other Intakes	$	34,925
	307	Wells and Springs	$	3,352,756
	308	Infiltration Galleries and Tunnels	$	106
	309	Supply Mains	$	439,307
	310	Power Generation Equipment	$	1,203
	311	Pumping Equipment	$	1,687,335
	320	Water Treatment Equipment	$	21,100
	330	Distribution Reservoirs and Standpipes	$	3,677,276
	331	Transmission and Distribution Mains	$	50,344,527
	333	Services	$	1,435,853
	334	Meters and Meter Installations	$	2,283,683
	335	Hydrants	$	172,036
	336	Backflow Prevention Devices	$	463,071
	339	Other Plant and Miscellaneous Equipment	$	210,713
	340	Office Furniture and Equipment	$	129,963
	341	Transportation Equipment	$	227,047
	343	Tools, Shop and Garage Equipment	$	148,034
	344	Laboratory Equipment	$	-
	345	Power Operated Equipment	$	170,192
	346	Communication Equipment	$	263,042
	347	Computer & electronic Equipment	$	400,568
	348	Miscellaneous Equipment	$	14,162
INCOME ACCOUNTS (404-434)				
Utility Operating Income				
	400	Operating Revenue	$	10,189,942
	401	Operating Expenses	$	7,074,538
	403	Depreciation Expense	$	1,600,776
	406	Amortization of Utility Plant Acquisition Adjustment	$	-
	407	Amortization Expense (no CIAC)	$	-
	408	Taxes Other than Income	$	1,012,020
	409	Income Taxes	$	269,632
	410	Provision for Deferred Income Taxes - Debit	$	87,390
	411	Provision for Deferred Income Taxes - Credit	$	-
	412	Investment Tax Credit	$	-
	413	Income from Utility Plant Leased to Others	$	-
	414	Gain/Loss from Utility Property Sales	$	610,876
	415	Revenues from Merchandising, Jobbing, and Contract Work	$	34,155
	416	Cost and Expenses of Merchandising, Jobbing, and Contract Work	$	3,181
	419	Interest and Dividend Income	$	3,541
	421	Nonutility Income	$	-
	426	Nonutility Expenses	$	21,640
	433	Extraordinary Income	$	-
	434	Extraordinary Deductions	$	-
Taxes Applicable to Nonutility Income and Deductions				
	408.2	Taxes Other than Income - Nonutility	$	-
	409.2	Income Taxes - Nonutility	$	-
	410.2	Provision for Deferred Income Taxes - Debit - Nonutility	$	-
	411.2	Provision for Deferred Income Taxes - Credit - Nonutility	$	-
Interest Expense				
	427	Interest Expense	$	397,367
	428	Amortization of Debt Discount and Expense	$	-
	429	Amortization of Premium on Debt	$	-
Retained Earnings Account (435-439)				
	435	Balance Transferred from Income	$	1,140,425
	436	Appropriations of Retained Earnings	$	-
	437	Preferred Stock Dividends Declared	$	-
	438	Common Stock Dividends Declared	$	(900,000)
	439	Adjustment to Retained Earnings	$	3,199,515
OPERATING REVENUE ACCOUNTS (460-475)				
	460	Unmetered Water Revenue	$	-
	461	1 Metered Sales to Residential Customers	$	7,563,357
	461	2 Metered Sales to Commercial Customers	$	1,154,470
	461	3 Metered Sales to Industrial Customers	$	-
	461	4 Metered Sales to Public Authorities	$	-
	461	5 Metered Sales to Multiple Family Dwellings	$	-
	462.1	1 Public Fire Protection	$	69,070
	462.2	2 Private Fire Protection	$	-
	464	Other Sales to Public Authorities	$	-
	465	Sales to Irrigation Customers	$	553,673
	466	Sales for Resale	$	81,396
	467	Interdepartmental Sales	$	-
	468	Special Contract/Agreement Revenue	$	-
	470	Forfeited Discounts	$	-
	471	Miscellaneous Service Revenues	$	207,635
	472	Rents From Water Property	$	-
	473	Interdepartmental Rents	$	-
	474	Other Water Revenues	$	314,254
	475	Cross Connection Sales & Services Revenues	$	246,087
OPERATION AND MAINTENANCE EXPENSE ACCOUNTS (601-675)				
Source of Supply and Expenses				
	601	Salaries and Wages - Employees	$	2,312,095
	603	Salaries and Wages - Officers, Directors and Majority Stockholders	$	416,824
	604	Employee Pensions and Benefits	$	900,803
	610	Purchased Water	$	366,822
	611	Telephone/Communications	$	86,170
	615	Purchased Power	$	978,778
	616	Fuel for Power Production	$	-
	617	Utilities - Other	$	16,818
	618	Chemicals & testing	$	498
	619	Office Supplies (excluding postage)	$	9,391
	619.1	Postage	$	3,029
	620	Materials and Supplies	$	156,625
	621	Repairs to Water Plant	$	132,636
	631	Contractual Services - Engineering	$	-
	632	Contractual Services - Accounting	$	17,813
	633	Contractual Services - Legal	$	53,591
	634	Contractual Services - Management Fees	$	-
	635	Contractual Services - Testing/Sampling	$	49,518
	636	Contractual Services - Other	$	-
	637	Contractual Services - Billing/Collections	$	115,966
	638	Contractual Services - Meter Reading	$	160,243
	639	Contractual Services - Other	$	126,882
	641	Rental of Building/Real Property	$	30,271
	642	Rental of Equipment	$	63,718
	643	Small Tools	$	15,484
	648	Computer & Electronic Expenses	$	123,584
	650	Transportation Expenses	$	531,539
	656	Insurance - Vehicle	$	28,132
	657	Insurance - General Liability	$	68,234
	658	Insurance - Workman's Compensation	$	23,985
	659	Insurance - Other	$	15,623
	660	Public Relations / Advertising Expense	$	1,073
	666	Regulatory Commission Expense - Amortization of Rate Case Expense	$	-
	667	Regulatory Commission Expense - Other	$	44,016
	668	Water Resource Conservation Expense	$	4,288
	670	Bad Debt Expense	$	18,108
	671.1	Cross Connection Control Program Expense	$	-
	671.2	Cross Connection Testin & Maintenance Services	$	1,140
	672	System Capactiy Development Program Expense	$	-
	673	Training & Certification Expense	$	49,463
	674	Consumer Confidence Report	$	1,440
	675	Miscellaneous Expenses	$	149,938

NOTES

Avion Water Company, Inc.

Notes and explanations:

INCOME STATEMENT

Avion Water Company, Inc.

400	Operating Revenue	$ 10,189,942
401	Operating Expenses	$ 7,074,538
403	Depreciation Expense	$ 832,321
406	Amortization of Utility Plant Acquisition Adjustment	$ -
407	Amortization Expense	$ -
408	Taxes Other Than Income Taxes (total)	$ 1,012,020
409	Income Taxes	$ 269,632
410.1	Provision for Deferred Income Taxes - debit	$ 87,390
411.1	Provision for Deferred Income Taxes - credit	$ -
412	Investment Tax Credit	$ -
413	Income From Utility Plant Leased to Others	$ -
419	Interest & Dividend Income	$ 3,541
427	Interest Expense	$ 397,367
428-429	Amortization of Premium/Discount on Debt	$ -
414	Gains/Losses From Utility Property Disposition (net)	$ 610,876
433-434	Extraordinary Income/deductions (net)	$ -
	NET UTILITY OPERATING INCOME	$ 1,131,091
421	Nonutility Income	$ -
415	Revenue From Merchandising, Jobbing, & Contracts	$ 34,155
426	Nonutility Expense	$ 21,640
408.2	Nonutility Taxes Other Than Income Tax	$ -
409.2	Nonutility Income Taxes	$ -
410.2	Nonutility Deferred Income Taxes	$ -
411.2	Nonutility Provision for Deferred Income Taxes Credit	$ -
416	Cost & Expense of Merchandising, Jobbing, Contracts	$ 3,181
	Net Income	$ 1,140,425

Avion Water Compa

Please do not submit to PUC until figures are balanced.

101	Utility Plant in Service (excluding CIAC)	$	73,175,180
108-110	Accumulated Depreciation & Amortization	$	23,654,841
	Subtotal	$	49,520,339
102-104	Other Utility Plant	$	-
105	Commission Approved Construction Work in Progress (CWIP)	$	1,473,173
114	Commission Approved Utility Plant Acquisition Adjustments	$	59,090
115	Accumulated Amortization of Commission Approved Acquisition Adjustments	$	-
190	Accumulated Deferred Income Taxes (asset)	$	-
	Subtotal	$	1,532,263
	Net Utility Plant	$	51,052,602
131	Cash	$	859,394
132	Special Deposits	$	-
141-142	Accounts Receivable	$	351,987
143	Accumulated Provision for Uncollectible Accounts	$	18,094
144	Notes Receivable	$	-
145-146	Accounts & Notes Receivable from Associated Companies	$	-
151	Materials & Supplies Inventory	$	511,606
133-135 & 162-174	Miscellaneous Current & Accrued Assets & Prepayments	$	584,490
	Net Current & Accrued Assets	$	2,289,383
181-186	Deferred Debits	$	8,565
	Total Assets	$	53,350,550
252	Advances for Construction	$	-
271	CIAC	$	36,090,745
272	Accumulated Amortization of CIAC	$	10,169,365
	Net CIAC & Advances for Construction	$	25,921,380
121	Nonutility Property	$	-
122	Accumulated Depreciation & Amortization (Nonutility)	$	-
123-127	Miscellaneous Nonutility Investments	$	-
	Nonutility Plant & Investment	$	-
221-224	Long-Term Debt	$	11,076,204
231	Accounts Payable	$	228,675
232	Notes Payable	$	8,560
233	Accounts Payable to Affiliated Companies	$	-
234	Notes Payable to Affiliated companies	$	-
235	Customer Deposits	$	1,500
236	Accrued Taxes	$	86,410
237	Accrued Interest	$	18,778
238-241	Miscellaneous Current and Accrued Liabilities	$	442,279
	Liabilities	$	11,862,406
251	Premium on Unamortized Debt	$	-
253	Other Deferred Credit	$	-
261-265	Reserves	$	-
	Other	$	-
281	Accumulated Deferred Income Taxes-Accelerated Amortization	$	191,688
282	Accumulated Deferred Income Taxes-Liberalized Depreciation	$	-
283	Accumulated Deferred Income Taxes-Other	$	-
		$	191,688
	Total Liabilities	$	12,054,094
201	Common Stock Issued	$	1,043,462
204	Preferred Stock Issued	$	-
207	Premium on Capital Stock	$	174,899
211	Other Paid in Capital	$	-
212	Discount on Capital Stock	$	-
213	Capital Stock Expense	$	-
214	Appropriated Retained Earnings	$	-
215	Unappropriated Retained Earnings	$	14,231,715
216	Reacquired Capital Stock	$	75,000
218	Proprietary Capital (Proprietorships & Partnerships Only)	$	-
	Total Equity	$	15,375,076
	Total Liabilities and Equity	$	53,350,550

Avion Water Company, Inc.

Operating Revenues		
Flat Rate	$	-
Metered - Residential	$	7,563,357
Metered - Commercial	$	1,154,470
Irrigation (including golf courses)	$	553,673
Fire Protection	$	69,070
Other Sales of Water	$	81,396
Other Operating Revenue	$	767,976
Total Operating Revenues	$	10,189,942
Operating Expenses		
Purchased Water	$	366,822
Purchased Power	$	978,778
Water Treatment	$	50,016
Supplies and Expenses	$	1,423,961
Repairs of Plant	$	132,636
Administrative & General	$	4,122,325
Total Operating Expenses	$	7,074,538
Other Revenue Deductions		
Depreciation & Amortization	$	832,321
Operating Income Taxes	$	357,022
Other Operating Taxes	$	1,012,020
Uncollectible Revenue/Bad Debt Expense	$	18,108
Total Revenue Deductions	$	2,219,471
Total Expenses and Deductions	$	9,294,009
Other Income	$	3,541
Interest on Long-Term Debt		
Other Interest Charges	$	397,367
Other Income Deductions	$	(87,390)
Net Operating Income (or Loss)	$	589,497

Assets & Other Debits		
Utility Plant	$	73,175,180
Less: Depreciation & Amortization Reserve	$	23,654,841
Other Property & Investments	$	859,394
Materials and Supplies	$	511,606
Other Current & Accrued Assets	$	2,450,646
Deferred Debits	$	8,565
Total Assets & Other Debits	$	53,350,550
Liabilities & Other Credits		
Capital/Common Stock	$	1,143,361
Retained Earnings	$	14,231,715
Long-Term Debt	$	11,076,204
Customer Deposits	$	1,500
Other Current & Accrued Liabilities	$	784,702
Advances for Construction	$	-
Other Deferred Credits	$	-
Contributions in Aid of Construction	$	25,921,380
Accumulated Deferred Income Taxes	$	191,688
Total Liabilities & Other Credits	$	53,350,550
Average Number of Customers		
Flat Rate		-
Metered - Residential		14,287
Metered - Commercial		579
Irrigation (including golf courses)		951
Fire Protection		-
Other		-
Total Customers		15,817

From: Jack Harvel <reporter@bendsource.com>
Sent: Mon, 24 Jul 2023 20:20:56 +0000
To: Dana Wilson <dwilson@bendoregon.gov>
Subject: Re: *NEW SUBMISSION* Public Records Request
Attachments:
· image001.png *(32 kb)*
· image002.png *(1254 b)*
· image003.png *(1556 b)*
· image004.png *(1570 b)*
· image005.png *(1322 b)*
· image006.png *(2038 b)*

Hi Dana,

So sorry, meant to get back to you sooner! We would like to proceed with the request, even though as you said in our phone call it may not have the information requested in our PRR. Thanks so much for your time!

Best,
Jack

--

Jack Harvel
Reporter at the Source Weekly
(816) 695-9988
Twitter: @JackHarvel

From: Dana Wilson <dwilson@bendoregon.gov>
Date: Thursday, July 6, 2023 at 1:17 PM
To: Jack Harvel <reporter@bendsource.com>
Cc: Robyn Jones <rojones@bendoregon.gov>
Subject: RE: *NEW SUBMISSION* Public Records Request
Hi Jack,

Thank you for your inquiry. Unfortunately, the City does not have the information you requested. We receive winter quarter consumption data on a sub-set of Avion customers who utilize City sanitary sewer services but we do not have a record of their entire customer base. The data is very limited and just allows us to calculate average consumption amounts between December and January with no financial information at all.

Feel free to reach out to me if you have any questions about my response.

[A picture containing text, clipart Description automatically generated]
Dana Wilson
Business Manager
My Pronouns: She, Her, Hers Why Pronouns?<https://www.google.com/url?q=https://pronouns.org/what-and-why%3D&source=gmail-imap&ust=1690837497000000&usg=AOvVaw1-YPSIWYES5aYm06Wa8gSB
>
Office: 541-388-5566
Mobile: 541-213-9851
[Visit the City of Bend's Facebook page.]<https://www.google.com/url?q=https://www.facebook.com/CityofBe%3D&source=gmail-imap&ust=1690837497000000&usg=AOvVaw2JR9vh4gsLZpUSSvTWeJjl
ndOregon>

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q=https://www.instagram.com/cit%3D&source=gmail-
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imap&ust=1690837497000000&usg=AOvVaw1qMXcwnaqcIjYVYHWRD0v5>
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imap&ust=1690837497000000&usg=AOvVaw2rW6NG9vRrwEYS3XyritFQ>

From: City of Bend <communications@bendoregon.gov<mailto:communications@ben=
doregon.gov>>
Sent: Thursday, July 6, 2023 10:56:43 AM (UTC-08:00) Pacific Time (US & Can=
ada)
To: Robyn Christie <rchristie@bendoregon.gov<mailto:rchristie@bendoregon.go=
v>>
Subject: *NEW SUBMISSION* Public Records Request

CAUTION: External Email. Use caution when opening attachments, clicking lin=
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Public Records Request
Submission #:
2549175
IP Address:
216.228.180.126
Submission Date:
07/06/2023 10:56
Survey Time:
7 minutes, 22 seconds

You have a new online form submission.
Note: all answers displaying "*****" are marked as sensitive and must be vi=
ewed after your login.

Name
Jack Harvel
Phone
(816) 695-9988
Email
Reporter@bendsource.com<mailto:Reporter@bendsource.com>
Address
704 NW Georgia Ave
Bend, OR 97703
Pursuant to the Oregon open records law, ORS 192.001 to 192.607, I=92m requ=
esting a copy of:
Avion=92s top 15 urban water users from the calendar year 2021, 2022 and 20=
23, the number of gallons they used and the amount they spent, and the tota=

ls from the month of July, as reported to the City in its annual reporting.
I agree to pay any reasonable copying and postage fees associated with this=
request. If my request results in the need for additional research, the Ci=
ty will provide an estimated cost and require a deposit prior to preparing =
the public record documents.
Check here to agree
Read-Only Content

Thank you,
City of Bend

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to others. Thank you.

CERTIFICATE OF SERVICE

I hereby certify that I served the foregoing **DECLARATION OF STEVEN M. WILKER IN SUPPORT OF DEFENDANT SOURCE WEEKLY'S OPPOSITION TO PLAINTIFF'S MOTION FOR SUMMARY JUDGMENT** on:

C. Robert Steringer
bob.steringer@harrang.com
Erica Tatoian
erica.tatoian@harrang.com
Harrang Long P.C.
111 SW Columbia Street, Suite 950
Portland, OR 97201

Attorneys for Plaintiff

☒ by electronic means through the Court's File & Serve system on the date set forth below; and

☒ by causing a copy thereof to be emailed to each attorney at said attorney's last-known email address on the date set forth below.

DATED: July 26, 2023.

TONKON TORP LLP

By: *s/ Steven M. Wilker*
Steven M. Wilker, OSB No. 911882

Attorney for Defendant Source Weekly

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TONKON TORP LLP
888 SW Fifth Avenue, Suite 1600
Portland, Oregon 97204
503-221-1440