CITY OF BELLINGHAM
WASHINGTON

Water System Plan

March 2025 / DRAFT

carollo

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Abbreviations

$/lf	cost per linear foot
°C	degrees Celsius
µg/L	micrograms per liter
µmhos/cm	micromhos per centimeter
AAGR	annual average growth rate
AC	Asbestos Concrete
ADD	average day demand
afy	acre-feet per year
AMI	advanced metering infrastructure
ASL	anticipated service lives
AWWA	American Water Works Association
BMC	Bellingham Municipal Code
BMP	Best Management Practice
BPS	booster pump station
CaCO3	calcium carbonate
CAO	Critical Areas Ordinance
Carollo	Carollo Engineers, Inc.
ccf	hundred cubic feet
CCP	Concrete Cylinder Pipe
CEC	contaminants of emerging concern
CFE	combined filter effluent
cfs	cubic feet per second
CI	Cast Iron
CIP	Capital Improvements Plan
City	City of Bellingham
colonies/mL	colony forming units per milliliter
comm	commercial
CON	Concrete
COP	Copper
CPCDD	City’s Planning and Community Development Department
CSMR	chloride-to-sulfate mass ratio
CT	contact time
DAF	dissolved air floatation
DBP	disinfection byproducts
DBPR	Disinfection Byproduct Rule
DI	Ductile Iron
DNS	determination of non-significance
DOC	dissolved organic carbon

DOE	Department of Ecology
DOH	Department of Health
DSL	distribution system leakage
ECI	Employment Cost Indices
ELA	Engineering, Legal, and Administrative
ENR	Engineering News-Record
EPDS	entry point to distribution system
EPS	extended period simulation
ERU	Equivalent Residential Unit
FCS	FCS, a Bowman company
FSS	fire-suppression storage
ft/sec	feet per second
G.O.	General obligation
GAL	Galvanized
gal/ft^2	gallons per square feet
GMA	Growth Management Act
GP	Georgia-Pacific
gpd	gallons per day
gpd/ERU	gallons per day per Equivalent Residential Unit
gpm	gallons per minute
HAA5	haloacetic acids
HAL	health advisory levels
HDPE	High Density Polyethylene
HFPO-DA	Hexafluoropropylene oxide dimer acid
HGL	hydraulic grade line
HP	horsepower
HVAC	heating, ventilation, and air conditioning
indust	industrial
IOC	inorganic contaminants
irrigc	irrigation commercial
ISDC	irrigation system development charge
kW	kilowatts
kWh	kilowatt hours
LCRI	Lead and Copper Rule Improvements
LCRR	Lead and Copper Rule Revisions
LF	linear feet
LRAA	locational running annual averages
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
Lummi	Lummi Tribal Water and Sewer District
LWMP	Lake Whatcom Management Program

LWWSD	Lake Whatcom Water and Sewer District
MCC	motor control center
MCL	maximum contaminant level
MCLG	maximum contaminant level goals
MDD	maximum day demand
mfr	manufacturing
MG	million gallon
mg/L	milligrams per liter
mgd	million gallons per day
MSDS	Materials Safety Data Sheets
MSL	mean seal level
N/A	not applicable
NCOD	National Contaminant Occurrence Database
NDMA	N-Nitrosodimethylamine
NTU	nephelometric turbidity units
O&M	operations and maintenance
OEL	Operational Evaluation Limit
OFM	Office of Financial Management
PAC	powdered activated carbon
PDD	peak day demand
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutane sulfonate
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonic acid
PHD	peak hour demand
PHF	peak hour flow
Plan	Water System Plan
PLC	programmable logic controller
ppt	parts per trillion
PRV	Pressure Reducing Valves
psi	pounds per square inch
PVC	Polyvinyl Chloride
PZ	Pressure Zone
R&R	replace and repair
RCP	representative concentration pathway
RCW	Revised Codes of Washington
RUL	remaining useful life
SAL	State Advisory Levels

SCADA	supervisory control and data acquisition
SDC	system development charge
SDWA	Safe Drinking Water Act
SEPA	State Environmental Policy Act
SFR	single family residential
SMP	Shoreline Master Program
SOC	synthetic organic contaminants
SOP	standard operating procedure
SS	standby storage
State	State of Washington
TAZ	Transportation Analysis Zone
TCR	Total Coliform Rule
TOC	total organic carbon
TTHMs	total trihalomethanes
UCM	Unregulated Contaminant Monitoring Program
UCMR	Unregulated Contaminant Monitoring Rule
UCMR3	Unregulated Contaminant Monitoring Rule 3
UCMR5	Unregulated Contaminant Monitoring Rule 5
UFRV	unit filter run volume
UGA	Urban Growth Area
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VFD	variable frequency drive
VOC	volatile organic contaminant
WAC	Washington Administrative Code
WD	Water District
WFI	Water Facilities Inventory
WIFIA	Water Infrastructure Finance and Innovation Act
WLCAP	Water Loss Control Action Plan
WQP	Water Quality Parameters
WRIA 1	Water Resource Inventory Area 1
WSDM	Water System Design Manual
WSP	Water System Plan
WSPP	Water Source Protection Plan
WTP	water treatment plant
WUE	water use efficiency

EXECUTIVE SUMMARY

ES.1 Introduction

This Water System Plan (Plan) updates the City of Bellingham's (City) Water System Plan. It was developed collaboratively by City staff, Carollo Engineers (Carollo), and FCS Group. This Plan documents the current status of the water system and evaluates future needs of the water utility. The data used for this Plan was current as of June 2022. The Plan was developed between 2022 and 2025 for approval in 2025. This Plan will be used as a guide in maintaining and improving the water system in the short-term over the next 10 years and also provides a planning framework for the 20-year, long-term planning horizon.

The purpose of this Plan is to document changes to the City's water system, identify required system modifications, and appropriately outline capital improvement projects to meet future water demands. Maintaining a current Plan is required to meet the regulations of the Washington State Department of Health (DOH) and the requirements of the Washington State Growth Management Act. This Plan complies with the requirements of DOH as set forth in the Washington Administrative Code (WAC) 246-290-100, Water System Plan.

This Plan contains timeframes, which are the intended framework for future funding decisions and within which future actions and decisions are intended to occur. However, these timeframes are estimates, and depending on factors involved in the processing of applications and project work, and availability of funding, the timing may change. The framework presented in this Plan does not represent binding commitments by the City.

Key points of the Plan including analysis results and recommendations are emphasized below, with more detail provided in the chapters.

ES.2 Description of Water System

The City owns and manages its water system for municipal water supply purposes. These purposes span a broad range of water uses, including residential, commercial, industrial, and government. The water system currently consists of 13 pressure zones, 13 reservoirs, 15 pump stations, 6 pressure-reducing valves, and approximately 440 miles of transmission and distribution pipelines. Water supply sources for the water treatment plant (WTP) include Lake Whatcom and the Middle Fork of the Nooksack River, both located on the east side of the service area. Lake Padden is also a source of municipal supply for the system, located to the south of the service area. The Washington State Department of Health (DOH) water system identification number for the City's municipal system is 05600.

The City's retail service area is shown on Figure ES.1. Retail service area is the specific area, defined by the municipal supplier, where the supplier has a duty to provide service to new service connections, as set forth in RCW 43.20.260, if:

1. Its service can be available in a timely and reasonable manner;
2. the municipal water supplier has sufficient water rights to provide the service;

3. the municipal water supplier has sufficient capacity to serve the water in a safe and reliable manner as determined by the department of health; and
4. it is consistent with the requirements of any comprehensive plans or development regulations adopted under chapter 36.70A RCW or any other applicable comprehensive plan, land use plan, or development regulation adopted by a city, town, or county for the service area and, for water service by the water utility of a city or town, with the utility service extension ordinances of the city or town.

Note - While the City's urban growth area (UGA) is included in the City's retail service area, new water service is not available in the UGA unless the property annexes or city council determines that service is necessary to protect basic public health and safety and the environment and certain other conditions are met. See discussion in Section 3.2.2.

The City's retail service area is coterminous with its UGA as shown in Figure ES.1. The City's retail service area includes portions of its UGA that are within other purveyors' water service areas as established by the Whatcom County Coordinated Water System Plan, although these overlapping areas are not depicted in Figure ES.1

While the City's retail service area includes its UGA, new water service is not available in the UGA unless the property annexes or city council determines that such service is necessary to protect basic public health and safety and the environment and certain other conditions are met. See BMC 15.36.010(B) and (D).

The City has also entered into water service agreements with several Water Districts and other small purveyors adjacent to the City's system to provide regular supply to these purveyors. The City's service area and interlocal agreements are further outlined in Chapter 1 and Appendix H.

The City manages its water system through its Public Works Department. Daily maintenance and operations are executed by the Operations Division, which is comprised primarily of operators, field crew, and laboratory staff. Water system planning, design, and other non-routine management of the water system are addressed by engineering staff within the Engineering Division. Figure ES.2 presents the water facility locations.

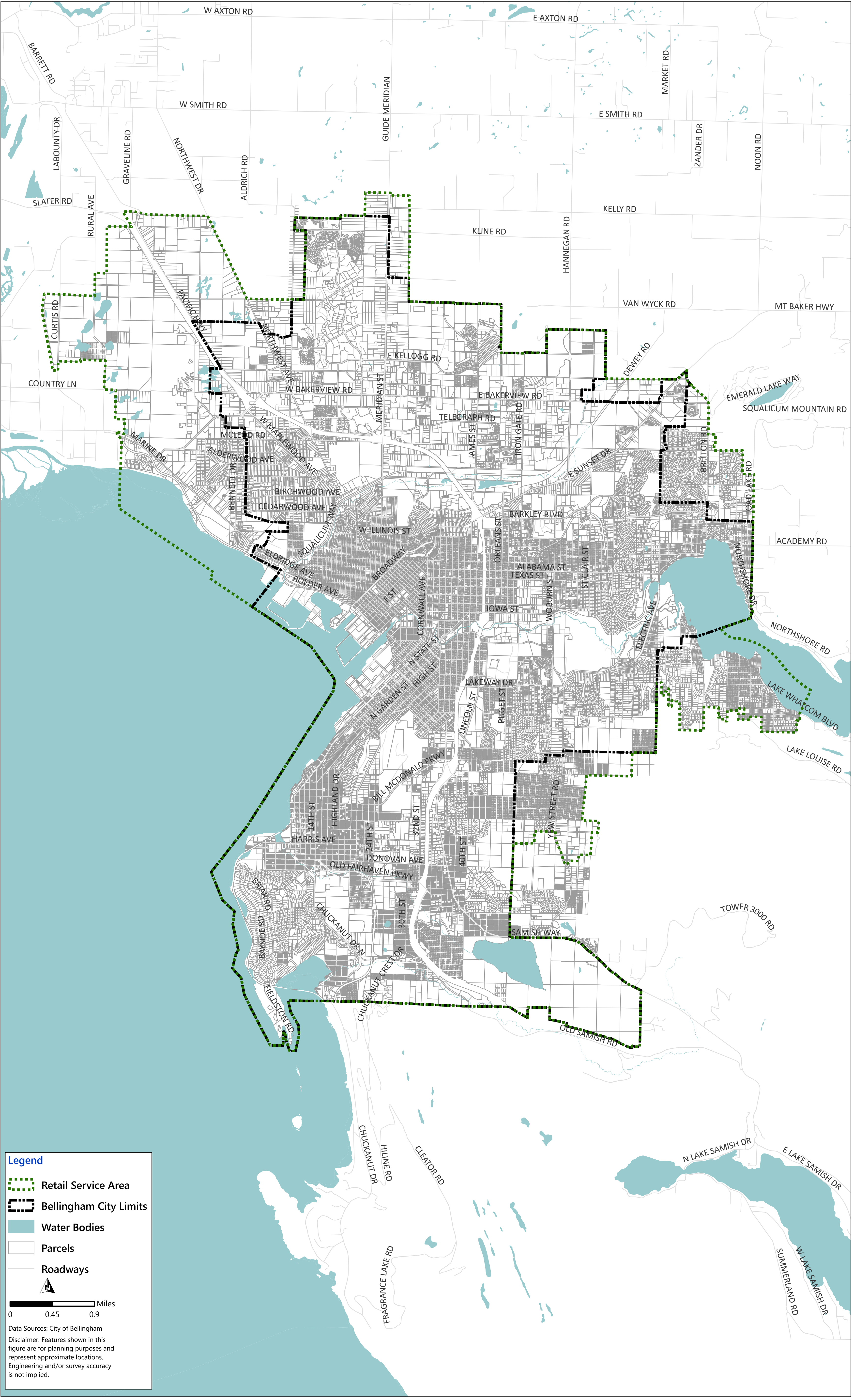

Figure ES.1 Retail Service Area

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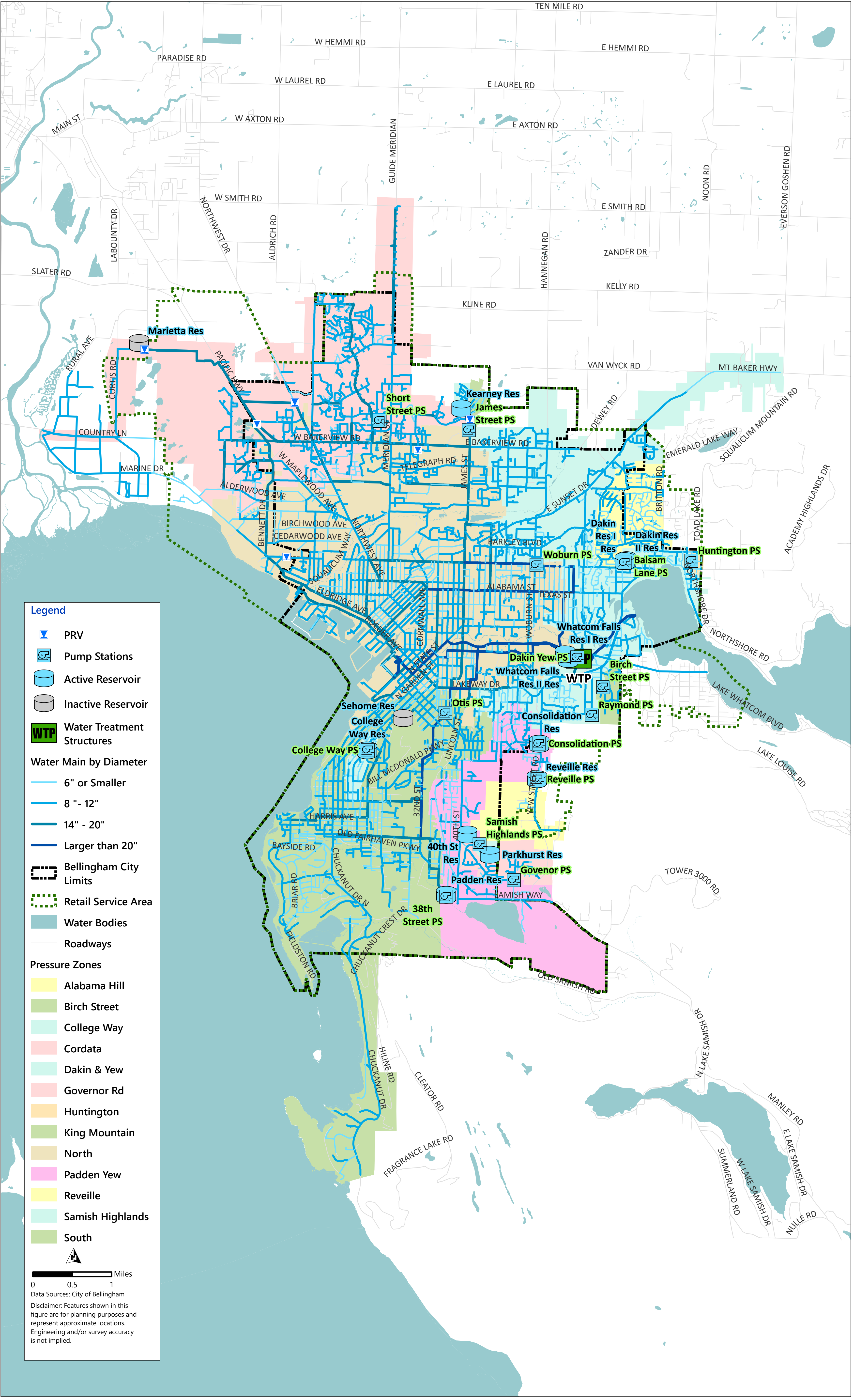


Figure ES.2 Existing System

CITY OF BELLINGHAM
WATER SYSTEM PLAN

ES.3 Policies and Criteria

The policies, design criteria, and standards summarized in this Plan are established by the City to provide the framework for planning, designing, operating, and managing its water system. The City strives to provide safe, reliable drinking water for its customers now and into the future.

Law is set by the federal government through federal regulations, by the State of Washington (State) in the form of statutes: RCW, WAC, by Whatcom County in the form of policies, and by Bellingham City Council in the form of ordinances and resolutions. City policies are established in order to provide a vision or mission for the Water Utility and to provide a framework for the planning, design, operation, management, and maintenance of the water system. City policies cannot be less stringent than or in conflict with adopted laws.

The City manages its water utility and water system in accordance with established federal and state regulations for public water systems.

ES.4 Basic Planning Data and Water Demand Forecasting

Projecting future water demand is a key part of the water system planning process. Demand projections are used to identify the system improvements required for supply, pumping, storage, and piping infrastructure. Three future water demand scenarios (Low, Medium, and High) were projected for the City. The Medium scenario's predictions most closely resemble the City’s future demands, while the Low and High demand projection scenarios provide a range within which the City’s future water demands are expected to fall. The Medium scenario was used for the Chapter 7 system analysis, which identifies future pumping, storage, and distribution system requirements. Demand is presented in terms of annual average daily demand (ADD) and maximum daily demand (MDD).

Figure ES.3 shows a chart of the system-wide demand projections, which accounts for future retail demand as well as wholesale demand from neighboring purveyors. The City's ADD is projected to be between 10.2 and 20 million gallons per day (mgd) in 2034 for the Low and High scenarios, respectively. By 2044, ADD is estimated to be between 11.3 mgd and 44 mgd for the Low and High scenarios, respectively.

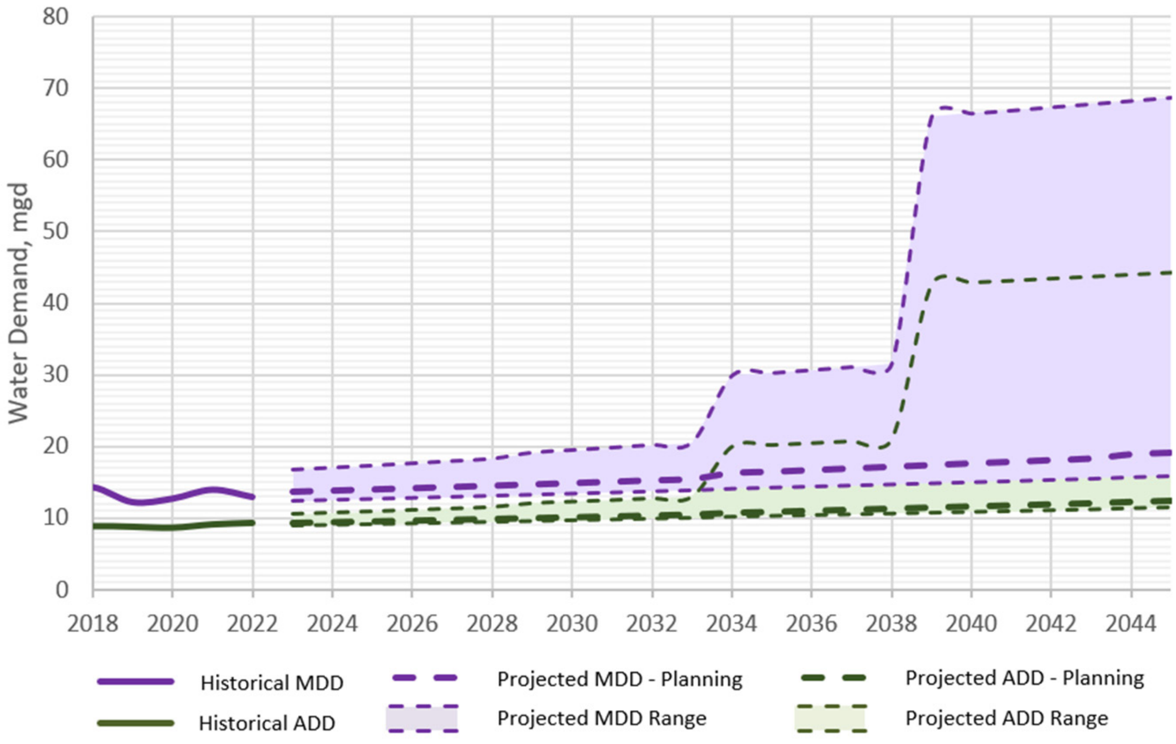


Figure ES.3 Projected Water Demand

ES.5 Water Use Efficiency and Conservation Plan

In 2003, the Washington State Legislature passed the Municipal Water Law to address the increasing demand on Washington's water resources. As part of this law, the state implemented the WUE Rule, which requires all municipal water suppliers to use water more efficiently in exchange for guaranteed, flexible water rights to help meet future demands.

While Table ES.1 summarizes the mandatory WUE measures, the City conducts many other conservation efforts as listed in Chapter 5.

Table ES.1 WUE Mandatory Measures

WUE Mandatory Measure	Status
Must implement the following WUE measures:	
Install production (source) meters	Implemented
Install consumption (service) meters	Implemented
Perform meter calibration	Implemented/Ongoing
Implement a WLCAP to control leakage if exceeds 10%	Implemented/Ongoing
Educate customers about water efficiency at least once per year	Implemented/Ongoing
Must evaluate or implement these WUE measures:	
Evaluate rates that encourage water demand efficiency	Implemented
Evaluate reclamation	Implemented

Notes:
WLCAP - Water Loss Control Action Plan.

ES.6 Water Supply Strategy

A study was done to evaluate current and future water resources to identify deficiencies and propose improvements. Chapter 6 outlines the City's of sources of supply and existing water rights, summarizes the purchased water supply, and makes recommendations for future supply facilities.

The water supply for the City's potable system and wholesale customers is exclusively sourced from Lake Whatcom and the Middle Fork of the Nooksack River. A transmission line takes water from Lake Whatcom to the City-owned-and-operated WTP. Additionally, the City holds three legacy water rights to divert and store water from Lake Padden for municipal purposes.

Figure ES.4 presents the System Supply versus Average Day and Maximum Day Demand Projections, respectively. According to these projections, the City's water rights are adequate to meet anticipated needs throughout the planning horizon of this Master Plan and through the next 100 years.

Based on the comparison between water rights and MDD, the City has sufficient water rights to meet projected demand through the next 100 years, even for the High demand scenario. The comparison between WTP supply shows there will be some need to expand the physical supply range based on current filtration rates. WTP capacity may require expansion in subsequent years, depending on the following demand scenarios:

- High Demand Scenario: MDD will reach both the current WTP supply range and theoretical capacity between the 10 and 20-year scenarios. That is to say these will be reached by 2034 and 2044 respectively.
- Medium Demand Scenario: The WTP supply range is adequate through 2044, and expansion will need to be considered in the 2050s.
- Low Demand Scenario: The WTP supply range is adequate through 2044, and expansion will need to be considered in the 2070s.

Due to the low likelihood of demands increasing at the High demand scenario for the next 10 years, no projects are recommended to increase the WTP capacity for this Plan. The water supply strategy for the City should be reconsidered during the next Plan when demand has further developed.

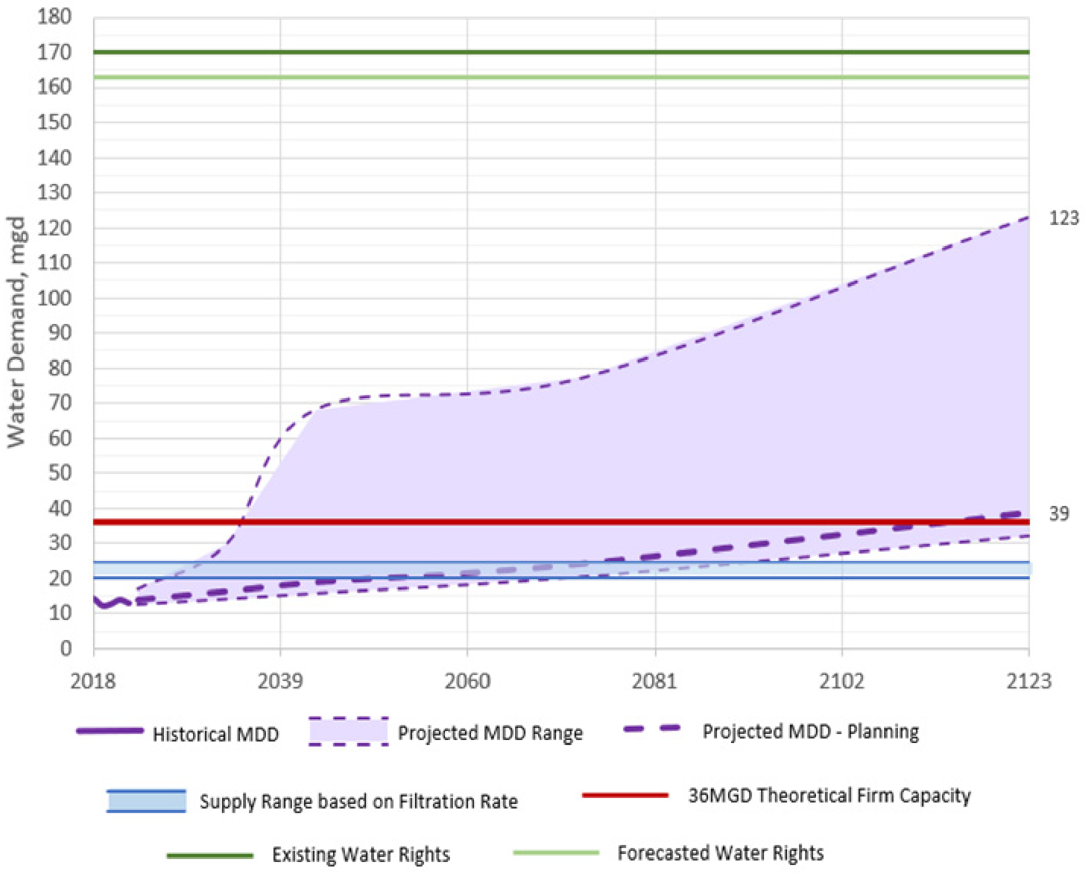


Figure ES.4 Long Range MDD Projections Versus Water Rights

ES.7 System Analysis

The system analysis identified potential future system deficiencies in the City's water distribution and based on the analysis results, Carollo recommended improvements to the system. Carollo evaluated the capacity of the pipelines using the City's updated and calibrated hydraulic model. Evaluations of the remaining assets were conducted in Microsoft Excel. The system analysis yielded a number of recommended improvements for the pump stations, reservoirs, pipelines, and pressure zones.

ES.7.1 Storage Analysis

The City's reservoir storage requirements depend on the water system's configuration, seasonal and daily variation in water-use patterns, and the reliability of various water system components. Water storage volumes are comprised of five components:

- Operational storage.
- Equalizing storage.
- Standby storage.
- Fire-suppression storage.
- Dead storage.

To evaluate storage capacities, the City's water distribution system was divided into five different storage areas containing 13 total pressure zones. A summary of the existing storage and storage needs in 2044 is shown in Table ES.2. The City has identified the King Mountain Zone and the Upper Yew Zone as the optimal locations for new storage tanks. A phased approach to storage recommendations is recommended, so storage needs are phased as demand increases and storage needs grow. This is described in more detail in Chapter 7.

Table ES.2 Storage Deficits by Planning Year

Storage Area	Total Storage (MG)	2024 Required Storage (MG)	2034 Required Storage (MG)	2044 Required Storage (MG)
Dakin and Yew 519	1.57	4.07	4.68	5.31
North 276	18.3	16.55	18.1	19.91
South 457	1.09	3.95	4.43	5.01
Padden Yew 696	0.92	0.84	0.99	1.16
Governor Road 873	0.18	0.35	0.35	0.35
Total	**22.06**	**25.76**	**28.55**	**31.73**
Deficiency (MG)		**3.70**	**6.49**	**9.67**

ES.7.2 Pumping Analysis

To evaluate pump station capacities, the City's water distribution system was divided into 12 different pumping areas containing 15 total pump stations. Open zones are ones with adequate equalizing storage, so the pump stations are only required to supply the MDD of the pumping area.

Closed zones are areas that are supplied solely through a pump station; therefore, the pump station is required to supply the PHD and fire flow.

Four pump stations were flagged as deficient and four different pump station projects are described in Chapter 7 to rehab or replace the station to meet future capacity needs.

ES.7.3 Distribution System Analysis

The calibrated InfoWater Pro model of the City's distribution system was used to analyze the system for future planning years, and projected system demands were added for the medium scenario for the 2034 and 2044 planning years. The hydraulic model was used to evaluate typical system conditions during diurnal operations and for fire flow availability.

During normal operations, the minimum pressure as set by the DOH during MDD at PHD was 30 psi at the service meter. DOH velocity criteria is to keep pipe velocities below 8 feet per second (ft/sec).

The City's goal is to provide a maximum of 100 psi at the service meter and keep pipe velocities below 8 ft/sec during peak hour flows (PHF).

Fire flows are typically the largest flows a system experiences and often a major factor in pipe sizing and network configurations. Using the InfoWater Pro fire flow test feature, the hydraulic model evaluated the fire capabilities at all hydrants in the system. Specifically, it systematically simulated a fire at each model node representing a fire hydrant for each of the planning years. All system nodes with service connections were tested for a minimum pressure of 20 psi during the point fire demands.

Six areas of low pressure were identified. These areas are addressed through proposed pressure zone rezoning and individual booster pump stations outlined in Chapter 7.

Fire flow recommendations are bundled into three different types of projects:

- P-1 - General program to address dead end deficiencies.
- P-2 - General program to address single family residential dead end deficiencies.
- Individual projects to address fire flow deficiencies.

ES.8 Water Quality and Water Treatment

The City owns and operates the Whatcom Falls WTP. The Whatcom Falls WTP is located within the City in Whatcom Falls Park. Chapter 8 provides an overview of the WTP in detail.

The City's source water protection efforts have focused on the Lake Whatcom watershed and the Middle Fork of the Nooksack River since the City utilizes both locations for sources water under existing water rights.

The City, in partnership with Whatcom County and Lake Whatcom Water and Sewer District jointly administer the Lake Whatcom Management Program (LWMP) to protect water quality and promote the long-term protection, preservation, and enhancement of the Lake Whatcom watershed. Lake Whatcom has been monitored for many years, generally beginning with regularity in the early 1960s although limited data prior to that period can be found in some early reports and studies.

In addition to monitoring, the three jurisdictions, through the LWMP, implement twelve program areas to protect the quality of water in the Lake Whatcom watershed. Program areas include Land Use, Stormwater, Monitoring, Property Acquisition, Aquatic Invasive Species Prevention, Hazardous Materials, Forest Management, Climate Change, Utilities and Transportation, Recreation, Administration, and Community Outreach and Education. The three jurisdictions plan to invest over $71 million over the next five years on sources water protection actions. The City's portion is expected to be $45 million and is funded out of the Water Fund 410. The LWMP is one way the City is responding to the Lake Whatcom Total Maximum Daily Load (TMDL) for Dissolved Oxygen. While those projects, actions, and costs are not included in this Water Supply Plan, they are important components of the City's overall strategy to provide high quality drinking water to Bellingham residents.

Table ES.3 summarizes all recommended Whatcom Falls WTP improvement projects identified from previous work by the City as well as the evaluations completed in this plan for inclusion in capital improvement planning, presented in Chapter 10.

Table ES.3 Whatcom Falls WTP Improvements Projects

Project	Source
Raw Water Intake Rehabilitation Improvements	▪ Intake Pipelines Condition Assessment (Jacobs 2024)
Redundant Raw Water Intake Feasibility Study	▪ Section 8.7.1 and Section 8.7.7
Redundant Raw Water Intake	▪ Section 8.7.1 and Section 8.7.7
Screenhouse Rehabilitation	▪ Gatehouse Condition Assessment Report (Jacobs 2024) ▪ Screenhouse Condition Assessment Report (Jacobs 2024) ▪ Tunnel Condition Assessment Report (Jacobs 2024)
Filter Rehabilitation	▪ Technical Memorandum WTP Filter Improvements (RH2 2023)
Soda Ash Feed System Replacement	▪ Technical Memorandum Soda Ash Improvements (RH2 2023)
Whatcom Falls WTP Flow Metering Improvements Study	▪ Chapter 2 ▪ Memorandum, City of Bellingham Gravity Flow Meter Assessment (Jacobs 2020)
Whatcom Falls WTP Flow Metering Improvements	▪ Chapter 2 ▪ Memorandum, City of Bellingham Gravity Flow Meter Assessment (Jacobs 2020)
Alum System Replacement	▪ Section 8.7.7
Powerhouse Demolition	▪ Section 8.7.8
SCADA System Evaluation	▪ Section 8.7.7
Polymer System Replacement	▪ Section 8.7.7
Filter Mechanical Equipment Replacement	▪ Section 8.7.7
MCC Replacement	▪ Section 8.7.7
Whatcom Falls WTP Seismic Resilience and Life Safety Evaluation	▪ Section 8.6
Whatcom Falls WTP HVAC System Improvements	▪ Section 8.7.8

ES.9 Operation and Maintenance

The City manages its water system and wastewater collection system in a cooperative manner within the same management unit, the Public Works Department. Daily maintenance and operations are executed by the Operations Division. The City's ongoing Operation and Maintenance Program is documented in this Water System Plan. The Program includes system management, operator certification, system control, water quality monitoring, emergency response, safety, cross-connection control, response to customer complaints, recordkeeping and reporting, and improvements.

The deterioration of water distribution pipes is an inevitable issue due to factors like corrosion, soil conditions, and manufacturing defects. Accurately assessing the condition of these pipes requires on-site inspection, which limits maintenance efforts and thus increases the risk of costly failures. Pipe failures can lead to significant economic losses, disruption to essential services, and risks to public health and safety.

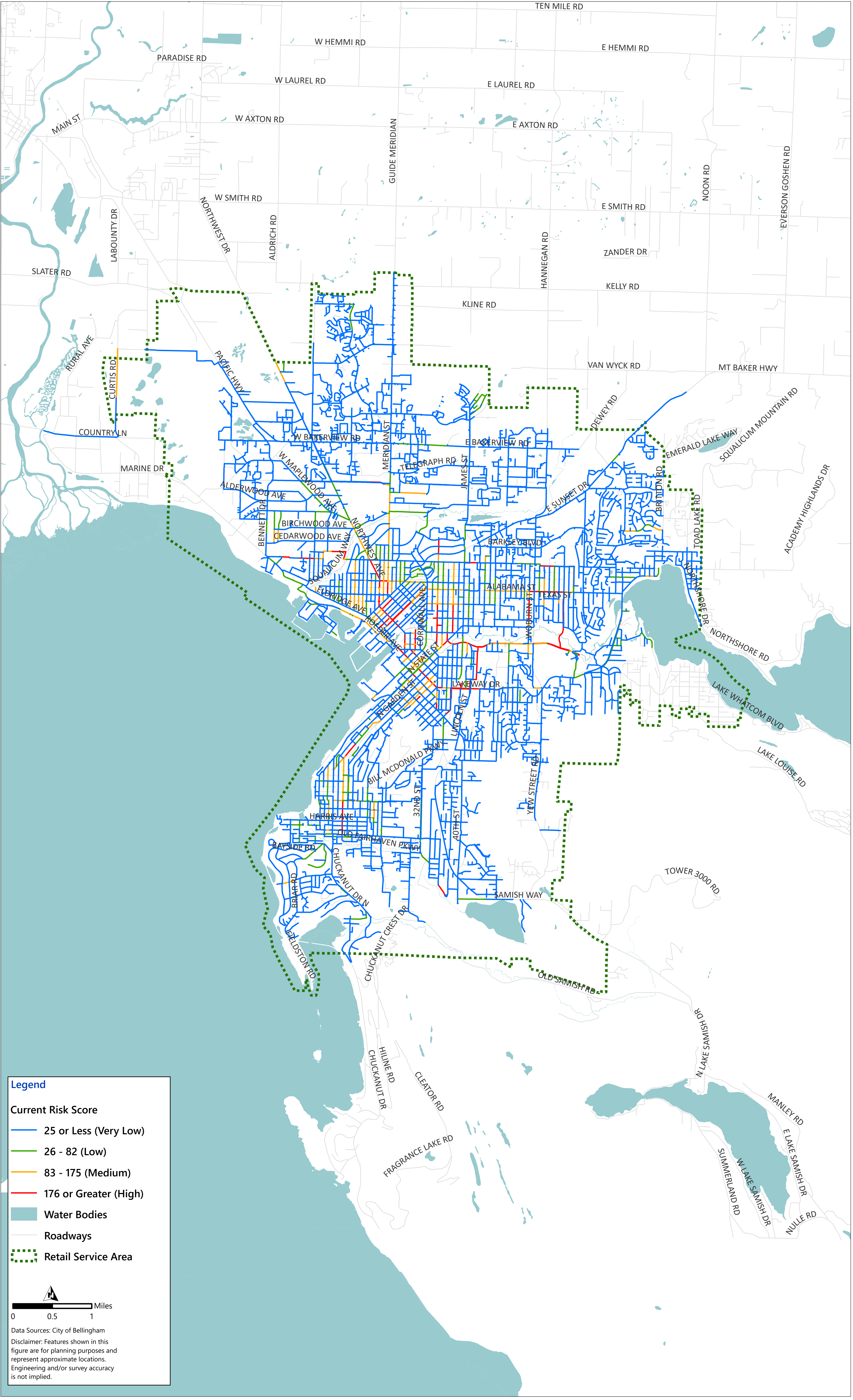
A risk assessment model is designed to be simple, cost-effective, and informative, with a focus on predicting pipe failures and prioritizing high-risk pipes for maintenance.

The risk assessment analyzed 7,406 pipe segments totaling 2,098,161 linear feet. The current Risk of Failure projections for those pipe segments are summarized in Table ES.4. Figure ES.5 shows the risk score of all pipe across the distribution system.

Table ES.4 Risk of Failure Summary

Risk Level	Count			Length of Pipe		
	Current	10 Year	20 Year	Current	10 Year	20 Year
Very Low	86.9%	81.2%	63.8%	83.7%	76.4%	57.4%
Low	3.7%	7.4%	18.1%	5.1%	10.4%	20.8%
Medium	5.6%	6.4%	11.7%	6.1%	6.6%	13.6%
High	3.8%	5.0%	6.3%	5.1%	6.6%	8.2%

The RUL analysis examined the pipes' material and installation year, as well as their materials' useful life, to determine the year during which each pipe would reach the end of its useful life. It is recommended that the City increase its annual pipe-replacement program and start replacing approximately 12,167 LF of pipe per year, targeting pipes that have reached the end of their useful life. This recommendation is outlined in the CIP, Chapter 10.



Data Sources: City of Bellingham

Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

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Figure ES.5 Pipeline Current Risk Score

ES.9.1 Design and Construction Standards

Capital improvements to the water system shall be designed in accordance with DOH and City performance, design, and construction standards. Major facility improvement plans and designs are required to be submitted to both the City and DOH for their review and approvals in accordance with Washington Administrative Code (WAC) 246-290. Construction of improvements to Bellingham's water system must be certified with respect to compliance with the City's design and construction standards, DOH requirements, and the design plans and specifications submitted to the City for review by the party undertaking the improvement. Certification of such compliance to DOH shall be effected by the completion of a Construction Report for Public Water System Projects (a DOH form), per WAC 246-290-040.

ES.10 Capital Improvement Plan

The City's Improvement Program summarizes the improvements planned over the 10- and 20-year planning horizon. As described above, the key improvements developed for the Program address treatment, distribution system storage, distribution system piping, and fire protection and minimum service pressure requirements are based on the analyses described in Section ES.3. The Capital Improvement Program is projected to cost about $529.5 million over the course of the next 20 years. Table ES.5 outlines the projects included in the CIP. Tables ES.5 and ES.6 summarize the CIP projects by project category and priority, respectively. Figures ES.6 and ES.7 summarize the percent of each project identified by project category and project type, respectively. Specific project details are provided in Chapter 10.

The Plan's capital projects are categorized by the following infrastructure:

- Pump Station (PS).
- Pressure Zone (PZ).
- Storage Facilities (ST).
- Programmatic (P)
- Distribution pipeline (D).
- Water Treatment Plant (WTP).
- General (G).

As part of the planning and development of the capital improvement plan, the water utility will continue to consider programs and projects to support the City's business plan, vision and mission for economic growth, social equity, and environmental sustainability goals. The water utility will continue to implement capital improvement projects in a transparent manner, informed by system and community needs and the financial, environmental, and social costs and benefits, to provide long-term community value.

The City's annual repair and replacement programs consist of the replacement of aging and undersized water mains throughout the water distribution and transmission system. This program reduces the likelihood of system failures, unplanned service interruptions, and claims for damages against the City.

Figure ES.8 illustrates the locations of the specific projects identified.

Table ES.5 CIP Summary Table by Cost Category

Project Category	Annual Cost	Total Cost	Percentage
Distribution Piping	$951,750	$19,035,000	3.6%
Annual Programs	$10,991,250	$219,825,000	41.4%
Pressure Zone	$6,050	$121,000	0.02%
Pump Station	$698,300	$13,966,000	2.6%
Storage	$7,439,100	$148,782,000	28.0%
General	$65,000	$1,300,000	0.2%
Treatment Plant	$6,428,100	$128,562,000	24.2%
Total Cost	**$26,579,550**	**$531,591,000**	**100.0%**

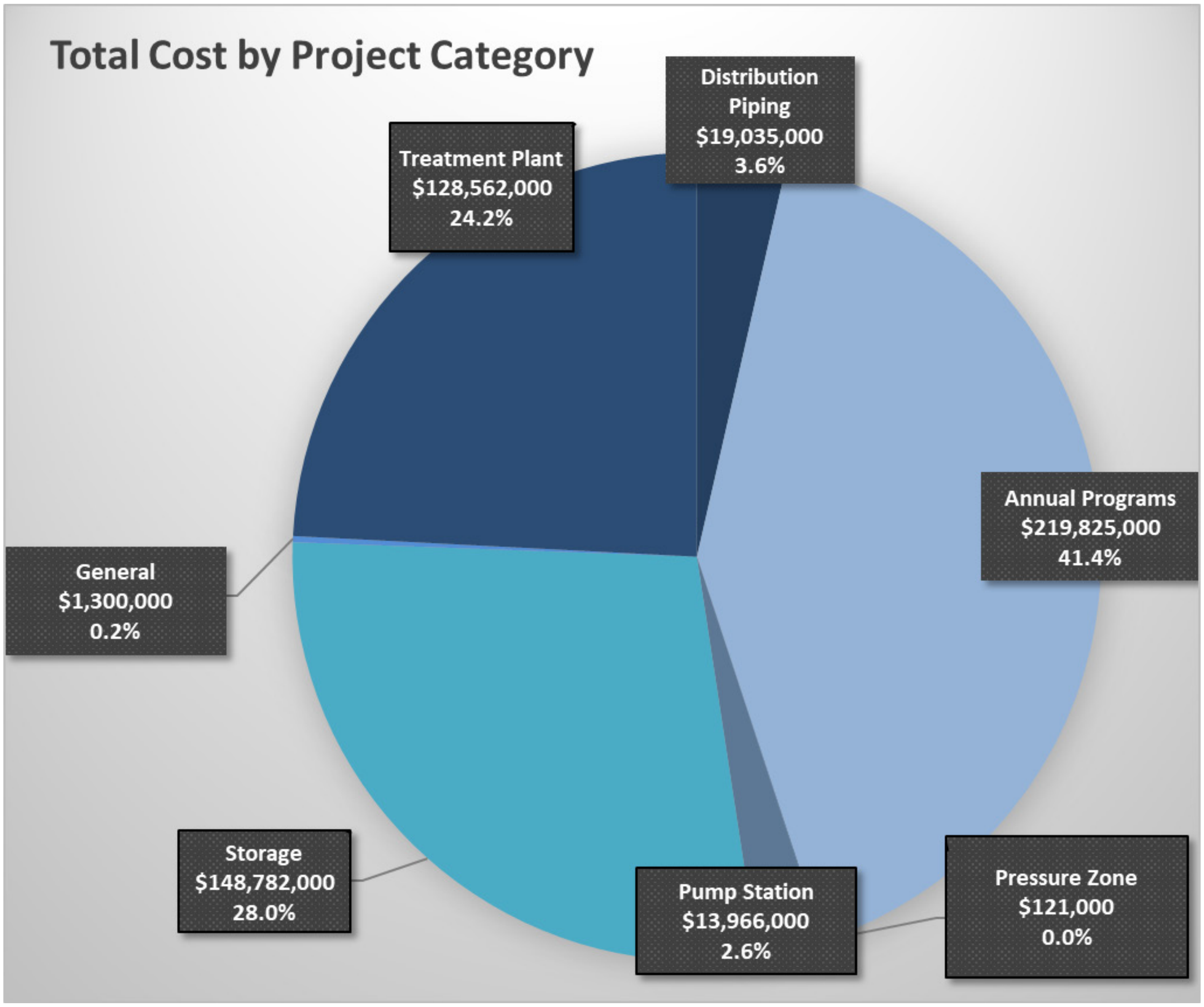

Figure ES.6 CIP Summary Table by Project Category

Table ES.6 CIP Summary Table by Project Priority

Project Priority	Total Cost	Percentage
0-10 years	$108,269,000	20.4%
10-20 years	$203,497,000	38.4%
Annual	$219,825,000	41.13%
Total Cost	**$531,591,000**	**100.0%**

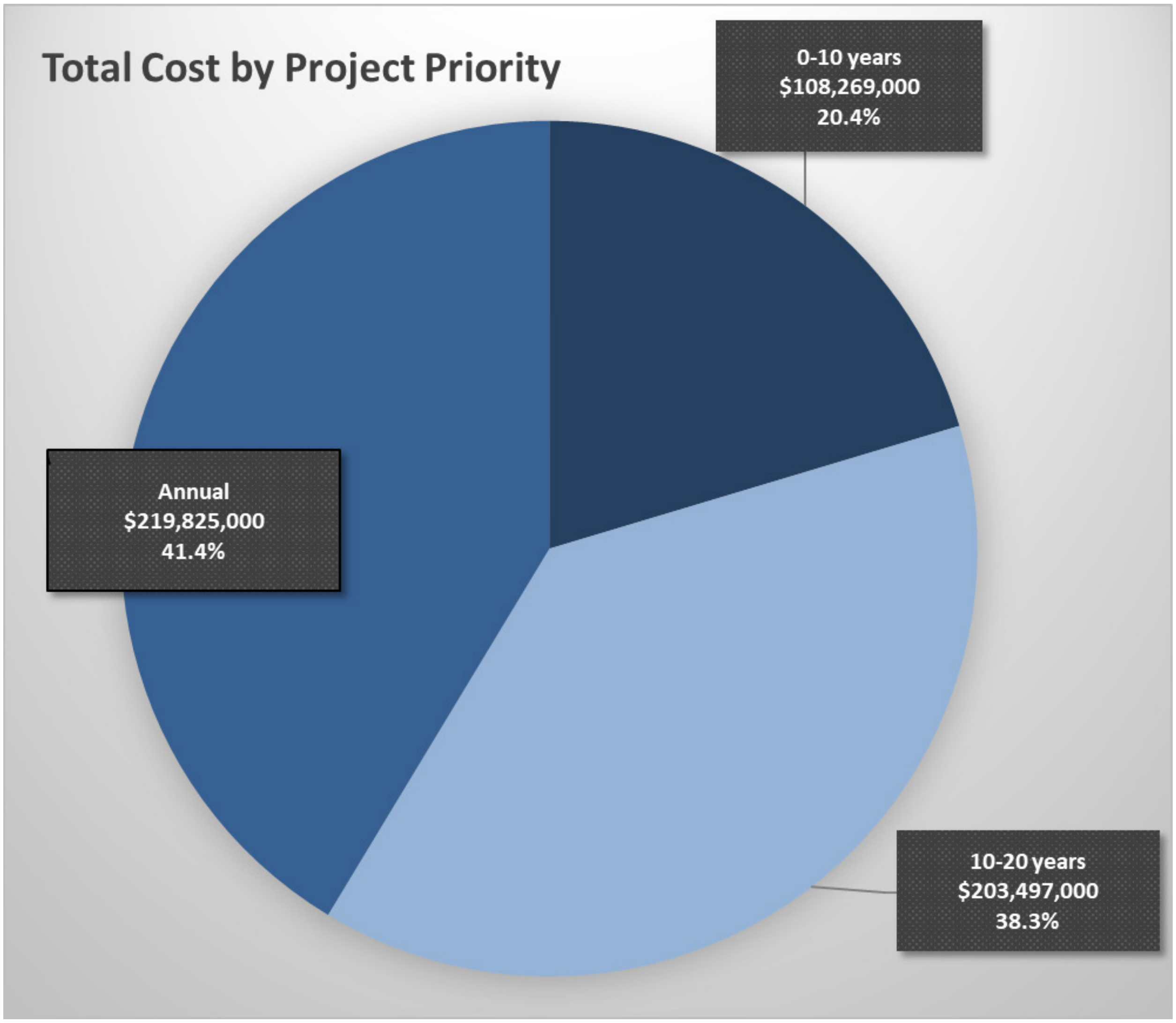

Figure ES.7 CIP Summary Table by Project Priority

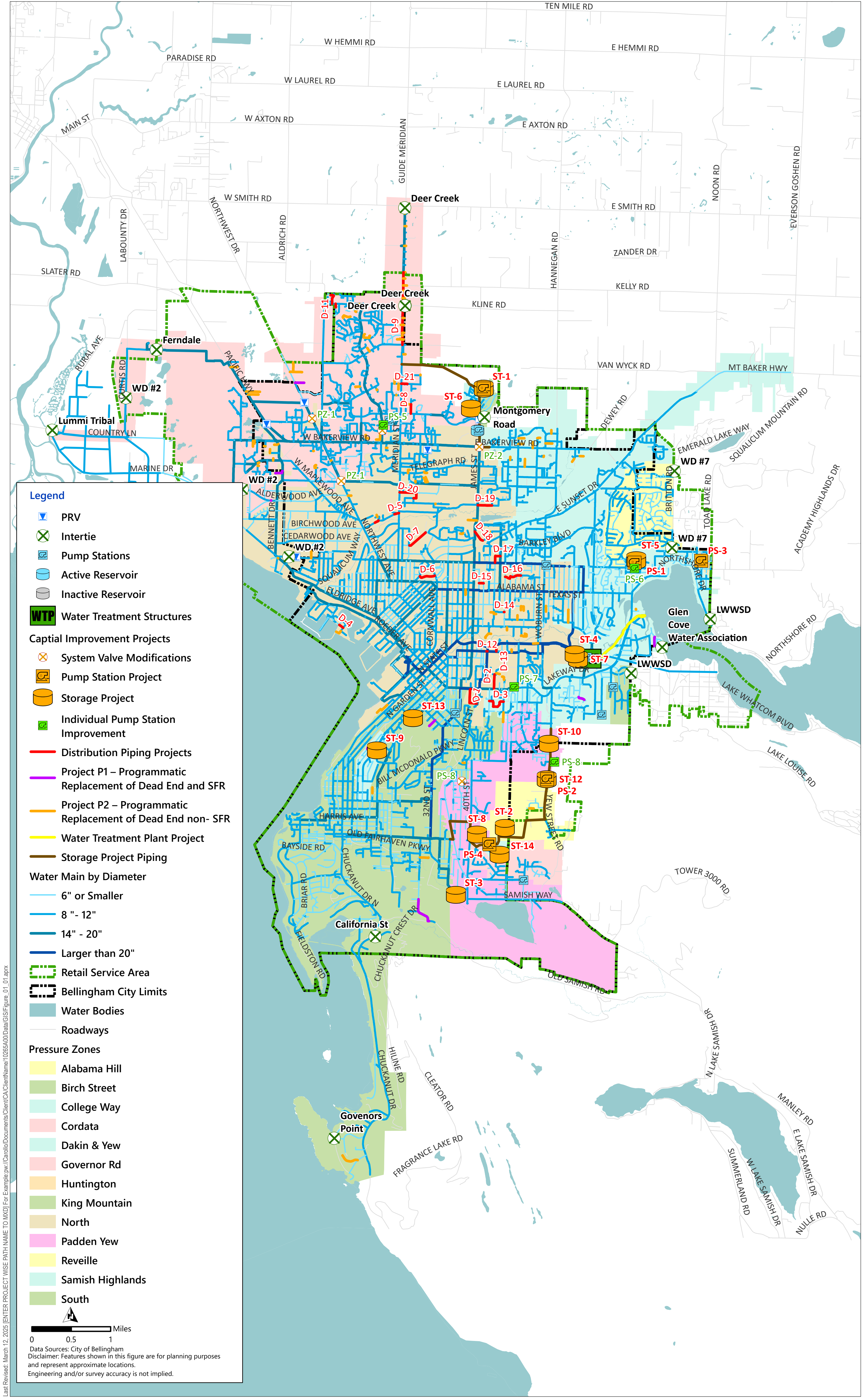

Figure ES.8 Recommended CIP Projects

ES.11 Financial Program

This section discusses the recent financial performance of Bellingham's water utility and presents a future projection of its revenues and expenses. The ability of the City to absorb costs associated with proposed capital improvements in the next few years, along with a discussion of potential funding sources, is also included. The utility's current rate structure is also outlined in this section.

Bellingham funds the water utility as an enterprise fund within the Public Works Department. As an enterprise fund, the Water Utility (Fund 410) is operated in a similar manner as a private business and is responsible for generating sufficient revenues to cover its operating expenses. Revenues for the fund are primarily generated from charges to customers for water service.

FCS Group evaluated two scenarios of cost escalation, Scenario 1 escalated the costs to the estimated year of construction, starting the R&R program at $11 million per year, while Scenario 2 begins at 2 million per year, increasing by $2 million annually to reach nearly $13 million by 2029. After discussions with City staff in December 2024, it was determined that Scenario 2 is more realistic than Scenario 1. These recommended rate adjustments allow the City to meet the following objectives:

- Continue to fund existing operations, plus inflation.
- Allow the utility to complete its 10-year CIP with the delays identified in Scenario 2.
- Pay for existing and new debt service while maintaining a debt service coverage ratio above 1.7.
- Maintain utility reserves at a healthy level throughout the forecast.

Figure ES.9 illustrates the projected annual capital expenditure, in escalated dollars, amounting to $247 million, which represents a reduction of nearly $40 million compared to Scenario 1.

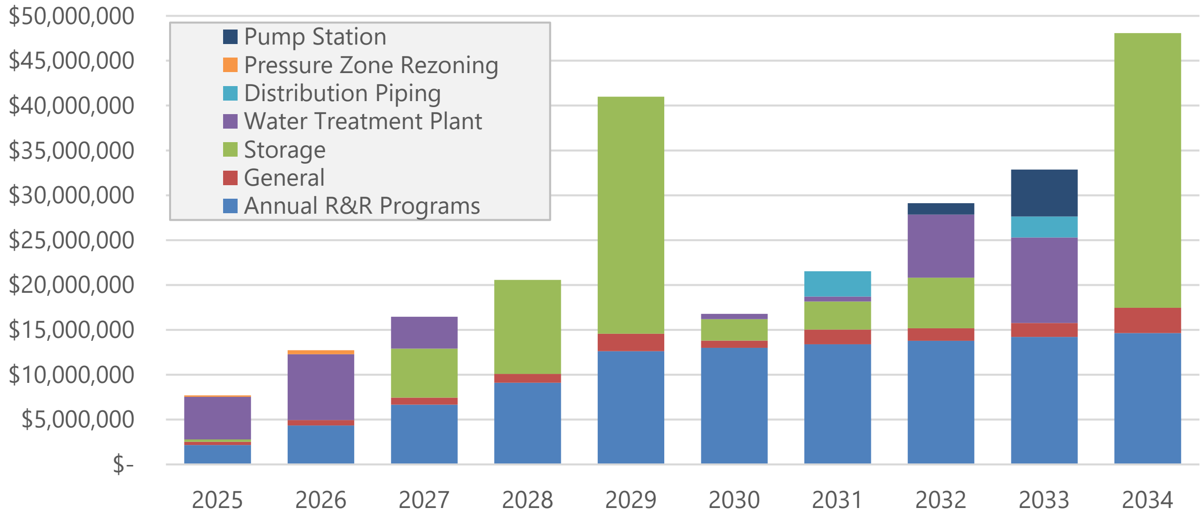

Figure ES.9 Capital Expenditure Forecast (Delayed CIP) - Scenario 2

CHAPTER 1 INTRODUCTION

1.1 Purpose

This Water System Plan (Plan) updates the City of Bellingham's (City) 2013 Water System Plan Update. It was developed collaboratively by City staff, Carollo Engineers (Carollo), and FCS Group. This Plan documents the water system's current status and evaluates the water City's future needs. The data used for this Plan was current as of 2022. The Plan was developed between 2022 and 2024 for approval in 2025. This Plan will be used as a guide for maintaining and improving the water system in the short-term over the next ten years. It will also provide a framework for the 20-year, long-term planning horizon.

This Plan's purpose is to document changes to the City's water system, identify required system modifications, and appropriately outline capital improvement projects to meet future water demands. Maintaining a current Plan is required to meet the regulations of the Washington State Department of Health (DOH) and the requirements of the Washington State Growth Management Act. The Plan complies with the requirements of DOH as set forth in the Washington Administrative Code (WAC) 246-290-100, Water System Plan.

This Plan contains timeframes, which are the intended framework for future funding decisions and within which future actions and decisions are designed to occur. However, these timeframes are estimates, and depending on factors involved in the processing of applications and project work, as well as the availability of funding, the timing may change. The framework presented in this Plan does not represent actual commitments by the City.

1.2 Authorization

Recognizing the importance of planning, developing, and financing water system facilities to provide reliable service for the existing customers and to serve anticipated growth, the City initiated the preparation of this Plan. In June 2022, the City selected the Carollo team to assist in the preparation of the updated Plan in accordance with applicable rules and regulations governing planning for water utility systems.

1.3 Objectives

This Plan has been prepared to serve as a guide for planning and designing future water system facilities and to assist the City in using its water resources in the most efficient manner possible. This Plan identifies system improvements intended to meet the expanding and changing needs of the City. Specific objectives of this Plan are addressed by individual chapters presented herein and include the following:

- Develop a document that can be updated periodically as additional information on the water system is obtained.
- Description of Existing System (Chapter 2): Document the existing water system supply, storage, and distribution facilities.

- Water System Policies, Criteria, and Standards (Chapter 3): Establish clear policies and criteria relating to water service within the City's water system.
- Planning Data and Water Demand Forecast (Chapter 4): Identify and estimate the effect of future land uses and population trends on the water system. Document historical water use and project future demands based on growth projections.
- Water Use Efficiency and Conservation (Chapter 5): Determine the City's current and proposed actions to comply with conservation planning requirements and to promote using water efficiently.
- Water Supply Strategy (Chapter 6): Conduct a supply evaluation that describes the City's sources of supply and existing water rights, summarizes the purchased water supply, and makes recommendations for future supply facilities.
- Distribution System Analysis (Chapter 7): Evaluate the capacity of the pipe network using the City's updated and calibrated hydraulic model. Summarize potential future system deficiencies in the City's water distribution network and offer recommended improvements to the system.
- Water Quality and Water Treatment (Chapter 8): Summarize the Water Treatment Plant facility, water quality regulations, and reporting requirements. Evaluate water quality against regulations, summarize water quality violations, and recommend improvements if necessary to meet anticipated or future water quality regulations.
- Operations and Maintenance (Chapter 8): Provide a comprehensive review of operations and maintenance of the City's system facilities.
- Capital Improvement Plan (Chapter 10): Develop a program of capital improvements, including priorities for design and construction.
- Financial Analysis (Chapter 11): Develop a plan for financial backing of required system improvements.
- Prepare the Plan to comply with the requirements of the DOH.

1.4 Location

The City lies in the southwestern portion of Whatcom County. Bellingham rings the shore of Bellingham Bay, protected by Lummi Island, Portage Island, and the Lummi Peninsula, and opens into the Strait of Georgia. It lies west of Mount Baker and Lake Whatcom and north of the Chuckanut Mountains and Skagit Valley.

Unincorporated Whatcom County bounds Bellingham on the north, east, and south. The total area within the current City limits and the outer harbor line of Bellingham Bay is 27.8 square miles. The total land surface area inside current City limits (excluding Lake Whatcom, Lake Padden, and Bellingham Bay) is about 25.5 square miles. The City's Urban Growth Area (UGA) includes an additional area of 11.5 square miles.

Bellingham's water service area abuts, overlaps, or both abuts and overlaps with a number of water systems, including Whatcom County Water District 2 (WD 2), Lummi Tribal Water and Sewer District (Lummi Tribal), Deer Creek Association, Water District 7 (WD 7), Glen Cove Water Co-Op, Lake Whatcom Water and Sewer District (LWWSD) (formerly Water District 10), California Street Water Association, and Montgomery Road Water Association. Figure 1.1 outlines the City's service area boundary and Figure 1.2 shows the City's neighboring water utilities.

Bellingham's water service area slopes from the hills in the east to Bellingham Bay in the west; several rolling hills between require many pressure zones to provide adequate service. It includes all of the developed area along the Bay and extends north to just south of Kelly Road.

1.5 Ownership and Management

The City owns and manages its water system for municipal water supply purposes, including a broad range of water uses, including residential, commercial, industrial, and government. The Washington State DOH water system identification number for the City's municipal system is 05600.

The City manages its water system through its Public Works Department. Daily maintenance and operations are executed by the Operations Division, which is comprised primarily of operators, field crew, and laboratory staff. Water system planning, design, and other non-routine management of the water system are addressed by engineering staff within the Engineering Division.

The main point of contact for the water system is as follows:

- Name: Mike Olinger
- Phone: 360-778-7725
- Email: molinger@cob.org
- Address: 2221 Pacific St., Bellingham, WA 98229

1.6 System History

The Bellingham water system began in 1895 when the Town of Whatcom granted the Bellingham Bay Waterworks Company a franchise. The source of water for this system was Lake Whatcom. The water facilities were purchased by New Whatcom (formerly the Towns of Sehome and Whatcom) in 1892. The southern portion of what is now Bellingham (formerly Fairhaven) was served by a separate, privately owned water system until 1935. The source of water for this system was Lake Padden. By 1960, a dam had been constructed on the Middle Fork Nooksack River, with a diversion by tunnel and pipeline to Lake Whatcom that served the entire City of Bellingham. Bellingham's Water Filtration Plant near Lake Whatcom began operation in 1968 with six mixed media gravity filters.

1.7 Existing Service Area Characteristics

The Legislature adopted the Growth Management Act (GMA) in 1990. The GMA provides that it is not appropriate for urban governmental services, which include water and sewer services, to be extended to or expanded in rural areas except in very limited circumstances that are necessary to protect public health and safety and the environment, and which do not permit urban development.

In 1979, the City enacted Ordinance 8728 relating to the extension of City water service outside City limits. Ordinance 8728 and other ordinances that followed created a number of water service zones outside City limits in which the City could contract to provide retail water service directly to customers within these zones.

The City's water service zone system was established prior to the state's adoption of the GMA in 1990 and was, in certain respects, inconsistent with the GMA.

The City repealed all of its water service zones in 2006 and 2011 in Ordinance 2006-03-026 and 2011-05-025. The repealing ordinances included a "grandfather" clause clarifying that the City did not intend to terminate any water service that was "in existence" as of the effective date of the repealing ordinances. The term "in existence" is defined in Ordinance 2006-03-026, 2006-06-064, and 2011-05-025.

Consistent with the GMA, Ordinance 2011-05-025 established new policies governing the expansion or extension of city water service outside city limits. It specified that new water service is not available in the UGA unless the property annexes or city council determines that such service is necessary to protect basic public health and safety and the environment. It specified that new water service is not available outside the UGA unless city council determines that such service is necessary to protect basic public health and safety and the environment and will not permit urban development. These policies are codified in BMC 15.36.010(B) and (C).

In 2019, the City enacted Ordinance 2019-02-003 to further amend BMC 15.36.010 to add subpart D containing additional criteria that must be met before new service will be provided outside city limits, including that the property to be served abuts an existing City water main.

1.8 Service Area Agreements

The City has entered into water service agreements with several Water Districts and other small purveyors adjacent to the City's system to provide regular water service to these purveyors. The City's service area and interlocal agreements are described in Appendix H. The flow provided to each purveyor is summarized in Table 1.1

Table 1.1 City of Bellingham Service Agreements and Interties

Name	Flow Direction	Supply Type	Capacity
WD 2	To WD 2	Regular supply.	1,100 gpm maximum at 20 psi.
WD 7	To WD 7	Regular supply.	500 gpm maximum at 20 psi.
LWWSD	To LWWSD	Domestic and fire supply.	750 gpm maximum.
California Street Water Association	To California Street Water Association	Regular supply – no fire flow.	None listed.
Montgomery Road Water Association (1)	To Montgomery Road Water Association	Regular supply.	
Deer Creek Water Association	To Deer Creek Water Association	Regular supply.	
Lummi Tribal	To Lummi Tribal	Regular supply.	1,000 gpm maximum at 30 psi.
Glen Cove Water Co-Op	To Glen Cove Water Co-Op	Regular supply.	None listed.
Ferndale Emergency Intertie	To Ferndale	Emergency.	7,000 gpm maximum.
Governors Point	To Governors Point	Regular supply.	None listed.

Notes:
(1) The Montgomery Road Water system is a small system with seven connections. Functionally, it is served in the same manner as Bellingham would serve a retail customer.
gpm - gallons per minute; psi - pounds per square inch.

All water service agreements are governed by the Bellingham Municipal Code (BMC) 15.36.080. Requests for new service or expanded service areas are governed by BMCs 15.36.060 and 15.36.090.

The City manages its water system in conformance with its water system policies. These policies are generally categorized per the policy categories presented in the DOH Planning Handbook. The DOH Water System Plan Checklist is located in Appendix G.

1.9 Environmental Assessment

The State Environmental Policy Act (SEPA), chapter 43.21C Revised Codes of Washington (RCW), requires all governmental agencies to consider the environmental impacts of a proposal before making decisions. A determination of non-significance (DNS) and SEPA Checklist have been prepared for this Plan in Appendices A and B. The City anticipates this Plan does not have probable significant adverse impacts on the environment in accordance with the DNS under WAC 197-11-340(2). Many of the projects proposed within the Plan will require subsequent project-specific environmental reviews and SEPA checklists as part of their preliminary and final design process.

1.10 Approval Process

This Plan is required to meet state, county, and local requirements. It complies with the requirements of the DOH as set forth in WAC 246-290-100. The City will submit this Plan to the DOH, the Washington State Department of Ecology (DOE), Whatcom County, adjacent utilities, and local governments as part of the Agency Review process.

1.11 Related Plans

Plans and planning activities that may affect Bellingham's water system are described in the following subsections. Smaller purveyors and districts, such as the Deer Creek Association and Montgomery Road Water Association, have not submitted water system plans to the City. The following is a list of plans related to the City's water treatment system:

- 1993 Comprehensive Water Plan, City of Bellingham, Washington, Public Works Department.
- 2009 Comprehensive Water Plan, City of Bellingham, Washington, Public Works Department.
- 2013 Water System Plan Update, City of Bellingham, Washington, Public Works Department.
- Whatcom County Population and Economic Forecasts, May 2002.
- City of Bellingham Urban Growth Area - DRAFT Land Supply Analysis Summary, March 2003.
- 2005 Comprehensive Plan, City of Bellingham.
- 2016 Comprehensive Plan, City of Bellingham.
- Whatcom County Coordinated Water System Plan Update, February 2000.
- 2025 Adopted Lake Whatcom Management Program Five Year Work Plan (2025-2029).

1.12 Acknowledgements

Carollo and FCS Group wishes to acknowledge and thank the following individuals for their efforts and assistance in completing this Plan:

- Jim Bergner, Project Manager.
- Brent Baldwin, Development Manager.
- Mike Wilson, Assistant Public Works Director - Engineering Division.
- Mike Olinger, Interim Co - Public Works Director.
- Renee LaCroix, Assistant Public Works Director - Natural Resources Division.
- Steven Bradshaw, Plant Superintendent.
- Nickolas Leininger, Whatcom Falls Plant Chief Operator.
- Riley Grant, Communication and Outreach Manager.

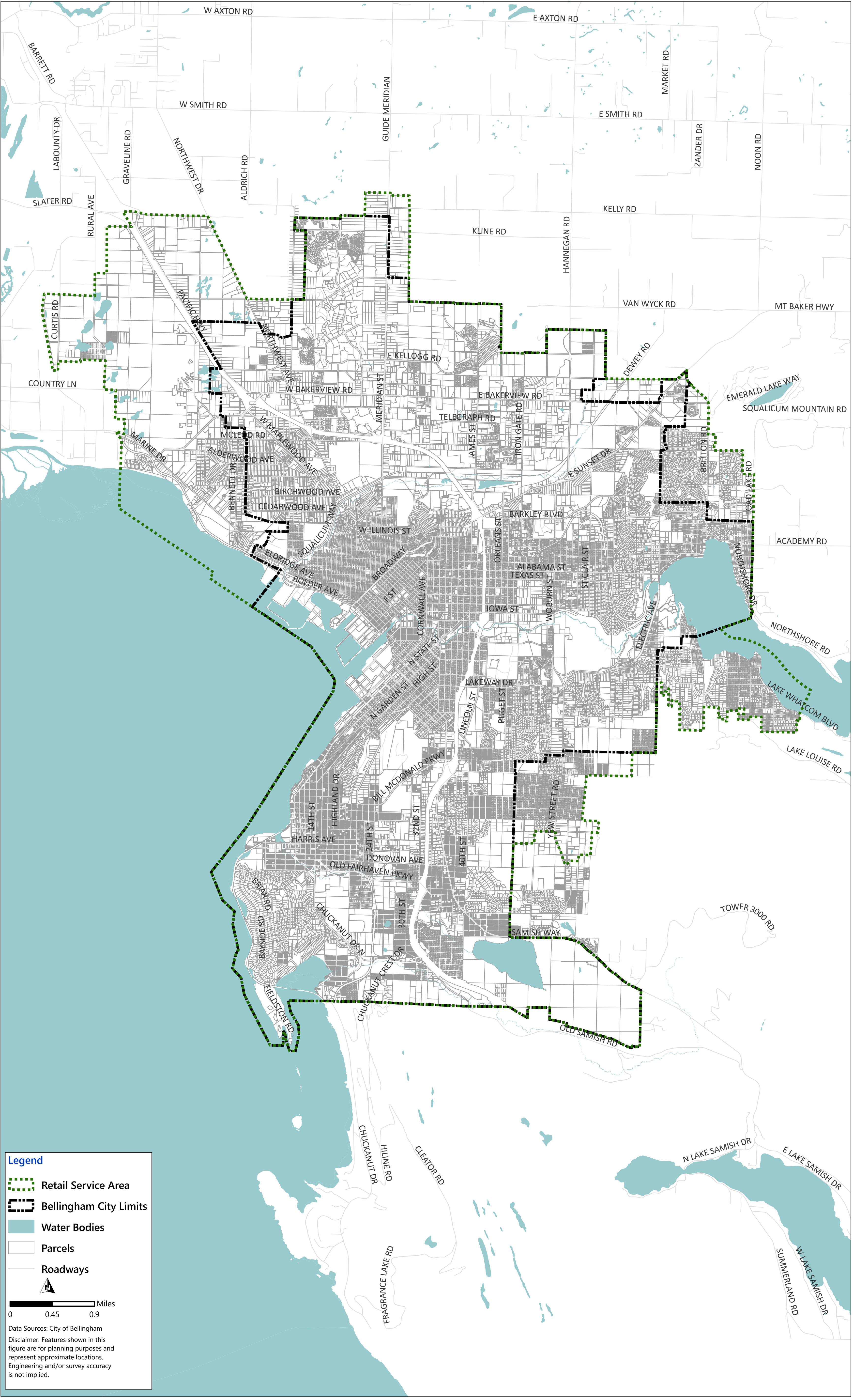

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Figure 1.1 Retail Service Area

CITY OF BELLINGHAM
WATER SYSTEM PLAN

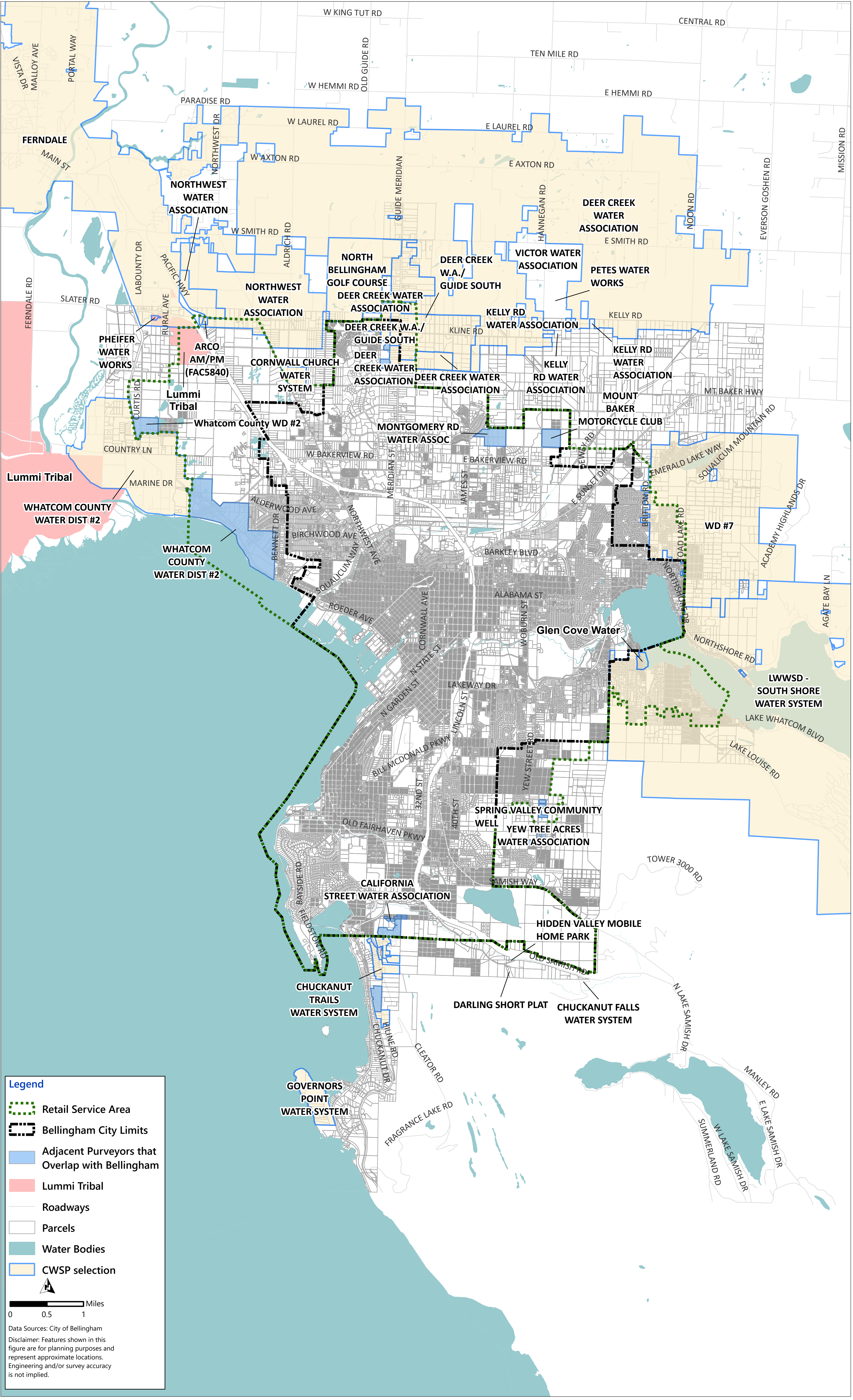

Figure 1.2 Adjacent Purveyors

CHAPTER 2 EXISTING SYSTEM

2.1 System Overview

This chapter presents an overview of the City existing water system facilities, which includes supply and transmission, treatment, storage, and distribution of potable water to residential, commercial, industrial, and wholesale customers. The City's Water Facilities Inventory (WFI) is located in Appendix I.

The City owns and operates its own water system. Figure 2.1 presents the City's water facility locations. The water system currently consists of 13 pressure zones, 13 reservoirs, 15 pump stations, six pressure reducing valves (PRV), and approximately 440 miles of transmission and distribution pipelines. Water supply sources for the system include Lake Whatcom and the Middle Fork of the Nooksack River, which are both located on the east side of the service area. The City maintains 15 interties with nine nearby water purveyors. Figure 2.2, the Existing System Hydraulic Profile, illustrates how water moves through the system. The City's water system facilities are detailed thoroughly below in Section 2.2.

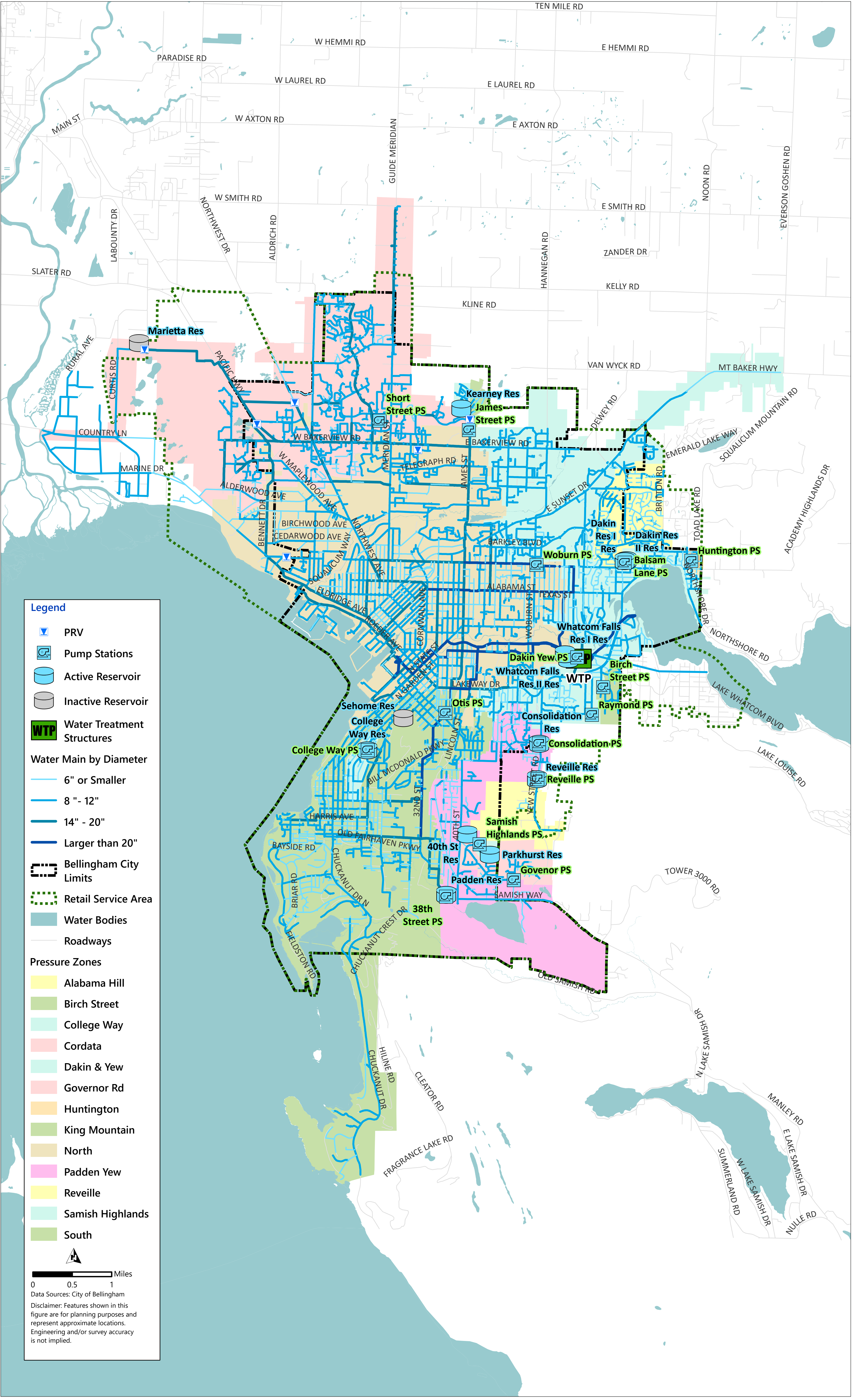

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Figure 2.1 Existing System

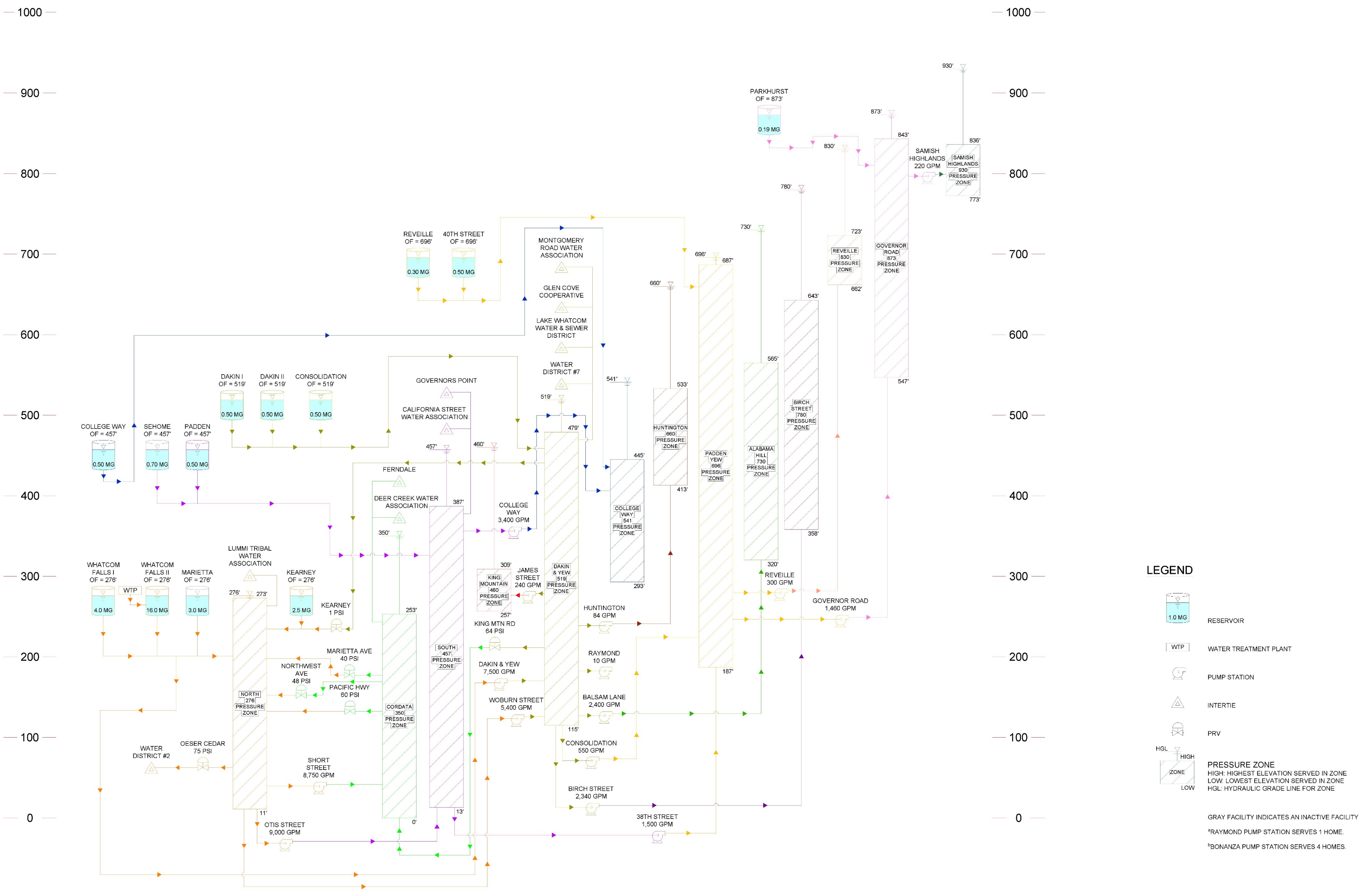


Figure 2.2 Existing System Hydraulic Profile

2.2 Water System Description

The City's water system has developed since the completion of the 2009 Water System Comprehensive Plan and the 2013 Water System Plan Update. A description of each facility and any significant changes are outlined in the following sections.

2.2.1 Pressure Zones

The City's water system has 13 distinct pressure zones (PZ). The hydraulic profile shown in Figure 2.2 displays how the pressure zones are connected and illustrates how water moves through the system between pressure zones. All PZs are served directly or indirectly from the City's Water Treatment Plant (WTP), which intakes water from Lake Whatcom. Although the system has 13 distinct PZs, not all of the PZs have separate storage facilities. A PZ that does not have a storage reservoir located in it is classified as a "closed" PZ, while a PZ that does have a storage reservoir is classified as an "open" PZ. Table 2.1 describes each PZ and its characteristics.

Table 2.1 Pressure Zones by Geographical Area

Pressure Zone	Open or Closed?	HGL (feet)	Maximum Elevation Served[1] (feet)	Minimum Elevation Served[1] (feet)
North	Open	276	206	1
Cordata	Closed	350	263	16
South	Open	457	461	12
King Mountain	Closed	460	386	230
Dakin and Yew	Open	519	463	113
College Way	Closed	541	461	256
Huntington	Closed	660	531	414
Padden Yew	Open	696	618	266
Alabama Hill	Closed	730	564	364
Birch Street	Closed	780	642	375
Reveille	Closed	830	721	660
Governor Road	Open	873	758	548
Samish Highlands	Closed	930	843	773

Notes:
HGL – hydraulic grade line.

2.2.2 Source of Supply

Lake Whatcom and the Middle Fork of the Nooksack River are the City's sources of supply to the WTP, as well as Lake Padden for municipal uses. These sources are described below.

2.2.2.1 Lake Whatcom

Lake Whatcom is the historic water supply source for the City, with the City's Water Claim dating back to 1883-1884. The City's intake tower in Lake Whatcom was constructed in 1940. The intake tower pulls water from below the water's surface, which is sent to a screenhouse through a tunnel and then to the WTP through a 66-inch diameter pipeline.

2.2.2.2 Middle Fork Nooksack River

In 1961, a diversion was constructed on the Middle Fork of Nooksack River to provide supplemental water to the City's system. The water from Nooksack River travels through a 40-inch diameter tunnel. The tunnel is a limiting component of the system's capacity since the tunnel has a smaller diameter than the pipeline from the intake tower to the WTP. This transmission system ends in Mirror Lake where the water from the Middle Fork of the Nooksack River is transported to Lake Whatcom through Anderson Creek. The 2.4 mile long Anderson Creek was re-channeled in 1960 in order to handle the flow from Mirror Lake to Lake Whatcom.

The simulated maximum pressure model indicated elevated pressures in the South 457 Zone. The City is aware of these pressures and has a plan to transfer parts of the South 457 Zone to the North 276 Zone. Details of this conversion project can be found in the 2017 457 Zone Conversion Report, located in Appendix DD.

2.2.2.3 Lake Padden, Silver Creek, and Ruby Creek

Lake Padden is also a historic water supply source for the City dating back to the early 1900s. The City acquired three water rights associated with lake Padden from Fairhaven City Water and Power in 1926 with the intent of using these water rights for municipal and industrial purposes. Two of these certificated water rights are surface diversions from Silver Creek to Lake Padden (up to 2.0 cfs) and from Ruby Creek to Lake Padden (up to 2.0 cfs). The third water right is for 780 acre-feet per year of Lake Padden storage for municipal supply.

2.2.3 Storage

Water storage in the distribution system supplies operational, equalizing, standby, and firefighting storage volumes. Storage is provided by reservoirs and one standpipe located within the distribution system. The City currently maintains thirteen tanks, but only eleven are in operation. This section presents a description of each of the storage facilities. Table 2.2 lists all of the City's existing storage tanks and summarizes the physical characteristics.

In February 2020, the City published a Reservoir Inspections, Evaluations, and Recommended Improvements document. A summary of the inspection reports for each reservoir is detailed below. The full inspection report is located in Appendix J.

2.2.3.1 Dakin I

Located at 3819 Balsam Lane, this 0.5-million gallon (MG), reinforced concrete, partially buried, domed roof reservoir was constructed in 1987. The reservoir serves the Dakin and Yew PZ through the Dakin and Yew Booster Pump Station (BPS), as well as the Alabama Hill PZ through the Balsam Lane BPS. In April 2019, a drained inspection of the Dakin I Reservoir was completed, and it was found to be in fair condition. On the visible sections of the exterior walls, cracking with efflorescence was observed, especially near the roof-to-wall interface, and on the exterior of the roof, there were minor circumferential and radial cracks. Inside the reservoir, coating on the walls made it difficult to determine if there was any cracking on the interior walls, and small blistering was found in the in the interior coating. The floor was also coated in a layer of sediment, making it harder to determine its condition, but there was no observable blistering.

2.2.3.2 Dakin II

Located at 3819 Balsam Lane and next to the Dakin I Reservoir, this 0.5 MG, strand wrapped prestressed concrete, partially buried, domed roof reservoir was built in 1990. The two Dakin Reservoirs are approximately three miles northwest of the Bellingham Central Business District in a forested area. The Dakin II Reservoir also serves the Dakin and Yew PZ and the Alabama Hill PZ. In April 2019, a drained inspection of the Dakin II Reservoir was completed, and it was found to be in good condition. Some minor cracking was observed on the exterior walls and roof, which was likely caused by stagnant water freezing and thawing due to organic material accumulating on the roof and blocking drains. Additionally, the roof drainage issue is allowing water to enter the reservoir. Inside the reservoir, cracking, mineralization, and organic staining was observed on the interior walls. There was no cracking found on the interior floor of the reservoir.

2.2.3.3 Marietta

Located at 1404 Marietta Avenue, this 2.5 MG, welded steel, above ground cylinder reservoir was built in 1969. The reservoir is located approximately five miles northwest of the Bellingham Central Business District in a forested neighborhood. Currently, the Marietta Reservoir is not in operation. In January 2019, an inspection of the reservoir was completed, and it was found to be in fair condition. The reservoir’s shell and roof supports were in good condition, due to coating materials that prevent corrosion. If the Marietta Reservoir is used again, it was recommended the maximum operating level be reduced, anchors removed, and flexible couplings installed in order to increase the seismic resiliency of the reservoir.

2.2.3.4 Whatcom Falls I

Located at 3201 Arbor Street, this 4.0 MG, welded steel, above ground reservoir was constructed in 1982. The Whatcom Falls I Reservoir shares its site with the Whatcom Falls II Reservoir and is approximately two miles east of the Bellingham Central Business District. This reservoir serves the North PZ. In June and November 2019, floating and drained inspections of the reservoir were completed, and it was found to be in fair to good condition. Heavy organic buildup was observed on the exterior walls and on the exterior roof. The interior walls had minor blistering of the interior coating, and above the waterline general surface corrosion was observed. In order to minimize seismic event slosh damages, the maximum operating level was recommended to be lowered.

2.2.3.5 Whatcom Falls II

Located at 3201 Arbor Street, this 15.6 MG, strand wrapped reinforced concrete, partially buried reservoir was built in 1993. The reservoir is located at the same site as Whatcom Falls I Reservoir and serves the North PZ as well. Whatcom Falls II is used for chlorine contact time. In June and November 2019, floating and exterior inspections of the reservoir were completed, and it was found to be in very good condition. Heavy organic loads were observed on the roof that can't be naturally shed by the reservoir due to the roof being very flat and unsuitable drains. Roof drainage issues hasn't caused roof slab, roof curb, or wall shotcrete issues, but it was recommended to continue to monitor the reservoir.

2.2.3.6 Kearney

Located at 465 Kearney Street, this 2.5 MG, strand wrapped prestressed concrete, partially buried reservoir was constructed in 2006. The reservoir is located in the North PZ and is served by gravity from the Whatcom Falls II Reservoir. In March 2019, a drained inspection of the reservoir was completed, and it was found to be in very good condition. Some efflorescence was observed on the exterior walls, and the roof was mostly clean with only minor organic growth. However, the roof drains onto the exterior walls, which is potentially causing delamination of the outer shotcrete layer in two distinct areas. The interior walls and floor did not exhibit any cracking.

2.2.3.7 Consolidation

Located at 2500 Yew Street Road, this 0.5 MG, reinforced concrete, mostly buried, domed roof reservoir was built in 1959. The reservoir is located approximately two miles southeast of Bellingham Central Business District near the edge of the City limits. It serves the Dakin and Yew PZ, which is fed by the North PZ through the Dakin and Yew BPS. In November 2019, a drained inspection of the reservoir was completed, and it was found to be in fair condition. On the exterior walls, cracking with efflorescence was observed, as well as the peeling and blistering of the exterior coating. The exterior roof displayed circumferential and radial cracking. Inside the reservoir, cracking was observed on the interior walls and roof, but no issues were found on the floor.

2.2.3.8 Padden

Located at 3820 Broad Street, this 0.5 MG, welded steel, above ground reservoir was built in 1967. The reservoir is located in the southern part of the City and is approximately three miles southeast of the Bellingham Central Business District in a forested area. The Padden Reservoir serves the South PZ. In April 2019, drained and floating inspections of the reservoir were completed, and it was found to be in fair to good condition. Significant corrosion was observed on the interior roof and supports. Additionally, interior and exterior coating had extensive blistering and was failing.

2.2.3.9 College Way

Located at 231 Highland Drive, this 0.5 MG, reinforced concrete, partially buried, domed roof reservoir was constructed in 1968. The reservoir is next to Western Washington University in a suburban residential neighborhood. It is in the South PZ and serves the College Way PZ through the College Way BPS. In March 2019, a drained inspection of the reservoir was completed, and it was found to be in fair condition. On the exterior walls, cracking with efflorescence and areas with missing topcoat were observed. The exterior roof had a circumferential crack that encompassed the entirety of the roof. The interior walls of the reservoir and the floor had intact coating.

2.2.3.10 Sehome

Located at 600 25th Street in the Sehome Hill Arboretum, this 0.7 MG, reinforced concrete, partially buried reservoir was built in the 1920s. It is 73 feet wide at the center and narrows to 66 feet at each end, resembling a football with the ends removed. The roof was added to the reservoir in the 1950s and has a slight slope. The reservoir is in the South PZ and is fed by the Otis Street BPS, but it has not been in operation for the past five years. In January 2019, an inspection of the reservoir was completed, and it was found to be in poor condition. It was observed that the reservoir doesn’t meet current structural or seismic codes because of minimal/missing wall reinforcement. Additionally, the sloped ground next to the reservoir drains surface runoff onto the roof. Replacement is recommended if the City desires to use a reservoir at this site.

2.2.3.11 Reveille

Located at 2400 Yew Street Road in a suburban neighborhood, this 0.3 MG, reinforced concrete, partially buried, domed roof reservoir was built in 1958. It is the oldest of the five domed roof reservoirs within the City’s water system. The reservoir serves the Padden Yew PZ. In May 2019, a drained inspection of the reservoir was completed, and it was found to be in fair condition. The exterior walls were observed to have some cracking with efflorescence and the roof coating was intact with minor circumferential and radial cracking as well. Inside the reservoir, minor cracking was present on the interior walls, roof, and floor.

2.2.3.12 40th Street

Located at 1399 40th Street, this 0.5 MG, reinforced concrete, almost completely above ground, domed roof reservoir was constructed in 1961. The reservoir is approximately two miles south-southeast of the Bellingham Central Business District in a forested area and serves the Padden Yew PZ. In April 2019, a drained inspection of the reservoir was completed, and it was found to be in fair condition. It was observed that the reservoir’s reinforcing was inadequate for static and seismic loads. Coating on the interior walls and floor made it difficult to determine if there was any cracking, but some blistering in the coating was observed on the floor.

2.2.3.13 Parkhurst

Located at 4329 Samish Crest Drive, this 0.185 MG, reinforced concrete, standpipe reservoir was built in 1997. A standpipe is considered a water structure that is taller than it is wide. The reservoir is located in the Governor Road PZ and is fed by the Governor Road BPS. In May 2019, a drained inspection of the reservoir was completed, and it was found to be in good condition. Issues observed with the standpipe were that the concrete in the lower courses was in poor condition, corrosion was visible on the interior appurtenances, and the dechlorination system was not compliant. Additionally, efflorescence was observed on the exterior walls of the standpipe.

Table 2.2 Existing Storage Facilities

Reservoir Name	Zone Served	Capacity (MG)	Year Constructed	Base Elevation (feet)	Overflow Elevation (feet)	Height (feet)	Diameter (feet)	Geometry
Dakin I	519 Dakin and Yew	0.5	1987	496.7	519	22.3	64	Pre-Stressed Concrete Cylinder
Dakin II	519 Dakin and Yew	0.5	1990	500.5	519	18.5	68	Pre-Stressed Concrete Cylinder
Marietta	276 North	3.0	1969	225	276	51	100	Steel Tank Cylinder
Whatcom Falls I	276 North	4.1	1984	258.8	276	17.2	201	Steel Tank Cylinder
Whatcom Falls II	276 North	15.6	1993	254	276	22.0	350	Pre-Stressed Concrete Cylinder
Kearney	276 North	2.49	2006	251.0	276	27	130	Pre-Stressed Concrete Cylinder
Consolidation	519 Dakin and Yew	0.5	1959	496.8	519	22.2	64	Steel Tank Cylinder
Padden	457 South	0.5	1958	432	457	25	59	Pre-Stressed Concrete Cylinder
College Way	541 College Way	0.5	1968	433	541	24	64	Steel Tank Cylinder
Sehome	457 South	0.7	1920	446	457	11	100	Concrete Rectangular Tank
Reveille	696 Padden Yew	0.3	1958	672.2	696	23.8	50	Pre-Stressed Concrete Cylinder
40th Street	696 Padden Yew	0.5	1958	669.2	696	26.8	60	Pre-Stressed Concrete Cylinder
Parkhurst	873 Governor Road	0.18	1997	838.5	873	34.5	30	Steel Tank Cylinder

2.2.4 Booster Pump Stations

The City maintains and operates 15 pump stations that provide regular and emergency supply from lower to higher PZs. A description of each of the pump stations is included in the following sections. Table 2.3 provides a summary of each pump station with the rated capacity of each pump.

2.2.4.1 Otis Street Pump Station

Located near the intersection of Otis Street and East Maple Street in a brick building, the Otis Street BPS pumps water from the North PZ to the South PZ and was constructed in 1967. It is the only pump station that supplies water to the South PZ. Water pumped to the South PZ from the Otis Street BPS is the sole supplier of water to the College Way PZ, which is pumped through the College Way BPS. Additionally, water from the Otis Street BPS is one of two suppliers of water to the Padden Yew PZ via the 38th Street BPS.

2.2.4.2 Dakin and Yew Pump Station

Located at the City WTP, the Dakin and Yew BPS supplies water to the Dakin and Yew PZ from the Whatcom Falls II (CT) Reservoir, which is located in the North PZ. Dakin and Yew BPS was constructed in 1995. It is one of two pump stations supplying the Dakin and Yew PZ, the second being the Woburn Street BPS. Along with water from the Woburn Street BPS, water from the Dakin and Yew BPS is pumped to three additional PZs: Padden Yew PZ, Alabama Hill PZ, and Birch Street PZ.

2.2.4.3 James Street Pump Station

Located in the northern part of the City, the James Street BPS supplies water to the King Mountain PZ from the Dakin and Yew PZ and was constructed in 2001. Previously, the James Street BPS supplied water from the North PZ but changed to serving water from the Dakin and Yew PZ in 2011. Because King Mountain is a closed PZ, James Street BPS must be able to meet peak hour demands. Additionally, since King Mountain PZ is a closed zone, typically James Street BPS would have to be able to supply fire flow demands, but the City expanded the Dakin and Yew PZ to much of the King Mountain area in order to provide fire flow. So, the James Street BPS is not required to supply fire flow capacity.

2.2.4.4 Woburn Street Pump Station

Located on Woburn Street and East Illinois Street in a brick building, the Woburn Street BPS pumps water from the North PZ to the Dakin and Yew PZ. The Woburn Street BPS serves as a redundant backup pump station to the Dakin and Yew BPS. Its two smaller pumps are manually operated routinely in order to maintain operating condition and to help water circulation through the system. The two larger, high flow pumps are used to in aid in fire flow demand and are controlled by a pressure sensor that initiates service when low pressure conditions are recorded. So, Woburn Street BPS typically is only in operation during low pressure conditions.

2.2.4.5 College Way Pump Station

Located near the intersection of Highland Drive and West College Way in a partially buried concrete building, the College Way BPS serves the College Way PZ from the South PZ and was constructed in 2006. It is the only pump station that serves the College Way PZ, which is a closed pressure zone, so the pump station must have fire flow capacity and provide peak hour demand.

2.2.4.6 Short Street Pump Station

Located in the northern part of the City near Whatcom Community College in a brick building, the Short Street BPS supplies water from the North PZ to the Cordata PZ, which is a closed zone. Short Street BPS is the only pump station supplying water to the Cordata PZ, so it must be able to meet peak hour demands and provide fire flow capacity. The pump station was constructed in 1987 and has a separate electrical service for its fire pumps.

2.2.4.7 Consolidation Pump Station

Located in an underground building at the intersection of Yew Street and San Juan Boulevard, the Consolidation BPS supplies water from the Dakin and Yew PZ to the Padden Yew PZ. It is one of two pump stations that supplies water to the Padden Yew PZ, the other one being the 38th Street BPS.

2.2.4.8 38th Street Pump Station

Located west of Lake Padden along the border of the South PZ and Padden Yew PZ, the 38th Street BPS pumps water from the South PZ to the Padden Yew PZ and was constructed in 1984. It is the second pump station that supplies the Padden Yew PZ.

2.2.4.9 Birch Street Pump Station

Located west of Lake Whatcom near the intersection of Birch Street and Riley Street, the Birch Street BPS supplies water from the Dakin and Yew PZ to the Birch Street PZ, which is a closed zone. Birch Street BPS is the only pump station supplying the Birch Street PZ. Consequently, Birch Street BPS must provide fire flow capacity and meet peak hour demand.

2.2.4.10 Balsam Lane Pump Station

Located at the end of Balsam Lane north of Lake Whatcom in a brick building, the Balsam Lane BPS pumps water from the Dakin and Yew PZ to the Alabama Hill PZ, which is a closed zone.

2.2.4.11 Governor Road Pump Station

Located in an above ground brick building along Governor Road to the north of Lake Padden, the Governor Road BPS pumps water from the Parkhurst Reservoir, which is located in the Padden Yew PZ, to the Governor Road PZ.

2.2.4.12 Reveille Pump Station

Located along Yew Street at the same site as the Reveille Reservoir, the Reveille BPS supplies water from the Padden Yew PZ to the Reveille PZ, which is a closed zone. Because Reveille BPS is the only pump station that boosts water to the Reveille PZ, it must be able to provide fire flow and peak hour demands.

2.2.4.13 Huntington Pump Station

Located Huntington Street just north of Lake Whatcom, the Huntington BPS pumps water from the Dakin and Yew PZ to the Huntington PZ, which is a closed zone.

2.2.4.14 Raymond Pump Station

Located on Raymond Street near Park Creek, the Raymond BPS supplies water from the Dakin and Yew PZ to one home. It is anticipated that the Raymond BPS will be decommissioned and replaced within the 20-year planning horizon.

2.2.4.15 Samish Highlands Pump Station

Located north of Lake Padden on Samish Crest Drive, the Samish Highlands BPS supplies water from the Governor Road PZ to the Samish Highlands PZ, which is a closed zone. The Samish Highlands BPS provides water to approximately 20 houses next to the existing Parkhurst Reservoir. It does not supply fire flow, which is instead provided by a private fire system through a fire department connection just down the slope from the neighborhood served by the Samish Highlands BPS.

Table 2.3 Booster Pump Stations

Name	Zone Pumps From	Zone Pumps To	Pump No.	Pump Capacity (gpm)	Pump TDH (feet)	Pump HP	Pump Manufacturer	Year Installed	Total BPS Max Capacity (gpm)	BPS Firm Capacity (gpm)	Back-up Capacity (gpm)	Standby Power Type	VFD?	Controls
Otis Street	North	South	1 2 3 4	3,500 3,500 1,000 1,000	215 220 220 220	150 250 250 100	Weinman De Laval De Laval Weinman/Crane	2014 1967 1967 2014	9,000	5,500		Portable	No	Allen-Bradley
Dakin and Yew	WhatcomFalls II in North	Dakin and Yew	1 2 3 4 5	1,500 1,500 1,500 1,500 1,500	285 285 285 285 285	150 150 150 150 150	GSP GSP GSP GSP GSP	1995 1995 1995 1995 1995	7,500	6,000		1000 kW, WTP Generator	No	Allen-Bradley
James Street	Dakin and Yew	King Mountain	1 2	120 120	260 260	10 10	PACO PACO	2001 2001	240	120		Portable	Yes	Siemens
Woburn Street	North	Dakin and Yew	1 2 3 4	2,000 2,000 700 700	282 282 300 300	100 100 75 75	Allis-Chalmers Allis-Chalmers PACO PACO	1985 1985 1999 1999	5,400	3,400		275 kW Generator	No	Allen-Bradley
College Way	South	College Way	1 2 3 4 5 6	600 600 1,000 1,000 100 100	145 145 108 108 135 135	150 150 400 400 7.5 7.5	American Marsh American Marsh American Marsh American Marsh American Marsh American Marsh	2006 2006 2006 2006 2006 2006	3,400	2,400		15 kW Generator	Yes	Allen-Bradley
Short Street	North	Cordata	1 2 3 4 5 6 7	2,500 2,500 750 750 750 750 750	350 350 350 350 350 350 350	200 200 40 40 40 40 40	Fairbanks Morse Fairbanks Morse PACO PACO PACO PACO PACO	1987 1987 1987 1987 1987 1987 1987	8,750	6,250		400 kW Generator	Yes	Allen-Bradley
Consolidation	Dakin and Yew	Padden Yew	1	550	200	40	PACO	1959	550	0		Portable	No	Siemens
38th Street	South	Padden Yew	1 2 3	500 500 500	338 338 338	75 75 75	PACO PACO PACO	1984 1984 1984	1,500	1,000		Portable	No	Allen-Bradley
Birch Street	Dakin and Yew	Birch Street	1 2 3 4	90 575 575 1,100	181 330 330 279	60 60 100 15	PACO/Grundfos PACO/Grundfos PACO/Grundfos PACO/Grundfos	2005 2005 2005 2005	2,340	1,240		75 kW Generator	Yes	Allen-Bradley
Balsam Lane	Dakin and Yew	Alabama Hill	1 2 3 4	600 600 600 600	196 196 196 196	60 60 60 60	PACO PACO PACO PACO	1994 1994 1994 1994	2,400	1,800		200 kW Generator	Yes	Allen-Bradley

Name	Zone Pumps From	Zone Pumps To	Pump No.	Pump Capacity (gpm)	Pump TDH (feet)	Pump HP	Pump Manufacturer	Year Installed	Total BPS Max Capacity (gpm)	BPS Firm Capacity (gpm)	Back-up Capacity (gpm)	Standby Power Type	VFD?	Controls
Governor Road	Padden Yew	Governor Road	1 2 3	180 180 1,100	215 215 210	10 10 40	Grundfos Grundfos Peerless	1999 1998 1998	1,460	350		Portable	No	Siemens
Reveille	Padden Yew	Reveille	1 2	100 200	217 217		PACO PACO	2014	300	100		30 kW Generator	No	Allen-Bradley
Huntington	Dakin and Yew	Huntington	1 2	42 42	180 180	3 3	Grundfos Grundfos	1996 1996	84	42		Portable	No	Siemens
Raymond	Dakin and Yew	Serves 1 home	1	10		1	Goulds 1 HP		10	0		None	No	None
Samish Highlands	Governor Road	Samish Highlands	1 2	110 110	94 94	5 5	Grundfos Grundfos	2012 2012	220	110		35 kW Generator	Yes	Allen-Bradley

Notes:
HP - horsepower; kW – kilowatts, TDH - total dynamic head; VFD - variable frequency drive.

2.2.5 Pressure Reducing Stations

PRVs in the City's water system were installed to help maintain pressure in low elevation areas and minimize high pressures. The PRVs hydraulically vary the flow rate through the valve to maintain a constant and preset discharge pressure up to the limit of the flow capacity of the valve. The City currently has six PRVs in operation, which are listed in Table 2.4.

Table 2.4 Pressure Reducing Stations

Name	Location	Receiving Zone	Supplying Zone	Valve Size (inches)	Valve Elevation (feet)	Pressure Setting (psi)
Northwest Avenue	4300 Northwest Avenue	Cordata	Cordata	4	165	48
Pacific Highway	4180 Pacific Highway	Cordata	Cordata	8	145	60
Marietta Avenue	1400 Marietta Avenue	Cordata	Cordata	8	190	40
King Mountain Road	4249 King Mountain Road	Dakin and Yew	Cordata	8	233	64
Kearney	465 Kearney Street	Dakin and Yew	North	12	247	1
Oeser Cedar	740 Marine Drive	North	WD No. 2	8	75	75

2.2.6 Distribution System

The City's water pipelines are shown in Figure 2.1. Tables 2.5 and 2.6 summarize the length of mains in the water system by diameter, material, and age. It should be noted that the pipeline summarized in Tables 2.5 and 2.6 are based on pipeline that was marked as being maintained by "COB Public Works" and does not include service laterals.

As seen in the tables below, the majority of pipeline in the water system is 6-inch or 8-inch diameter piping, with approximately 58 percent of the system being either 6-inch or 8-inch diameter pipeline. Additionally, the most common material in the water system is ductile iron, which accounts for approximately 66 percent of piping in the system.

Table 2.5 Pipe Inventory: Length by Diameter

Diameter (inches)	Total Length (feet)	Total Length (miles)	Percent (%)
≤4	118,782	22.5	5.1%
6	512,750	97.1	22.1%
8	837,905	158.7	36.1%
10	155,103	29.4	6.7%
12	322,909	61.2	13.9%
14	4,749	0.9	0.2%
16	138,771	26.3	6.0%
20	61,966	11.7	2.7%
24	46,725	8.8	2.0%
30	12,499	2.4	0.5%
36	10,947	2.1	0.5%

Diameter (inches)	Total Length (feet)	Total Length (miles)	Percent (%)
42	101	0.02	<0.1%
48	18,075	3.4	0.8%
60	972	0.2	<0.1%
66	1,541	0.3	0.1%
72	61,127	11.6	2.6%
Unknown	16,110	3.1	0.7%
Total	**2,321,030**	**439.6**	**100%**

Table 2.6 Pipe Inventory: Length by Material and Install Year

Material/ Install Year	1890s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	2000s	2010s	2020s	Unknown	Total (feet)	Total (miles)	Total System %
Asbestos Concrete (AC)	0	0	0	0	1,597	9,310	2,821	6,602	0	13	0	0	0	1,863	22,206	4.2	1.0%
Brass	0	0	0	0	0	0	0	0	0	0	0	0	10	0	10	<0.1	<0.1%
Concrete Cylinder Pipe (CCP)	0	0	0	0	0	0	16,675	0	17,071	0	0	0	0	0	33,746	6.4	1.5%
Cast Iron (CI)	0	45,976	117,489	54,198	65,957	167,805	114,892	42,018	8,492	3,039	1,265	0	0	5,256	626,387	118.6	27.0%
Concrete (CON)	0	0	0	0	0	0	0	0	0	0	0	0	0	59,354	59,354	11.2	2.6%
Copper (COP)	0	0	0	0	0	0	457	287	0	152	132	8	8	0	1,044	0.2	<0.1%
Ductile Iron (DI)	0	441	150	448	8	1,552	27,592	244,790	305,253	465,838	290,352	143,869	26,627	31,958	1,538,878	291.5	66.3%
Fiberglass	0	0	0	0	0	0	0	0	0	0	0	234	0	1,056	1,290	0.2	0.1%
Galvanized (GAL)	0	0	0	0	0	15	0	0	0	0	0	0	0	0	15	<0.1	<0.1%
High Density Polyethylene (HDPE)	0	0	0	0	0	0	0	0	0	0	0	1,439	152	0	1,591	0.3	0.1%
Polyvinyl Chloride (PVC)	0	0	0	0	0	0	636	3,298	955	0	195	4,117	179	517	9,897	1.9	0.4%
Steel	2,155	0	0	0	0	5,950	0	0	667	972	0	0	0	20	9,764	1.8	0.4%
Wood	1,401	0	0	0	0	0	0	0	0	0	0	0	0	0	1,401	0.3	0.1%
Unknown	0	1,417	0	0	0	0	0	0	0	0	0	0	0	14,030	15,447	3.0	0.7%
Total (feet)	3,556	47,834	117,640	54,646	67,562	184,632	163,075	296,994	332,438	470,013	291,944	149,667	26,977	114,054	2,321,032	439.6	100%
Total (miles)	0.7	9.1	22.3	10.3	12.8	35.0	30.9	56.2	63.0	89.0	55.3	28.3	5.1	21.6	439.6		
Total System Percent	0.2%	2.1%	5.1%	2.4%	2.9%	8.0%	7.0%	12.8%	14.3%	20.3%	12.6%	6.4%	1.2%	4.9%	100%		

2.2.7 Interties

The City has 15 supply interties with nine neighboring systems, which are detailed in Table 2.7. The City's intertie connections only supply water to other systems. The Ferndale emergency intertie was recently approved in April 2022. Figure 2.3 shows the locations of the City's intertie connections.

Table 2.7 Interties

Account Number	Meter Size	Location	Other System	Flow Direction	Max Flow Rate (gpm)	Type of Service
017925 020504	4 6	3900 Lakeway Drive 2117 Northshore Drive	LWWS	To LWWS	750	Domestic and Fire Supply
017856 017948 022272	6 6 6	740 Marine Drive 4500 Curtis Drive 3701 Williamson Way	WD No. 2	To WD No. 2	1,100 at 20 psi	Regular Supply
027049 017924	4 4	3972 Britton Road 3608 Britton Road	WD No. 7	To WD No. 7	500 at 20 psi	Regular Supply
020769	6	1801 Marine Drive	Lummi Tribal	To LummiTribal	1,000 at 30 psi	Regular Supply
030263 030301 030260	8 6 4	5296 Guide Meridian 4780 Meridian Street 4780 Meridian Street	Deer Creek	To Deer Creek	N/A	Regular Supply
022206	2	667 Montgomery Road	Montgomery Road	To Montgomery Road	N/A	Regular Supply
022734	1.5	2700 California Street	California Street	To California Street	N/A	Regular Supply – No Fire Flow
017371	4	1615 Euclid Avenue	Glen Cove Water Association	To Glen Cove Water Association	N/A	Regular Supply
033737	8	Intersection of Marietta Avenue and Wynn Road	Ferndale	To Ferndale	N/A	Emergency
2018-0568	4	515 Pleasant Bay Road	Governors Point	To Governors Point	N/A	Domestic and Fire Supply

Notes:
N/A - not applicable.

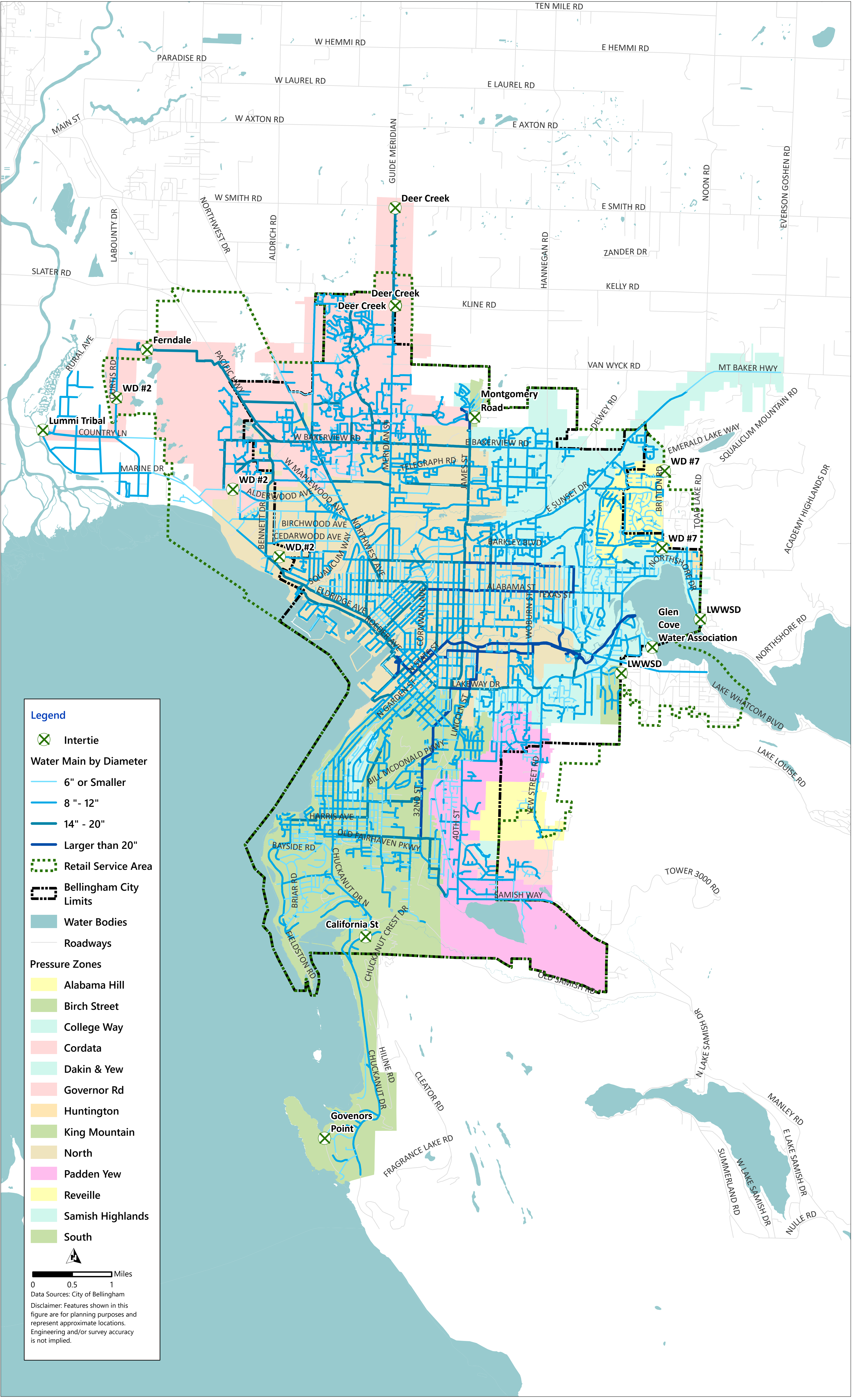


Figure 2.3 Interties

2.2.8 Treatment

The City's WTP is located west of Lake Whatcom in Whatcom Falls Park and was constructed in 1968. The WTP uses a conventional surface water process train that consists of dissolved air floatation (DAF) and multi-media granular filtration. First, water passes through the screenhouse near Lake Whatcom and then flows to the WTP where alum is added at a rapid mixer for coagulation before flowing entering the DAF trains. Each DAF train consists of a flocculation basin and DAF basin. Clarified water then flows to the filter influent flume where polymer is added, with water then flowing into one of six multi-media granular filters. The filters are made up of 16.5 inches of anthracite coal, 9 inches of silica sand, 4.5 inches of garnet, and 9 inches of graded gravel. Each filter has a surface area of 560 square feet and a filtration rate of 6 gpm per square foot.

The theoretical filtration capacity of the plant is 29.0 million gallons per day (mgd), but since one filter is often being backwashed, the effective filtration capacity of the plant, using five of the six filters, is 24.2 mgd. The hydraulic design capacity of the WTP is 36.0 mgd. After filtration, the water is chlorinated as it flows into the Whatcom Falls II Reservoir. Additional chlorine is added in the Whatcom Falls II Reservoir before the water leaves to enter the distribution system. Soda ash is added as well to adjust pH. The City's WTP is analyzed in greater detail in Chapter 8 - Water Quality and Water Treatment.

2.2.9 Telemetry and SCADA

The City utilizes both fiber optic and radio supervisory control and data acquisition (SCADA) to monitor and control its water system. The SCADA system creates daily reports that detail hourly reservoir levels, flow rates at the plant, and flow rates at pump stations throughout the day. SCADA information was used in the system analysis, which is discussed in Chapter 7 - Distribution System Analysis.

2.3 Summary of Updates to System Since 2013 Plan

Since the 2013 Plan, the City has worked diligently to maintain and update its water system facilities. The following list details completed projects since the 2013 Plan:

- Lake Whatcom Water Quality Projects:
  - 2015 - EV-103 Bloedel Donovan Park Improvements.
  - 2015 - EV-104 Lake Whatcom ROW Retrofits.
  - 2016 - EV-113 NEP Phosphorus Management Lake Whatcom - Shepardson St and Huntington St.
  - 2018 - EV-108 Academy Road Stormwater Improvements.
  - 2018 - EV-125 and EV-139 E. North St and E. Oregon St Phosphorus Reduction Retrofit.
  - 2019 - EV-163 Pullman St Vault Retrofit - Northshore Dr and Pullman St.
  - 2019 - EV-159 Lake Whatcom Water Quality - Northshore Dr and Huntington St and Flynn St.
  - 2022 - EV-155 Park Place Stormwater Facility Rebuild.

- Watermain Replacement Projects:
    - 2013 - EW-205 Watermain Replacement - Lindberg Ave/Magnolia St/Northwest Ave.
    - 2014/15 - EW-220 Watermain Replacement - E Champion St/E Sunset Dr/Nevada St.
    - 2016 - EW-230 Watermain Replacement - W Holly St/E St.
    - 2017 - EW-231 Watermain Replacement - Donovan Ave Phase I.
    - 2018 - EW-233 Watermain Replacement - Lorraine Ellis Ct/E Maplewood Ave/W Illinois St.
    - 2019 - EW-234 Watermain Replacement - Donovan Ave Phase II.
    - 2023 - EW-238 Watermain Replacement - Valencia St.

CHAPTER 3 POLICIES AND CRITERIA

3.1 Introduction

The policies, design criteria, and standards summarized in this chapter are established by the City to provide the framework for planning, designing, operating, and managing its water system. The City strives to provide safe, reliable drinking water for its customers now and into the future.

The policies, design criteria, and standards used in the Plan originate from the following sources:

- 2009 Water System Plan.
- Bellingham 2016 Comprehensive Plan.
- Whatcom County Comprehensive Plan.
- Bellingham Municipal Code (BMC).
- Bellingham Development Guidelines and Improvement Standards (2018).
- 2020-2024 Lake Whatcom Management Program Work Plan.
- DOH Water System Design Manual (WSDM).

Law is set by the federal government through federal regulations, by the State of Washington (State) in the form of statutes: RCW, WAC, by Whatcom County in the form of policies, and by Bellingham City Council in the form of ordinances and resolutions. City policies are established in order to provide a vision or mission for the Water Utility and to provide a framework for the planning, design, operation, management, and maintenance of the water system. City policies cannot be less stringent than or in conflict with adopted laws.

The City manages its water utility and water system in accordance with established federal and state regulations for public water systems. City policies and standards set forth in Section 3.3 of this chapter provide a consistent framework for the planning, design, construction, maintenance, operation, and service of the City's water system and water supply sources.

3.2 Service Area

The Legislature adopted the Growth Management Act (GMA) in 1990. The GMA provides that it is not appropriate for urban governmental services, which include water and sewer services, to be extended to or expanded in rural areas except in very limited circumstances that are necessary to protect public health and safety and the environment, and which do not permit urban development.

3.2.1 Historical Background on Water Service Outside City Limits

In 1979, the City enacted Ordinance 8728 relating to the extension of City water service outside City limits. Ordinance 8728 and other ordinances that followed created a number of water service zones outside City limits in which the City could contract to provide retail water service directly to customers within these zones.

The City's water service zone system was established prior to the state's adoption of the GMA in 1990 and was, in certain respects, inconsistent with the GMA.

The City repealed all of its water service zones in 2006 and 2011 in Ordinance 2006-03-026 and 2011-05-025. The repealing ordinances included a "grandfather" clause clarifying that the City did not intend to terminate any water service that was "in existence" as of the effective date of the repealing ordinances. The term "in existence" is defined in Ordinance 2006-03-026, 2006-06-064, and 2011-05-025.

Consistent with the GMA, Ordinance 2011-05-025 established new policies governing the expansion or extension of city water service outside city limits. It specified that new water service is not available *in the UGA* unless the property annexes or city council determines that such service is necessary to protect basic public health and safety and the environment. It specified that new water service is not available *outside the UG*A unless city council determines that such service is necessary to protect basic public health and safety and the environment and will not permit urban development. These policies are codified in BMC 15.36.010(B) and (C).

In 2019, the City enacted Ordinance 2019-02-003 to further amend BMC 15.36.010 to add subpart D containing additional criteria that must be met before new service will be provided outside city limits, including that the property to be served abuts an existing City water main.

3.2.2 Retail Service Area

Retail service area is the specific area, defined by the municipal supplier, where the supplier has a duty to provide service to new service connections, as set forth in RCW 43.20.260, if:

1. Its service can be available in a timely and reasonable manner;
2. the municipal water supplier has sufficient water rights to provide the service;
3. the municipal water supplier has sufficient capacity to serve the water in a safe and reliable manner as determined by the department of health; and
4. it is consistent with the requirements of any comprehensive plans or development regulations adopted under chapter 36.70A RCW or any other applicable comprehensive plan, land use plan, or development regulation adopted by a city, town, or county for the service area and, for water service by the water utility of a city or town, with the utility service extension ordinances of the city or town.

The City's retail service area is coterminous with its Urban Growth Area (UGA) as shown in Figure 3.1. The City's retail service area includes portions of its UGA that are within other purveyors' water service areas as established by the Whatcom County Coordinated Water System Plan, although these overlapping areas are not depicted in Figure 3.1.

While the City's retail service area includes its UGA, new water service is not available in the UGA unless the property annexes or city council determines that such service is necessary to protect basic public health and safety and the environment and certain other conditions are met. See BMC 15.36.010(B) and (D).

3.2.3 Service Area

Service area is the most expansive of all the service area types. As defined by the Washington State Department of Health and as set forth in WAC 246-290-010 definition 225, a purveyor's "service area" is the specific area where (A) its water system currently serves and (B) areas where future water service is planned.

The portion of the City's service area that is currently served by the City is shown in Figure 3.2. It includes (1) the City's retail service area, (2) properties outside the retail service area currently served pursuant to legacy retail water service zone contracts (see "historical background" discussion in Section 3.2.1 above), (3) areas served through wholesale water contracts, and (4) areas served through emergency intertie agreements.

The City's service area does not include any areas where future water service is planned, other than those limited instances when city council finds, pursuant to BMC 15.36.010(C) and (D), that retail water service to a property outside the UGA is necessary to protect basic public health and safety and the environment and will not permit urban development and the property abuts an existing water main.

3.2.4 Neighboring Water Systems within Service Area

Included in the service area is the retail service area, and areas where wholesale water is provided. It is recommended that these locations be metered to ensure contractual limits are not exceeded. Water Districts and their individual contractual amounts are detailed in Chapter 4.

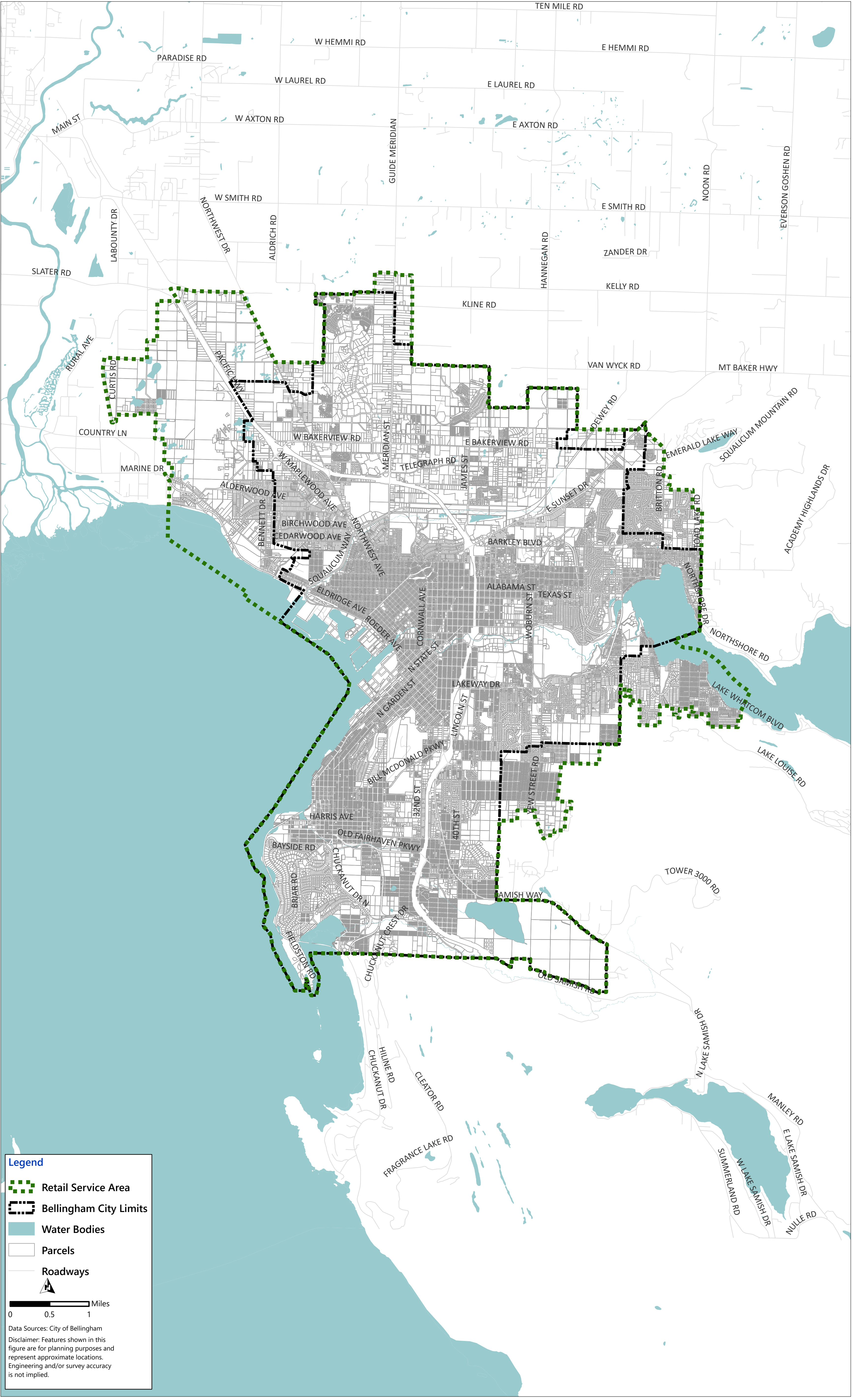
The City's neighboring Group A and Group B water systems located within the City Limits and the UGA, respectively are presented below in Tables 3.1 and 3.2.

Table 3.1 Neighboring Water Systems Within City Limits

Water System Name	Group
Deer Creek Water Association	Group A
Chuckanut Trails Water System	Group A
LWWSD	Group A
Montgomery Road Water Association	Group B
California Street Water Association	Group B

Table 3.2 Neighboring Water Systems Within UGA

Water System Name	Group
Whatcom County WD No. 2	Group A
Northwest Water Association	Group A
Whatcom County WD No. 7	Group A
Glenn Cove Water	Group A
Forest Park Mobile Home Park	Group A
Spring Valley Community Well	Group B



Last Revised: March 13, 2025 [ENTER PROJECT WISE PATH NAME TO MXD] For Example:pw:\\Carollo\Documents\Client\CA\ClientName\10265A00\Data\GIS\Figure_01_01.aprx

Figure 3.1 Existing Service Area
CITY OF BELLINGHAM
WATER SYSTEM PLAN

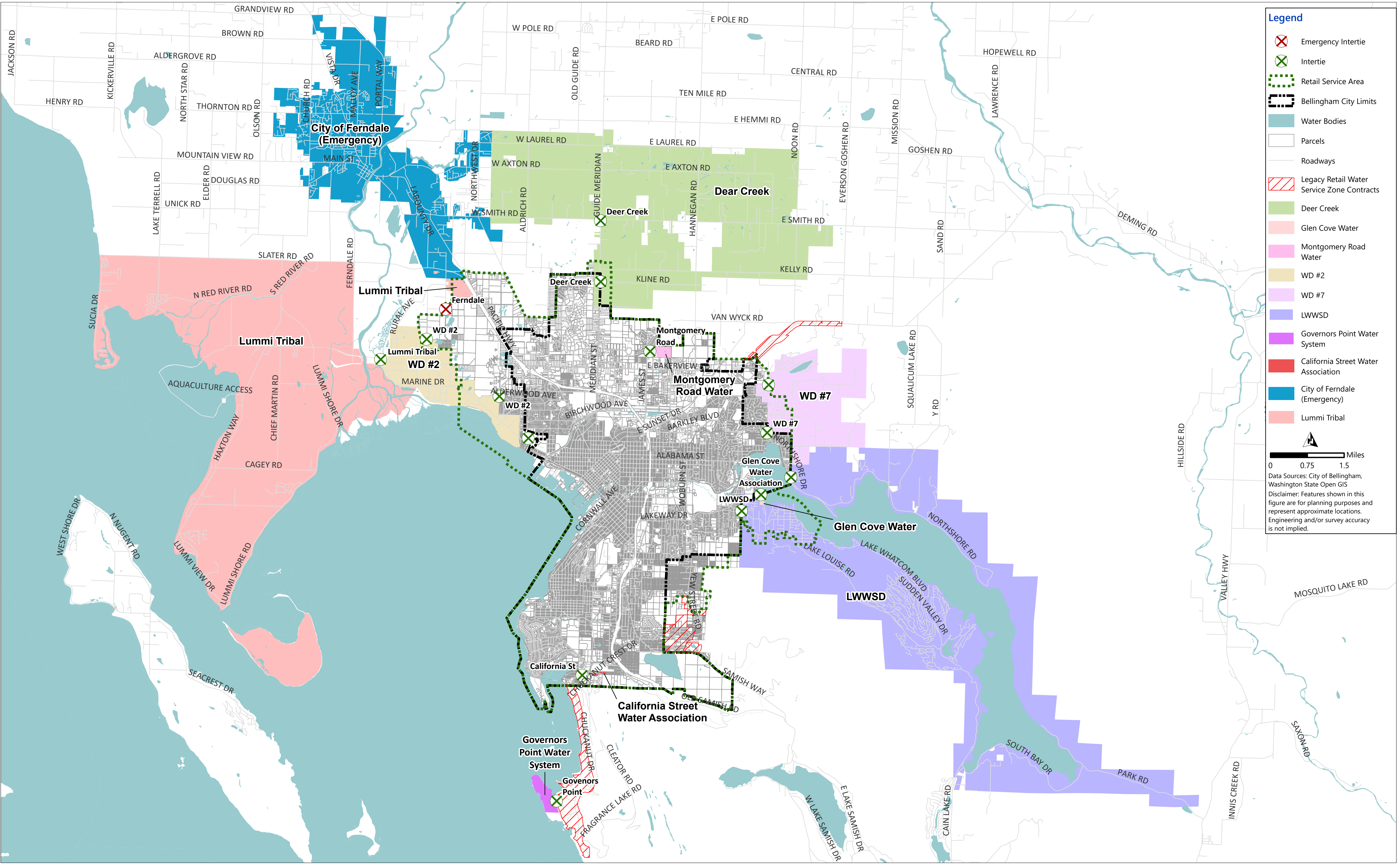


Figure 3.2 Service Area

3.3 Policies, Criteria, and Standards

The City's policies, criteria, and standards were organized into the following categories:

- Service.
- Coordination with Other Agencies.
- Environmental.
- System Reliability and Maintenance.
- Utility Billing.
- General Design.
- Fire Protection.
- Distribution System.

3.3.1 Service Policies/Standards

The service policies and standards outlined in Table 3.3 consist of policies relating to the growth, management, and service of the water system. The extension of water service to any future service area would only occur in accordance with the policies and standards detailed in this section.

3.3.1.1 Recommendation

While the City does not currently have written policy prohibiting the use of private wells within the City's retail service area, it is recommended by Carollo the City develop a policy to clearly define the use of private wells.

Table 3.3 Service Policies/Standards

Subject	Policy/Standard	Source
Service Ownership and Responsibility	▪ Bellingham shall own and maintain all water mains and service lines in established City and County streets or other utility rights-of-way. The property owner shall own and maintain the service line from the meter to the premises served, as well as other facilities such as pressure-reducing valves, pumps, or cross-connection devices on the customer side of the meter.	2009 Water System Plan
Timely and Reasonable	▪ Provide water service to all customers within the City's retail service area consistent with applicable City policies, resolutions, ordinances, the Municipal Water Law, Washington State DOH rules and guidelines, and applicable federal, state, and local laws and plans. ▪ Respond to water service requests within 30 days, typically within two weeks.	2024 Water System Plan
Urban Growth Area	▪ Bellingham intends to provide "urban" levels of water service throughout its existing and future service area. The City strives to provide such levels of service within its existing service area. Levels of service in the future service area that are less than those of the existing service area will be improved over time in coordination with other water utility priorities. Payment for water main extensions may be paid for by the person benefitting from the extension, the City, or a local improvement district.	2009 Water System Plan
15.08.010: Types of Water Service	▪ The following types of water service are provided by the City: » A - Single-family services include only those services connecting the city water system to a single-family dwelling unit, including single-family homes, duplexes, mobile homes, manufactured homes, condominiums, apartments, and similar residential uses, with separate individual meters to each distinct unit. » B - Non-single-family services include all commercial and retail enterprises, restaurants, government facilities, parks, recreational facilities, non-profit enterprises, schools, churches, and all other services not covered by subsection A, C, D, E, or F of this section. » C - Fire protection service is a water service installed solely for the purpose of providing water to automatic fire sprinklers, on-site fire hydrants, or standpipes. All privately owned fire protection services shall include a flow-detection device of a type approved by the director of public works. No domestic water supply connections are allowed on a fire protection service. » D - Resale water service is a wholesale metered service by which potable water is provided under contract to a water district or association for resale. » E - Industrial water service is non-potable water supplied for industrial or other purposes. » F - Irrigation water service is a service using potable water for landscaping and irrigation purposes only. All irrigation systems must have a meter and dedicated irrigation service unless the service is on a lot that is less than or equal to 10,000 square feet. » G - Bulk water service is a metered potable water service provided at bulk water filling stations to customers with water-hauling vehicles. (Ord. 2014-03-014 § 1; Ord. 2012-12-060 § 1; Ord. 2006-08-081; Ord. 2005-01-005; Ord. 2004-11-081 § 3; Ord. 1999-12-092; Ord. 10093 § 10, 1990; Ord. 8982 § 12, 1981).	BMC 15.08: Water Service
15.08.020: Application for water service	▪ Any person desiring to have a premises within city limits connected with the city water supply system shall make application to the public works director on printed forms furnished for that purpose. Every such application shall be made by the owner or the purchaser under a real estate contract of the premises to be benefited, or by his authorized agent. ▪ The application must describe the property to be served, state fully the purposes for which the water is required, and indicate that by signing the form, the applicant agrees to conform to the ordinances, rules, and regulations established as conditions for use of water, and further agrees, as a condition to the furnishing of water, that the city has the right to shut off the water supply as required for such things as, by way of example, nonpayment, repairs, extensions, or doing other necessary work. Decisions of the public works director on applications for water service under this subsection may be appealed to the hearing examiner. The written appeal and the appeal fee, if any, must be received by the public works department by no later than 5:00 p.m. on the fourteenth day following the date the decision was issued. (Ord. 2012-12-060 § 2; Ord. 2006-08-081; Ord. 9618 § 11, 1986; Ord. 8982 § 13, 1981).	BMC 15.08: Water Service
15.08.030: Limitation on water use	▪ No person supplied with water from the city mains shall be entitled to use it for any purpose other than those stated in the application for service or to supply other persons or premises in any way. (Ord. 8982 § 14, 1981).	BMC 15.08: Water Service
15.08.040: Water service connections	▪ When the premises is located within the City and fully abuts upon a street or city-owned utility easement through which there is a city water main, the premises' owner may apply for a service. Upon approval of the service by the director of public works and upon such conditions as required by the director, the director of public works shall issue a permit for its installation. ▪ When the premises within the city limits for which service is sought does not fully abut a street or city-owned utility easement through which there is a city water main, the application for service may be accepted for review; however, the utility must be constructed and accepted by the city prior to approval of building permits for the adjacent land use. The public works director has the administrative authority to determine if the property requesting service is the last developable lot and may grant an exception for service without requiring a main extension. ▪ When the premises for which service is sought does not fully abut a main with sufficient pressure and capacity to provide the required flow at the property line, the application for service may be accepted for review; however, the deficiency of pressure or capacity must be improved prior to issuance of the permit. ▪ All premises supplied with city water must have an individual and separate water meter. Premises so supplied will not be allowed to supply water to any other premises. The public works director may require individual buildings on any premises to be separately metered; however, auxiliary uses to single-family residential parcels shall not require separate meters. The director may exempt fire protection services from this requirement. ▪ All water service connections shall be metered. ▪ All water service customers who are not served by a water meter shall be connected to a city water meter by the city and shall be charged for measured consumption plus the base cost of service. ▪ Infill housing sites developed under Chapter 20.28 BMC may be divided into lots that do not abut a water main, provided: » The parent site meets the requirements of this BMC 15.08.040; » A separate private water service line is installed to city standards from a main to each lot prior to final plat approval; » The public works director determines that no main extension is necessary for the orderly extension or efficient looping of the public water system. ▪ In all cases where meters are damaged, stolen, altered, lost, injured or broken by owners or occupants of premises, they shall be replaced or repaired under the direction of the director of public works and the cost charged against the owner or occupant; and in case of nonpayment for meter damage, the water shall be shut off, and will not be turned on until such charge and the charge for turning on the water are paid in the same manner as provided for delinquent payments. (Ord. 2012-12-060 § 3; Ord. 2009-08-048; Ord. 2008-08-081; Ord. 2006-08-081; Ord. 2004-11-081 § 4; Ord. 9618 § 12, 1986; Ord. 9073 § 5, 1982; Ord. 8982 § 15, 1981).	BMC 15.08: Water Service

Subject	Policy/Standard	Source
15.08.060: Water Service Installation	▪ All water services, including materials and construction methods, shall be installed in accordance with current American Water Works Association (AWWA) standards and all city standards and specifications established by the public works director or designee. ▪ Installation of a requested water service will be scheduled after the finance director has notified the department of public works that all applicable fees and charges have been paid. ▪ The department of public works shall be the entity responsible for the installation of the service. The director may, at his option, select either installation by city forces or by construction contract. Installation, in whole or in part, by private parties may be allowed under conditions set by and at the discretion of the public works director. ▪ The location of the water service will be determined by the public works department. ▪ Water service shall consist of the connection to the main, the corporation stop at the main, pipeline from the water main to the meter, meter box, setter, meter and corporation stops. Water services shall be owned and maintained by the city from the main to the meter box, including all appurtenances therein. ▪ The water service shall be installed within city rights-of-way or easements in accordance with city standards. ▪ All services shall be reviewed by the public works department using the Uniform Plumbing Code and the AWWA "Sizing Water Service Lines and Meters"; except that standby fire-protection services shall be sized based on fire-flow requirements determined by the fire department. ▪ Water service and electrical services lines shall not share the same trench unless: » They are separated by a minimum of 24 inches; or » The electric line is in a rigid metallic conduit. ▪ No electric grounding devices or wires from any utility shall be attached to any water service unless authorized by the director of public works. ▪ No sewer service shall be installed within five feet of a water service unless it is located at least 24 inches below the water service. ▪ Meters shall be of the type designated by the director of public works and shall be installed at the cost of the person requesting water service. (Ord. 2012-12-060 § 5; Ord. 2004-11-081 § 6; Ord. 10131, 1990; Ord. 9618, 1986).	BMC 15.08: Water Service
15.08.070: Turning on water service.	▪ Water service may only be turned on after the finance director has notified the director of public works that all applicable fees have been paid, irrespective of whether the service is new, or is one whose water has been shut off for any reason. (Ord. 8982 § 18, 1981).	BMC 15.08: Water Service
15.08.080: When main extension required.	▪ A main extension is required whenever property within the water service zone is subdivided or developed and that property does not abut a water main, or when an existing abutting water main is not adequate to provide the required water pressure or flow characteristics. Minimum flow is that set by state law, which is currently 30 psi at normal peak flow. (Ord. 2018-12-036 § 5; Ord. 2004-11-081 § 7; Ord. 8982 § 19, 1981).	BMC 15.08: Water Service
15.08.090: Petition for water main extension.	▪ The person desiring a main extension shall petition the director of public works requesting permission to extend the city's water system. ▪ The director of public works shall review the request, and if the requested extension is determined to be desirable, shall provide the petitioner with the design requirements for the extension. If the requested main extension is determined to be an undesirable extension of the water system, the petition shall be denied. (Ord. 8982 § 20, 1981).	BMC 15.08: Water Service
15.08.130: Energizing main extensions.	▪ No main extension shall be energized other than for test purposes by duly authorized personnel until the main extension has been accepted by the city and all fees and charges have been paid. If energizing a main is necessary to restore service to existing customers, fire hydrants will not be activated until acceptance of the main extension. (Ord. 8982 § 24, 1981).	BMC 15.08: Water Service
15.08.140: Transfer of service on new water main.	▪ When the water main abutting a premises is replaced, the existing active services will be transferred to the new main without payment of additional fees or charges. ▪ When the service connection for a premises is not on a main abutting the premises, and a main extension installs a new water main adjacent to the premises, the owner of the premises will be required to pay the necessary latecomer's or other construction charges before the service will be transferred to the new main. No additional charges will be made to transfer the service. (Ord. 8982 § 25, 1981).	BMC 15.08: Water Service
15.08.160: Authority to shut off water.	▪ The department of public works has the right at any time, after giving reasonable notice, to shut off the water supply for repairs, extensions, violations of this code, and any other reason other than nonpayment of rates. ▪ The city is not responsible for any damage caused by the breaking, bursting or collapsing of any boilers, tanks, pipelines or fixtures, or any damage whatever resulting directly or indirectly from shutting off of water, when timely notice is given. (Ord. 8982 § 27, 1981).	BMC 15.08: Water Service
15.08.190: Temporary discontinuance of service.	▪ A temporary discontinuance of water service may be requested by the owner of a premises or an agent of the owner with the express written authority to make such a request. The request shall be in writing, be submitted at least 10 working days before the requested discontinuance, state the estimated duration of the discontinuance, and be on forms provided for that purpose in the office of the finance director. ▪ The minimum period of time for a temporary discontinuance of water service is 30 days, but in no case shall be longer than three years, in which case the service shall be considered abandoned under BMC 15.08.200. ▪ Resumption of water service shall be in writing on the forms provided for that purpose in the office of the finance director. ▪ Water and sewer service billing shall stop for the duration of the temporary discontinuance, provided such temporary discontinuance is approved hereunder. However the shutoff and turn-on shall be subject to the fees for such service provided by this chapter. (Ord. 2006-08-081; Ord. 2001-02-007; Ord. 9371 § 1, 1984; Ord. 8982 § 30, 1981).	BMC 15.08: Water Service
15.08.200: Abandoned services.	▪ An abandoned service is any water service that has not been used for a period of three years or longer except for services installed as part of a main extension and not put into service, which will not be considered abandoned. Abandonment under this section shall not relieve the property owner or other responsible party of any financial responsibility for charges incurred at the premises for water service. ▪ A property with an abandoned city water service located outside the city's corporate limits but within the city's urban growth area may apply for one new single-family water service with a service meter size of one inch or the same size service meter as the water service previously abandoned, whichever is smaller. ▪ A new water service for a premises where an abandoned service exists may use the existing abandoned water service if it is determined to be in satisfactory condition by the director of public works or his designee. If the abandoned service is reactivated without modification, the applicant shall be refunded that portion of the fees and charges expressly stated for service installation. A credit for the system development charge shall be provided as set forth in BMC 15.08.230. All other fees and charges shall be the same as for a new service. (Ord. 2012-05-025 § 1; Ord. 2012-01-002 § 1; Ord. 2006-08-081; Ord. 9371 § 1, 1984; Ord. 8982 § 31, 1981).	BMC 15.08: Water Service

Subject	Policy/Standard	Source
15.04.060: Reduction of water supplied.	▪ In case of emergency, shortage, or whenever the public health, safety, or the equitable distribution of water demands, the director of public works may change, reduce, or limit the time for uses of water, or may impose restrictions and schedules for specified uses of water, or may temporarily discontinue specified uses of water. ▪ Water service may be temporarily interrupted for purposes of making repairs, extensions, or doing other necessary work. ▪ Before changing the use of water, the department shall notify, insofar as practicable, all water consumers affected. ▪ In addition to the penalties described in BMC 15.04.040(E), persons found in violation of this section and as provided by BMC 15.04.040(E) and 15.04.040(A) and B shall be subject to water shutoff upon nonpayment of fines, or for continuing violation of this section. Each and every day that such prohibited activity continues beyond the notice period shall be considered a separate violation. (Ord. 2001-07-051; Ord. 8982 § 6, 1981).	BMC 15.04: Administrative Provisions for Water, Sewer, and Surface and Stormwater Utility Billing
15.04.080: Ownership and control.	▪ The ownership of all water, sewer and surface and stormwater mains and appurtenances in the public streets or other utility easements owned by the city is vested solely in the city, and the person responsible for the construction of such mains shall furnish a deed of conveyance for such mains upon acceptance by the department of public works. The department will operate and maintain all approved and accepted mains in established city and county streets or other utility rights-of-way. It shall be a misdemeanor to remove or change any part thereof without the approval of the department. (Ord. 10056 § 3, 1990; Ord. 8982 § 8, 1981).	BMC 15.04: Administrative Provisions for Water, Sewer, and Surface and Stormwater Utility Billing
15.36.010: Policies for expansion or extension of city water and/or sewer service outside corporate limits.	▪ The city council adopts the following policies regarding the extension or expansion of water and/or sewer service outside the city's corporate limits: » A - Historically, the city has contracted to provide retail water and/or sewer service directly to some customers outside the city's corporate limits. The city does not intend to terminate any such water or sewer service that is in existence as of the ordinance codified in this chapter's effective date. For purposes of this chapter, "in existence" means the property is currently receiving service and/or has a fully signed, valid, and recorded utility service zone agreement. However, the city will not modify, expand, or extend this existing direct retail water and/or sewer service except as provided in subsections B and C of this section and BMC 15.36.040. » B - The city will provide new direct retail water and/or sewer service to property within the city's urban growth area only after the property annexes to the city. The city will not modify, extend, or expand direct retail water and/or sewer service in the city's urban growth area without annexation unless the city council determines that such modification, extension, or expansion is necessary to protect basic public health and safety and the environment. » C - The city will not modify, extend, or expand direct retail water and/or sewer service outside the city's urban growth area unless the city council determines that such modification, extension, or expansion is necessary to protect basic public health and safety and the environment, and the modification, extension, or expansion will not permit urban development. » D - If the public health and safety and the environment exception in subsection B or C of this section is met, the city will provide water and/or sewer service to the property from a city-owned main under the following conditions: ▪ The property abuts a city water and/or sewer main, or the property owner can provide proof of legal access to the city main through an adjacent property or right-of-way; ▪ For water service, the property owner demonstrates to public works that a line of less than four-inch diameter from the city water main can provide a minimum of 30 psi at normal peak flow to the property line of the requested service without aid of boosters or pumps, and the water meter is placed at the edge of the public right-of-way or at a location approved by public works; ▪ For sewer service, the property owner demonstrates to public works that sewage from the property can be safely discharged to the city sewer main; ▪ The property owner executes and records a city-approved agreement to use the city water and/or sewer service for the existing use of the property and not for a new or expanded use, and to not protest annexation or subdivide the property prior to annexation; and ▪ If both water and sewer service are requested under subsection B or C of this section, each requested service independently meets the public health and safety and the environment exception. ▪ The city has also contracted to provide wholesale water and/or sewer service to some districts and associations outside the city's corporate limits. The city will continue to provide wholesale water and/or sewer service in accordance with the terms of these contracts. The city will not extend or expand wholesale city water and/or sewer service unless the city council determines that such extension or expansion meets the requirements of BMC 15.36.020 and 15.36.040. (Ord. 2019-02-003; Ord. 2011-05-025; Ord. 2004-09-063; Ord. 8982 § 70, 1981; Ord. 8728 § 3, 1979).	BMC 15.36: Water and Sewer Service Outside Corporate Limits
15.36.020: Wholesale services to districts and associations.	▪ All contracts for wholesale water and/or sewer service, whether new or extensions of existing agreements, shall be executed by the mayor as provided in Bellingham City Charter Section 5.02. In no event shall the mayor execute such contracts without the express authorization of the city council. Requests for such wholesale service contracts shall first be directed to the director of public works, and shall thereafter be processed as provided in BMC 15.36.030. Existing contracts with districts and associations for water and/or sewer service may be renewed or extended and contracts negotiated with newly formed districts or associations, but all such contracts shall be subject to the terms and conditions of this chapter. ▪ All new contracts as well as existing contracts being negotiated for renewal relating to sewer service shall include provisions specifically providing the maximum quantities of effluent that will be accepted for transmission and treatment. All new contracts as well as existing contracts being negotiated for renewal relating to water service shall include provisions specifically providing the maximum quantities that will be supplied at the point of distribution. ▪ All new contracts as well as existing contracts being negotiated for renewal relating to wholesale sewer services shall include provisions requiring the district or association to comply with all state and applicable local laws pertaining to the extension of sewer services in rural areas, including but not limited to the Growth Management Act provisions codified in RCW 36.70A.110(4) and the district's or association's comprehensive sewer plan as approved, or conditionally approved, by the Washington State Department of Ecology pursuant to RCW 90.48.110. [Ord. 2014-02-007; Ord. 2011-05-025; Ord. 2004-09-063; Ord. 8982 § 70, 1981; Ord. 8728 § 4, 1979].	BMC 15.36: Water and Sewer Service Outside Corporate Limits

Subject	Policy/Standard	Source
15.36.030: Requests for contracts for direct retail service or wholesale service – Procedure.	▪ All requests for retail or wholesale water and/or sewer service outside the city corporate limits shall be made to the director of public works and shall include a fee as set by city council resolution. The director shall review each request for compliance with the city's policies regarding the modification, extension, or expansion of water and/or sewer service as stated in BMC 15.36.010. If the director determines that the request does not comply with the policies, the director shall notify the applicant that the request is denied. If the applicant requests that the denial be reviewed by the city council, such request along with the director of public works' recommendation shall be forwarded to the city council for review. ▪ If the director determines that the request meets the city's policies regarding the modification, extension, or expansion of water and/or sewer service as stated in BMC 15.36.010 or the applicant requests city council review of the director's denial of the request, the request along with the director's recommendation shall be presented to city council for review. As part of its review of the request, city council may request that the public works department prepare a feasibility report regarding the provision of water and/or sewer service based on system related criteria and/or that the planning and community development department prepare an impact report with recommendations addressing those criteria set out in BMC 15.36.040. ▪ Following further consideration of the matter by the city council, the city attorney shall be advised as to whether or not a contract for water and/or sewer service should be prepared and what terms should be included in the contract for services. In making its determination, the city council shall consider the recommendation of the administrative departments, the policies set out in BMC 15.36.010, and the criteria set out in BMC 15.36.040, as well as any other applicable statutes, ordinances, or policies and procedures of the city. ▪ City council shall consider a motion to authorize the mayor to execute a contract for the modification, extension, or expansion of water and/or sewer service only after the formal contract has been prepared and presented to the city council for review. (Ord. 2011-05-025; Ord. 2004-09-063; Ord. 8728 § 5, 1979).	BMC 15.36: Water and Sewer Service Outside Corporate Limits
15.36.040: Criteria for determining whether services should be provided.	▪ The criteria to be considered in determining whether water and/or sewer service should be provided are: » The consistency of the proposed development with the following land use plans, regulations, statutes, and development standards acceptable to the city: ▪ Consistency with the goals, policies and land use designations in Whatcom County's adopted subarea plan for the area; the applicable goals and policies in Bellingham's comprehensive plan; and the provisions of the city/county interlocal agreement related to annexation and development in Bellingham's urban growth area; ▪ Consistency with all city design and development standards and environmental regulations; ▪ Consistency with the city water and sewer extension policies in BMC 15.36.010; and ▪ Consistency with all relevant state statutes and regulations, including the Growth Management Act; » The expected impact such development might have on city streets and arterials as currently developed; » For property located within the Lake Whatcom watershed, whether the proposed development might be expected to adversely impact the watershed; » Whether or not adequate consideration has been given to retention and discharge of stormwater so as to preclude adverse impact upon the city; and » Whether it is in the best interests of the city to authorize the requested extension or expansion of water or sewer services even though sufficient capacity is available within existing transmission lines. (Ord. 2011-05-025; Ord. 2004-09-063; Ord. 9461 § 2(B), 1985; Ord. 8728 § 6, 1979).	BMC 15.36: Water and Sewer Service Outside Corporate Limits
15.36.050: Boundary review board approval required.	▪ As required by RCW 36.93.090 (4) relating to the jurisdiction of the county-wide boundary review board, no extension of permanent water and/or sewer services outside city's existing service area, as defined in RCW 36.93.090(4) shall be approved unless the initiators thereof have gained the approval of the Whatcom County boundary review board. For the purposes of this section, "extension of permanent service" shall be deemed to be limited to that service which requires the installation of additional water mains or sewer mains whether to be a part of the city's system or a district's or association's system. ▪ While it shall be the obligation of the requesting party to process the application through the boundary review board, such requests should not be made it advance of the city's approval to provide service and in the event the applicant gains the approval of the board prior to city approval, the city reserves the right to refuse or to condition any such service. (Ord. 2011-05-025; Ord. 2004-09-063; Ord. 10899 § 2, 1997; Ord. 9461 § 1, 1985).	BMC 15.36: Water and Sewer Service Outside Corporate Limits
15.38.010: Proposal – Considerations	▪ When considering annexation proposals, the following criteria will be given consideration: » The city should have the capacity to provide the full range of urban services to newly annexed areas in a timely manner without reducing the level of those services to other city residents and businesses.	BMC 15.38: Annexation Criteria and Procedures
Wheeling Water	▪ Bellingham does not currently wheel water to another water system. Any potential future requests to use the City's transmission or distribution system infrastructure for wheeling water to benefit another utility will be addressed on a case-by-case basis to assess any detrimental impacts to the City resulting from such wheeling.	2009 Water System Plan
Satellite Systems	▪ It is the current policy of Bellingham not to promote the creation of or manage satellite water systems.	2009 Water System Plan
Oversizing	▪ When the water system is being extended by a private developer and Bellingham has identified a future extension beyond that proposed by the private developer, the extension shall be oversized to meet the City's future plans for the system. The City will pay for costs related to oversizing the facilities installed by the private developer.	2009 Water System Plan

3.3.2 Coordination with Other Agencies

Table 3.4 summarizes policies regarding the City's coordination with other agencies, which includes but is not limited to Whatcom County, federal and state agencies, other public and private utilities, and tribal governments. In addition to the policies outlined in Table 3.4, the City is currently working with Whatcom County on updating their Coordinated Water System Plan.

Table 3.4 Coordination with Other Agencies

Subject	Policy	Source
Policy CF-23	Continue to work in collaboration with Whatcom County, the Lake Whatcom Water and Sewer District, and the Sudden Valley Community Association to develop and implement the five-year Lake Whatcom Work Programs.	2016 Comprehensive Plan
Policy CF-24	Cooperate with Whatcom County, other cities in the county, tribal governments, federal and state agencies, and public and private utilities in conserving water.	2016 Comprehensive Plan
Policy CF-41	Bellingham and the existing service districts within the UGA (water associations, utility districts, etc.) shall execute interlocal agreements to coordinate plans for serving areas within the boundary prior to annexation.	2016 Comprehensive Plan
Intergovernmental Cooperation	To adequately plan for growth and implement the policies of the Growth Management Act, the governmental jurisdictions in Whatcom County, including the Lummi Nation and Nooksack Tribe, and the Port of Bellingham shall work together to establish ongoing mechanisms to improve communication, information sharing and coordinated approaches to common problems.	Whatcom County Comprehensive Plan
Water Quality and Water Quantity	The cities, and the county, in cooperation with other municipal corporations, tribal governments, federal and state agencies, and public and private utilities shall cooperate in the protection of water resources and in drawing upon said water to support growth.	Whatcom County Comprehensive Plan

3.3.2.1 Recommendation

Carollo recommends that the City expand upon Policy CF-41, which is summarized in Table 3.4 above, to look beyond the UGA in the future when executing interlocal agreements to coordinate plans.

3.3.3 Environmental Policies and Criteria

Table 3.5 summarizes the City's environmental policies, criteria and goals that relate to the City's water system.

Table 3.5 Environmental Policies

Subject	Policy/Goal	Source
Shoreline Master Program	▪ Shorelines are a specifically-designated environmental feature and are protected and managed by the City's Shoreline Master Program (SMP). Adopted in 2013, the SMP implements the Washington State Shoreline Management Act and its policies. These policies include protecting the ecological function of the state's shorelines and their associated natural resources by identifying areas for preferred uses and economic development, restoring previously impacted shorelines, and providing opportunities for the general public to have access to and enjoy shorelines.	BMC 22: Shoreline Master Program
Critical Areas	▪ Critical areas as defined in the GMA include wetlands, fish and wildlife habitat conservation areas (including streams), frequently flooded areas, geologically hazardous areas, and critical aquifer recharge areas (there are none in the City). The GMA requires the City to adopt development regulations to protect the functions and values of critical areas and to protect public safety. ▪ The City adopted its first complete Critical Areas Ordinance (CAO) in December 2005, in accordance with the GMA. The CAO replaced the Wetland/Stream Regulatory Chapter, which was adopted in 1991 as the City's first set of regulations to protect wetlands and streams. The City has adopted several updates to the CAO in order to be consistent with best available science as required by GMA.	BMC 16.55: Critical Areas
16.80.030: Lake Whatcom Reservoir Regulatory Provisions Purpose	▪ The purposes of this chapter are to: » Ensure a long-term, sustainable drinking water supply in order to protect public health, safety, and welfare. » Protect and restore the water quality of the Lake Whatcom Reservoir and its tributaries. » Implement management actions that emphasize prevention of water quality impacts over treatment strategies. » Specify development standards that will reduce phosphorus inputs to the lake as a part of the total maximum daily load response plan required by the Washington State Department of Ecology. » Implement appropriate strategies for both public and private properties to significantly reduce phosphorus inputs. » Provide for a fair, predictable and consistent application of land use regulation that will also recognize the rights of private property owners and Lake Whatcom watershed residents. (Ord. 2009-06-040; Ord. 200101-001).	BMC 16.80: Lake Whatcom Reservoir Regulatory Provisions
Lake Whatcom Management Program	▪ The Lake Whatcom Management Program is guided by the general goals established in the 1992 Joint Resolution of the City, Whatcom County, and the Lake Whatcom Water and Sewer District. These are: » To recognize Lake Whatcom and its watershed as the major drinking-water reservoir for the county and develop public and private management principles for the lake and watershed consistent with a drinking water reservoir environment. » To protect, preserve and enhance water quality and manage water quantity to ensure long-term sustainable supplies for a variety of uses, with priority placed on domestic water supply. Management programs and actions will be made in recognition of existing contractual agreements and potential for review and renegotiation in light of these goals. » To prioritize protection over treatment in managing Lake Whatcom and its watersheds. Management actions shall reflect a long-term view of replacement or treatment costs. » To manage water quantity to sustain long-term efficient use of the water for beneficial uses within the county that are consistent with a drinking-water reservoir, and recognize the integral link with the Nooksack River and associated water resource concerns. » To ensure that opportunities for public comment and participation are provided in policy and management program development, and to promote public awareness and responsible individual actions. » To promote learning, research, and information opportunities which better our understanding of the watershed system, the impacts of activities, and the benefits and potentials of policies implemented.	2020-2024 Lake Whatcom Management Program Work Plans
Policy EV-1	▪ Focus on protection over treatment in managing Lake Whatcom and its watershed.	2016 Comprehensive Plan
Policy EV-2	▪ Emphasize prevention of invasive aquatic species from entering Lake Whatcom.	2016 Comprehensive Plan
Policy EV-3	▪ Continue to work in collaboration with Whatcom County, the Lake Whatcom Water and Sewer District, and the Sudden Valley Community Association to develop and implement the five-year Lake Whatcom Work Program.	2016 Comprehensive Plan
Policy EV-4	▪ Support the adopted Lake Whatcom Work Program and dedicate the resources to continue to update and implement it.	2016 Comprehensive Plan
Policy EV-5	▪ Manage recreational uses on the lake and in the watershed in a manner that prevents degradation of water quality and habitat.	2016 Comprehensive Plan
Policy EV-6	▪ Implement programs, regulations, and incentives that result in sustainable land use practices, such as LID, that prevent the degradation of water quality in the lake.	2016 Comprehensive Plan
Policy EV-7	▪ Continue to designate receiving zones for development rights transferred from the Lake Whatcom watershed in areas of the City appropriate for higher densities.	2016 Comprehensive Plan
Policy EV-8	▪ Continue the Lake Whatcom Watershed Property Acquisition Program.	2016 Comprehensive Plan
Policy EV-42	▪ Mitigate for and adapt to climate change through implementation of the City's Climate Protection Action Plan.	2016 Comprehensive Plan
Policy EV-44	▪ Promote resiliency to climate change and natural disasters and coordinate efforts with neighboring jurisdictions (see Whatcom County Natural Hazards Mitigation Plan).	2016 Comprehensive Plan
Policy EV-46	▪ Promote energy efficiency in both municipal buildings and in buildings throughout the community.	2016 Comprehensive Plan
Policy EV-50	▪ Preserve the existing water supply and ensure an adequate future water supply despite capacity impacts associated with climate change.	2016 Comprehensive Plan
Policy EV-54	▪ Increase the efficiency of water and energy use in municipal facilities.	2016 Comprehensive Plan
Policy EV-52	▪ Provide convenient means for energy and resource conservation within municipal operations and throughout the community.	2016 Comprehensive Plan

3.3.4 System Reliability and Maintenance Policies and Standards

Table 3.6 outlines the City's maintenance standards and policies, as well as system reliability policies.

Table 3.6 System Reliability and Maintenance Policies and Standards

Subject	Policy/Standard	Source
Water Shortage Response Plan	▪ The City developed a Water Shortage Response Plan in 2001. The Water Shortage Response Plan identifies procedures for making water available to customers during water and shortages. The Plan provides an overview of Drought Management Strategy, four Phases of Curtailment (Advisory, Voluntary, Mandatory, and Emergency) of water use and a Short Term Emergency Curtailment Plan.	2009 Water System Plan
Water System Emergency Response Plan	▪ The City developed a Water System Emergency Response Plan for Public Works Operations in 2005. This plan provides the following: » Potential hazards and how to address them, » Concepts of operations as they relate to emergencies, » Provides a list of available emergency equipment, » Defines crisis communications, incident management, training and exercises, and the handling of water quality contamination.	2009 Water System Plan
System Maintenance	▪ The City proactively operates and maintains its water system as an effective means of system management. The City began developing an operations and maintenance manual in the mid-1990s and makes periodic updates and adds material.	2009 Water System Plan
Backup Power Requirements	▪ All pump stations constructed since 1996 have backup power systems. All pump stations serving closed zones are equipped with backup power generation equipment. All future pump stations will include backup power in their design. Bellingham also maintains multiple portable generators for use in case of power failure at stations not equipped with on-site backup power generation.	2009 Water System Plan
Preventative Maintenance Program	▪ Pump stations: bi-weekly water pump run, monthly pump station check, annual fire extinguisher inspection. ▪ Reservoirs: monthly reservoir check, semi-annual reservoir valve exercise, annual reservoir check, annual fire extinguisher inspection, monthly level check. ▪ Gate house: monthly gate house check. ▪ Pipeline: monthly line cathodic protection check. ▪ Lake Whatcom Control Dam: quarterly lube and inspection. ▪ Screenhouse: annual fire extinguisher inspection, annual screenhouse check, semiannual screen inspection, semi-annual screenhouse inspection. ▪ Water Treatment Plant: quarterly backwash pump greasing, annual backwash pump inspection, annual backwash level calibration, annual filter flow loop calibration (all 6 filters), annual filter headloss loop calibration, annual filter valve oil check, annual Dakin & Yew pump oil change, annual Dakin & Yew flow meter check, annual alum pressure transmitter calibrate, monthly chlorine analyzer reagent replacement, monthly sample cell cleaning, quarterly replacement of analyzer tubing, daily verification of online chlorine analyzer, weekly sodium hypochlorite pump output verification, bi-weekly water pump run, monthly emergency generator run, annual raw water flow loop calibration, annual Dakin & Yew flow calibration, annual clearwell level calibration.	2009 Water System Plan
15.08.260: Cross-connection control	▪ Applicability. All consumers with service connections to the purveyor's public water system. ▪ Purpose: » Protect the public water system from contamination due to backflow through cross-connections; and » Eliminate or control cross-connections between the public water system and the consumer's water system. ▪ Responsibility: » The consumer's responsibility for cross-connection control shall begin at the service connection. » Consumers shall be responsible for the: ▪ Elimination of cross-connections when possible; or ▪ Control of cross-connections at the service connection (premises isolation); or ▪ Control of cross-connections, within the consumer's water system, by relying on in-premises protection when premises isolation is not required by WAC 246-290-490 and this method is approved by the director. » Consumers are responsible for the installation, testing, inspection, repair, maintenance, and proper operation of approved backflow preventers required for the control of cross-connections between their premises and the public water system. ▪ General Requirements: » The rules and regulations of the Washington State Department of Health as published in WAC 246-290-490 are hereby adopted by reference as they may be from time to time amended. » Consumers shall comply with the city's cross-connection control program policies and procedures as they may be from time to time amended. » An approved backflow preventer is required on all private fire lines, appropriate to the assessed degree of cross-connection health hazard, and shall incorporate a water meter for detecting water consumption. The approved backflow preventer shall be placed such that access for the city is provided to physically or electronically read the detecting meter. » Consumers shall permit periodic entry to their premises (in accordance with BMC 15.04.030), by a cross-connection control specialist, for the determination of cross-connection health hazards and compliance with cross-connection control requirements.	BMC 15.08: Water Service
Pump Station Redundancy	▪ WAC 246-290-235 and the DOH WSDM state that pump stations are sized to provide peak daily flows with the largest unit out of service.	2009 Water System Plan
Water Shortage Contingency Plan	▪ The City developed a Water Shortage Contingency Plan in 2015. This Plan provides guidelines to manage water supply and demand in the event of a supply disruption. The Water Shortage Contingency Plan can be found in Appendix T.	2015 Water Shortage Contingency Plan

3.3.5 Financial Policies

The City's financial policies related to the Water Utility are summarized in Table 3.7.

Table 3.7 Financial Policies

Subject	Policy	Source
15.04.005: Purpose – Liability for damage	▪ This title is enacted as an exercise of the police power of the city, to protect and preserve the public peace, health, safety and welfare by regulating the city's water, sewer, and surface and stormwater utility. The city recognizes that it cannot solve all problems related thereto by enactment of this type of legislation; this title is therefore to be construed as an effort to make best possible use of available resources, and not an attempt to provide complete protection to all the city's inhabitants. » It is expressly the purpose of this title to provide for and promote the health, safety and welfare of the general public, and not to create or designate any particular class of persons who will or should be especially protected by its terms. » It is the specific intent of this title to place the obligation of complying with its requirements on the owner or occupant of premises within its scope, and no provision of this title is intended to impose any duty whatsoever upon the city or any of its officers, for whom the implementation or enforcement of this title is discretionary and not mandatory. » Nothing contained in this title is intended to be, nor shall be construed to create, the basis for any liability on the part of the city or its officers for any injury or damage resulting from the failure of the owner or occupier of premises to comply with the provisions of this title, or by reason or in consequence of any act or omission in connection with the implementation or enforcement of this title on the part of the city or its officers. (Ord. 10056 § 3, 1990; Ord. 9073 § 4, 1982).	BMC 15.04: Administrative Provisions for Water, Sewer, and Surface and Stormwater Utility Billing
15.04.020: Responsibility for administration and enforcement	▪ The directors of finance and public works are responsible for the administration and enforcement of this title, as provided herein. (Ord. 2021-04-014 § 2; Ord. 8982 § 2, 1981).	BMC 15.04: Administrative Provisions for Water, Sewer, and Surface and Stormwater Utility Billing
15.04.030: Entry of premises for inspection	▪ Whenever necessary to make an inspection to enforce any of the provisions of this chapter, or whenever the director of public works has reasonable cause to believe that there exists on any premises any condition not in conformity with any of the provisions of this title, the director may enter such premises at all reasonable times to inspect the same or to perform any duty imposed upon him; provided, that if such building or premises be occupied, he shall first present proper credentials and demand entry; and if such building or premises be unoccupied, he shall first make a reasonable effort to locate the owner or other persons having charge or control of the building or premises and demand entry. If entry is refused, the director shall obtain an administrative inspection warrant to secure entry. ▪ No owner or occupant of any premises shall fail or neglect, after proper demand is made, to permit entry by the director for the purpose of inspection to enforce this title. (Ord. 8982 § 3, 1981).	BMC 15.04: Administrative Provisions for Water, Sewer, and Surface and Stormwater Utility Billing
15.08.150: Payment for water mains.	▪ Water mains laid in public rights-of-way or easements and connected to city mains may be paid for by: » The person benefiting from the installation; or » The city; or » A local improvement district, as provided by law. ▪ The city may, in accordance with state law, grant the person constructing a new water main the right to reimbursement from other abutting property owners benefited by the improvement pursuant to Chapter 14.02 BMC. (Ord. 10906 §§ 1, 4, 1997; Ord. 8982 § 26, 1981).	BMC 15.08: Water Service
15.08.210: Accounts – Funds.	▪ All accounts for water shall be kept by the finance director by reference to the address, or, if necessary, the legal description of the property to which water service is provided. ▪ Accounts shall be billed on a regular schedule determined by the finance director. ▪ The water fund is created. Moneys deposited to this fund shall be used for capital, operation and maintenance of the water system, including water system improvements. (Ord. 2007-12-107; Ord. 8982 § 32, 1981).	BMC 15.08: Water Service
15.08.050: Water service fees	▪ Prior to approval of an application for water service, the fees applicable to the requested service shall be determined. The fees consist of the system development charge, assessments, installation fees, and other charges as specified in this chapter. ▪ Specified fees shall be paid to the finance director in full at the time of application. The finance director shall advise the department of public works when payment has been received. (Ord. 2012-12-060 § 4; Ord. 2004-11-081 § 5; Ord. 9618 § 13, 1986; Ord. 8982 § 16, 1981).	BMC 15.08: Water Service
15.08.215: Installation permit fees.	▪ An application permit fee is charged for each service connection application. The fee for application shall be determined by the public works director by separate fee schedule. (Ord. 2012-12-060 § 6; Ord. 2004-11-081 § 9; Ord. 9618 § 16, 1986; Ord. 9073 § 6, 1982).	BMC 15.08: Water Service
15.08.220: Calculation of service installation or tap fee.	▪ For metered water service installations, the city shall charge an installation fee. The fee shall be based on the city's cost of installing the water service from the main to the property line, including, but not limited to, main taps, corporation cocks, valves, pipelines, meters, and other materials, labor, and equipment necessary to install the service. In addition, the party requesting the service is responsible for performing all excavation and restoration work at their expense. The installation fee for services four-inches in diameter or less shall be a flat fee for each size. The director of public works shall analyze previous installation costs for each service size, shall determine the fee schedule annually, and shall give 60 days' public notice thereof. The installation fee for services larger than four inches in diameter shall be based on an installation cost estimate prepared by the public works director or his designee. ▪ For water main extension and fire service line installations, the city shall charge a tap fee. The fee shall be based on the city's cost of installing a tap on the existing main and inspecting the connection. In addition, the party responsible for installing the water main extension or fire service line is responsible for performing all excavation and restoration work at their expense as necessary to facilitate the connection. The tap fee for connections 12 inches or less in diameter shall be a flat fee for each size. The director of public works shall analyze previous tap installation costs for each tap size, shall determine the fee schedule annually, and shall give 60 days' public notice thereof. The fee for taps larger than 12 inches in diameter shall be based upon a cost estimate prepared by the public works director or his designee. ▪ The fees imposed under this section shall be in addition to all other connection charges, service fees, permit costs or usage rates. ▪ All facilities installed within city rights-of-way or easements shall be and remain the property of the city and may be modified or removed by the department of public works in conformity with this chapter. (Ord. 2016-02-006; Ord. 2012-12-060 § 7; Ord. 2004-11-081 § 10; Ord. 9371 § 1, 1984; Ord. 8982 § 33, 1981).	BMC 15.08: Water Service

Subject	Policy	Source
15.08.230: Connection charges.	▪ Charges imposed to connect to and receive city water service shall consist of the following: » A system development charge determined pursuant to BMC 15.08.250(C), reflecting the demand placed on the system. » If applicable, a connection fee for the specific property involved, as determined by the department of public works, to ensure that each connected property bears its equitable share of the cost of the system, plus interest pursuant to subsection (A)(3) of this section. » The connection fee herein shall include accrued interest at a rate fixed at the federal reserve rate for a 10-year treasury note, as determined on the recording date of the statement of intent to collect; provided, that interest shall only be accrued for a period not to exceed 10 years; and provided further, that no interest shall be collected within the first 90 days of recording of the statement of intent to collect; and provided further, that the aggregate amount of the interest shall not exceed the equitable share of the cost of the system allocated to a given property owner. » Any applicable private latecomer charges and interest. ▪ System development charge credits are available and shall be calculated as follows: » If an existing service is exchanged for a larger service, credit shall be given for the smaller service at the current rate. » No refunds will be given for exchange or reactivation to smaller size services. » If an abandoned service is reactivated, credit shall be given for the last service size in use. Flat rate single-family service will be considered a five-eighths-inch service. Value of credit shall be current charge for that size service irrespective of whether a fee was ever collected. » The system development charge for single-family residential shall be subject to review by the public works department using the Uniform Plumbing Code and the AWWA “Sizing Water Service Lines and Meters”; except that standby fire protection services shall be sized based upon fire flow requirements determined by the fire department and not included in the calculation of the system development charge pursuant to BMC 15.08.250 (C). ▪ Upon application by the owner, a partial exemption of not more than 80 percent of the system development charge imposed by this chapter may be granted to a low-income housing development, as defined below: » The director of planning and community development, after consultation with the director of public works, may grant an exemption to a low-income housing project listed in an annual consolidated action plan approved by city council. » The city council may grant an exemption to a low-income housing project not included in an annual consolidated action plan. » The decision to grant, partially grant or deny an exemption shall be based on the public benefit of the specific project, the extent to which the applicant has sought other funding sources, the financial hardship to the project of paying the system development charge, the impacts of the project on public facilities and services, and the consistency of the project with adopted city plans and policies relating to low-income housing. » An exemption granted under this subsection must be conditioned upon requiring the developer to record a covenant approved by the director of planning and community development that prohibits using the property for any purpose other than for low-income housing. At a minimum, the covenant must address price restrictions and household income limits for the low-income housing, and require that, if the property is converted to a use other than for low-income housing as defined in the covenant, the property owner must pay the applicable system development charge in effect at the time of any conversion. Covenants required by this subsection must be recorded with the Whatcom County auditor. » “Low-income housing” means housing with a monthly housing expense that is no greater than 30% of 80% of the median family income adjusted for family size, for Bellingham, as reported by the United States Department of Housing and Urban Development. ▪ The system development charge imposed by this chapter may be reduced for qualifying projects in targeted urban villages pursuant to BMC 20.37.030. (Ord. 2015-12-048 § 3; Ord. 2015-07-029 § 4; Ord. 2012-05-025 § 2; Ord. 2011-03-008; Ord. 2004-11-081 § 11; Ord. 2002-01-002; Ord. 10571 § 1, 1994; Ord. 9846 § 4, 1988; Ord. 9738 § 1, 1987; Ord. 9371 § 34, 1984).	BMC 15.08: Water Service
15.08.240: Computation of use rates.	▪ Use rates for water service and consumption are determined as follows: » Single-family unmetered water services and unmetered duplex water services shall be charged a monthly rate for each month of service or portion thereof. Unmetered duplex water services shall be twice the rate for single-family unmetered services. Effective January 1, 2017, all services in the city of Bellingham shall be metered and no customer will be charged on a flat rate. » Single-family metered water services shall be charged a fixed rate based on meter size and a volume rate per 100 cubic feet of water used. » Transitional single-family services include those services less than one inch connected to the water system prior to January 1, 2013, and not participating in the voluntary metering program and who were billed based on a flat rate basis in 2012. For billing purposes, single-family unmetered services converted to single-family metered services shall be charged the current transitional single-family service rate on January 1st of the year following installation of the meter by the city of Bellingham. Beginning January 1, 2016, all customers moving from a flat rate to a metered rate shall be billed at the standard metered single-family rate. Transitional single-family services shall be charged a fixed rate based on meter size and a volume rate per 100 cubic feet of water used. » Contract sales of water for resale by water districts and associations shall be as covered by agreement between the city and the water district or association in accordance with Chapter 15.36 BMC. » Non-single-family water services including multiple dwelling units, commercial, and institutional, shall be charged a fixed rate based on meter size and a volume rate per 100 cubic feet of water used. » Irrigation water services shall be charged a fixed rate based on meter size and a volume rate per 100 cubic feet of water used. » Funds received for the connection charges shall be credited to a reserve cash line in the water fund. » Funds received for the connection charges covered under BMC 15.08.230(A)(2) and (3) shall be credited to a capital cash line in the water fund. All system development charges covered under BMC 15.08.250 shall be credited to a capital cash line in the water fund. » If a meter is found to be out of order by failing to register properly, the account shall be charged at the average monthly consumption as shown by the meter during the corresponding period of the preceding year. [Ord. 2012-12-060 § 8; Ord. 2007-12-107; Ord. 2004-10-071; Ord. 2002-03-016].	BMC 15.08: Water Service

Subject	Policy	Source
15.08.250: Water rates and charges	▪ The rates charged for each shutoff or turn-on are: » During normal work hours: $25.00 each; and » After normal work hours: $75.00 each. ▪ The hydrant fee assessed for each lineal foot of main extension or portion thereof is: $5.00. ▪ System development charges are as follows: » For a new or exchanged service: charges are outlined in BMC. ▪ For service beginning on or after January 1, 2011, and each year thereafter, the charges levied in 2011 shall continue with an annual adjustment each year in January by an inflationary factor tied to the Consumer Price Index, All Urban Consumers (CPI-U), Seattle-Tacoma-Bremerton Index. » For all services located outside the corporate limits of the city, that will be served directly by the city and not through a wholesale contract, the system development charge is computed in the same fashion, except that an additional surcharge of 50% is imposed. » An irrigation system development charge (ISDC) is hereby created and shall apply to all new irrigation water services. ▪ The charge for an ISDC shall be as follows: charges are outlined in BMC. ▪ Irrigation system development charges shall be applied to all new irrigation systems that are required to have a dedicated irrigation water service. No ISDC shall apply to new irrigation systems that are excepted from that term's definition under BMC 15.08.010(F). ▪ The following water use rates are: charges are outlined in BMC: » Unless otherwise abrogated by the city council, beginning January 1, 2019, and each year thereafter, the water utility rates levied in 2018 shall continue with an annual adjustment each year in January by an inflationary factor tied to the Consumer Price Index, All Urban Consumers (CPI-U), Seattle-Tacoma-Bremerton index. The inflationary factor shall be calculated and rates shall be adjusted by the finance director in September of each year using 12 prior months of Consumer Price Index data. » The Lake Whatcom watershed land acquisition and preservation program charges shall be added to the aforementioned fixed base and volume charges as follows: ▪ 2012 rate: $12.00 per month for all single-family services, both metered and unmetered. ▪ 2012 rate: $24.00 per month for flat rate, unmetered duplexes. ▪ 2012 rate: $5.00 per month plus $0.64 per 100 cubic feet of water consumed for all non-single-family services including untreated industrial water. ▪ Unless otherwise abrogated by the city council, beginning January 1, 2013, and each year thereafter, the Lake Whatcom watershed property acquisition and pollution control charges levied in 2012 shall continue with an annual adjustment each year in January by an inflationary factor tied to the Consumer Price Index, All Urban Consumers (CPI-U), Seattle-Tacoma-Bremerton index. The inflationary factor shall be calculated and rates shall be adjusted by the finance director in September of each year using 12 prior months of Consumer Price Index data. » Untreated Industrial and Irrigation Water. Untreated water for industrial or other nonpotable purposes shall be billed at 80% of the fixed base and volume rate for nonresidential services. ▪ The fire protection service rate is $125.00 per year. ▪ The tampering fee is $100.00 per occurrence. ▪ Water rates and charges for services outside the city limits are 150% of the aforementioned usage rates and connection charges except those services that are part of a water district or association and served as part of a wholesale contract. ▪ Lake Whatcom watershed property acquisition and pollution control program fund uses: » The watershed charges provided for in this chapter shall be used to fund the following pollution control measures and their associated maintenance, operation and administrative expenses: ▪ Lake Whatcom watershed land acquisition; ▪ Other property acquisition and land preservation measures in the Lake Whatcom watershed, including, but not limited to, purchases of transfer of development rights, easements, restrictive covenants, and access/use rights; ▪ Capital projects and improvements, including, but not limited to, infiltration projects on public and private land in the Lake Whatcom watershed; and ▪ Repayment and debt service on bonds or other financing instruments used to finance the pollution control measures in the Lake Whatcom watershed. » The city council shall determine the prioritization of acquisitions and other pollution control measures and shall also determine allowed uses and improvements to acquired property. Thirty percent of the revenue generated by the Lake Whatcom watershed property acquisition and pollution control program charge (net of operating, administrative, and debt service expenses) shall be used for purchasing property for capital projects or the design and construction of capital projects to address pollution from stormwater runoff. (Ord. 2016-10-035 § 1; Ord. 2014-03-014 § 2; Ord. 2012-12-060 § 9; Ord. 2012-02-005 § 1; Ord. 2011-01-002; Ord. 2007-12-107; Ord. 2006-08-081; Ord. 2004-11-081 § 12; Ord. 2004-10-071; Ord. 2003-10-068; Ord. 2001-02-007; Ord. 2000-09-058; Ord. 1999-12-092; Ord. 10785, 1996; Ord. 10571 § 2, 1994; Ord. 10364 § 1, 1992; Ord. 10093 § 1, 1990; Ord. 9846 § 5, 1988; Ord. 9618 § 18, 1986; Ord. 9386, 1984; Ord. 9371 § 1, 1984; Ord. 9159 § 1, 1982; Ord. 8982 § 36, 1981).	BMC 15.08: Water Service

Subject	Policy	Source
15.04.070: Reduced rates for low income senior and disabled citizens.	▪ Any low income senior or disabled citizen who satisfies the reduced rate criteria in this section and who lives in a residence receiving a separate city of Bellingham water or sewer service and water or sewer bill is entitled to a rate reduction for water, sewer and storm and surface water utilities. ▪ A senior aged 62 or older or a disabled person with a gross household income of $35,000 or less in 2012 (adjusted annually thereafter using the Whatcom County low income property tax exemption qualifying annual household income eligibility limit) is entitled to have their water, sewer and storm and surface water rates reduced by the following amounts: » For purposes of this section, “gross income” shall have the same definition as provided in 26 USC 61, as currently enacted or hereafter amended. ▪ Nonprofit agencies providing affordable housing for low income households and public housing authorities, such as the Bellingham housing authority or other similar entity, receiving public funds for low income housing may obtain a rate reduction of 10 percent if the premises have rents restricted by a federal, state or city housing program for households earning less than 60 percent of area median income. ▪ All persons claiming the discount provided for in this section shall first be required to file an application with the city requesting the reduction. The application shall provide information sufficient for the city to verify the applicant’s eligibility to participate in this reduced rate program. Customers receiving the rate reduction must renew their application annually in accordance with administrative procedures promulgated by the finance director. (Ord. 2012-12-059 § 1; Ord. 2006-06-063; Ord. 2005-07-056; Ord. 2003-05-024 § 2; Ord. 2001-02-007; Ord. 10056 § 3, 1990; Ord. 9846 § 2, 1988; Ord. 9618 § 3, 1986; Ord. 9371 § 1, 1984; Ord. 9164 § 1, 1982; Ord. 8982 § 7, 1981).	BMC 15.04: Administrative Provisions for Water, Sewer, and Surface and Stormwater Utility Billing
15.04.090: Payment, temporary discontinuance, delinquent accounts, and penalty.	▪ Billing shall be completed by the finance department on a basis as determined by the finance director. Failure to pay said bills in full by the due date listed on the bill shall render the account delinquent. ▪ Billings shall be addressed to the occupant of a premises, unless the owner, the purchaser under a real estate contract, or the authorized agent of either requests otherwise in writing. ▪ If a billing statement contains charges for more than one utility, the city will apply the moneys received in the following manner: first, to pay off any outstanding sewer charges; second, to pay off any outstanding storm and surface water charges; and third, to pay off any outstanding water charges. ▪ If water service is temporarily discontinued as provided for in BMC 15.08.190 as currently enacted or hereafter amended, the city will not bill for either water or sewer utility service during the prior city authorized temporary discontinuance period. However, during the authorized temporary discontinuance period, storm and surface water utility fees and charges will continue to accrue at the normal rate and will continue to be regularly billed unless the customer prepays the entire amount of the storm and surface water charges that will accrue during the temporary discontinuance period before the temporary discontinuance period begins, unless provided otherwise by written agreement. ▪ Delinquent accounts for sewer and storm and surface water utility charges may bear interest at a rate of up to eight percent per annum, or at such other rate as may be authorized by law, computed on a monthly basis from the date of delinquency until paid in full. ▪ In addition to interest, a delinquent water, sewer and/or storm and surface water utility account may also be charged a late-payment penalty of $5.00 or one and one-half percent per billing period, whichever is greater. (Ord. 2004-11-081 § 1; Ord. 2001-02-007; Ord. 9846 § 3, 1988; Ord. 9618 § 4, 1986; Ord. 8982 § 9, 1981).	BMC 15.04: Administrative Provisions for Water, Sewer, and Surface and Stormwater Utility Billing
15.04.095: Finance director’s authority to adjust water, sewer and surface and stormwater utility bills.	▪ The finance director or the finance director’s designee is authorized to adjust water, sewer and surface and stormwater utility bills as follows: » Breaks or Leaks in Water Service Line. When the customer has suffered a break or leak in the portion of the water service line between the water meter and the external entrance to the structure being served, the customer may apply to the finance director for an adjustment of his or her water and sewer bill, subject to the following requirements and limitations: ▪ No adjustment for water bills shall be allowed for any leaks or service breaks that occur after the external entrance to the premises. This shall include, by way of example and not limitation, leaks in toilets, faucets, water heaters, and spigots. No adjustment for water bills shall be allowed for any leaks or breaks in a metered irrigation line. ▪ No customer may obtain more than one leak adjustment for the same metered water account in any 10-year period. Sewer billings may be adjusted for additional leaks in the water service line; provided, that the owner demonstrates to the finance director’s reasonable satisfaction that the excess water consumption did not enter the sewer system. ▪ The break or leak in the service line and its repair must be documented in a manner that is acceptable to the finance director. Documentation shall include a licensed plumber’s itemized invoice, repair order, city of Bellingham public works department inspection documentation or other documentation as necessary to support the adjustment request and to document any repairs. ▪ A request for an adjustment shall be on form(s) provided by the finance department. ▪ The finance director shall determine the amount of the adjustment in his or her discretion. The adjustment amount shall not exceed 50% of the amount determined to be the excess usage charge for water and 100% of the excess usage charge for sewer; provided, that the excess water consumption did not enter the sewer system. No adjustment for sewer charges shall be allowed if the excess consumption entered the sewer. Historical records may be used to assist in the determination of the adjustment amount. ▪ No adjustment shall be made for billings made more than one year prior to the date of the customer’s application for adjustment, or the date the city discovered the leak or break, whichever occurred first. No more than two billing cycles may be adjusted per leak adjustment. » Utility Billing Errors. If, upon receipt of an application for an adjustment, or during an audit or examination of the customer’s account, the finance director determines that the city has overbilled or underbilled a customer for water, sewer or surface and stormwater due to city error, then the finance director shall notify the customer in writing and cause a backcharge, refund or credit to be issued to the customer to correct the error. No backcharge, refund or credit shall be issued to correct billings for a billing cycle that ended more than one year prior to the date that the city discovered the error or received the customer’s application for a credit or refund, whichever occurred first. Notwithstanding the foregoing, backcharges to correct underbillings resulting from customer fraud shall apply retroactively to the maximum extent permitted by law. » Appeals. Any determination made under this section may be appealed in accordance with the procedures in BMC 15.04.120. (Ord. 2021-04-014 § 2; Ord. 2002-03-016).	BMC 15.04: Administrative Provisions for Water, Sewer, and Surface and Stormwater Utility Billing

3.3.6 Design Standards

Table 3.8 describes the City's general design standards associated with the management of the water utility and design of the water system.

Table 3.8 General Design Standards

Subject	Standard	Source
Minimum Pipeline Size	▪ Residential zones: The minimum size water main shall be 8 inches in diameter with an average gridded spacing not to exceed 600 feet. An 8-inch diameter main shall be used where an average grid of 600 feet is not possible, however, the maximum ungridded length may not exceed 1,500 feet. Four-inch diameter pipelines may be allowed by the Department when future extension is not anticipated, such as in a cul-de-sac, provided the main does not serve a fire hydrant. ▪ Commercial, industrial, and institutional zones: The minimum size water main shall be 8 inches in diameter with an average gridded spacing not to exceed 600 feet. A 10-inch diameter water main shall be used when the system is not gridded. The maximum ungridded length and size of the water main may be determined by site conditions and requirements for fire flow. ▪ Water supply mains: Where required, the minimum size supply main shall be 12 inches in diameter and shall be spaced on approximately 3,000 foot centers. The actual size of the supply main shall be determined by its ability to deliver water based on the peak-daily demand, plus designated fire flow.	Development Guidelines and Improvement Standards (2018)
Valve Spacing	▪ Valves shall be placed on each main at a junction point (node) and should be spaced along the water main at intervals not to exceed 500 feet for pipeline sizes 10 inches in diameter and above, and not to exceed 800 feet for pipeline sizes less than 10 inches in diameter. Gate valves shall be used on all diameter pipelines.	Development Guidelines and Improvement Standards (2018)
Fire Hydrant Spacing	▪ Fire hydrants shall be spaced as follows: » One- and two-family unit developments: no greater than 500-foot intervals along public streets or approved fire routes. » All other developments: not greater than 300-foot intervals along public streets or approved fire access routes.	Development Guidelines and Improvement Standards (2018)
Fire Hydrant Specification	▪ Fire hydrants will only be allowed on 8-inch or greater lines.	2023 Water System Plan

3.3.7 Distribution System Criteria and Standards

The City's distribution system criteria and standards are summarized below in Table 3.9.

Table 3.9 Distribution System Criteria and Standards

Subject	Policy/Standard	Source
Storage Requirements	The storage requirements equal to operating storage plus equalizing storage plus the largest of (WAC 246-290-235, WSDM Chapter 9) standby storage or fire suppression storage.	2009 Water System Plan
Standby Storage Volumes	WSDM Chapter 9.	2009 Water System Plan
Capacity	Capacity of pumping facilities, transmission and distribution pipelines, and storage reservoirs must provide refilling of reservoir equalizing volume at the end of the maximum day.	2009 Water System Plan
Service Pressure and Flow	Bellingham shall provide domestic water to its customers in sufficient quantity to meet maximum day demands and at a pressure that meets or exceeds all minimum applicable regulations, except during emergency conditions. The City's goal is to provide system pressure of at least 30 psi, measured at the service meter.	2009 Water System Plan
Minimum System Pressure	Per City Policy (WSDM Chapter 8) Distribution facilities are sized to provide a minimum system pressure of 30 psi during peak hour demands and 20 psi during maximum daily demand plus fire flows.	2009 Water System Plan
Maximum System Pressure	Per WAC 246-290-230 and the City's WSDM pressures shall not exceed 100 psi.	2009 Water System Plan
Maximum Pipeline Velocity	Water main non-fire condition maximum velocity is limited to 8 feet per second according to the WSDM, Chapter 6. Maximum pipeline velocity under fire flow conditions should not exceed 10 feet per second, or else a hydraulic transient (water hammer) analysis for transmission mains is required per WAC 246-290-230(9).	DOH WSDM
Telemetry System	Bellingham utilizes both fiber optic and Aveva SCADA to monitor and control the water system.	2009 Water System Plan

CHAPTER 4 WATER DEMAND FORECAST

4.1 Introduction and Methodology Overview

Three future water demand scenarios (Low, Medium, and High) were projected for the City using the following information:

- Historical consumption trends from 2012 to 2022.
- Transportation Analysis Zone (TAZ) population and employment demographic projections.
- Medium and high population projections from the City’s Planning and Community Development Department (CPCDD) derived from Washington State’s Office of Financial Management (OFM) Growth Management Program population forecasts
- Future predictions of the impacts placed on demands by factors such as water use efficiency (WUE), climate change, and the expected future consumption of the City’s largest water consumers.

The Medium scenario's predictions most closely resemble the City’s future demands, while the Low and High demand projection scenarios provide a range that the City’s future water demands are expected to fall within. The Medium scenario was used for the Chapter 7 system analysis, which identifies future pumping, storage, and distribution system requirements.

Between 2018 and 2022, the City’s average day demand (ADD) was approximately 8.9 mgd. During that time, historical maximum day demands (MDD) were approximately 13.2 mgd. The City’s typical Single-Family household consumes 154 gallons per day (gpd).

While historical data from 2012 to 2022 is presented throughout this Chapter, only data from 2018 to 2022 was analyzed because 2018 is the first year the system was fully metered.

4.2 Land Use

The City’s retail water service area encompasses the city limits and its unincorporated UGA. This includes those portions of its designated UGA that are not within another purveyor’s water service area as established by the Whatcom County Coordinated Water System Plan.

Figure 4.1 shows the City’s existing zoning, which was used as a baseline for the analysis presented in this chapter, while Figure 4.2 shows future land use.

4.3 Historical Supply and Consumption

The City provided historical water production records, the number of connections, and consumption data between 2012 and 2022 in order to establish historical demand trends. The data was evaluated to characterize the water use of the City’s customers, develop key demand parameters, and predict future water demand.

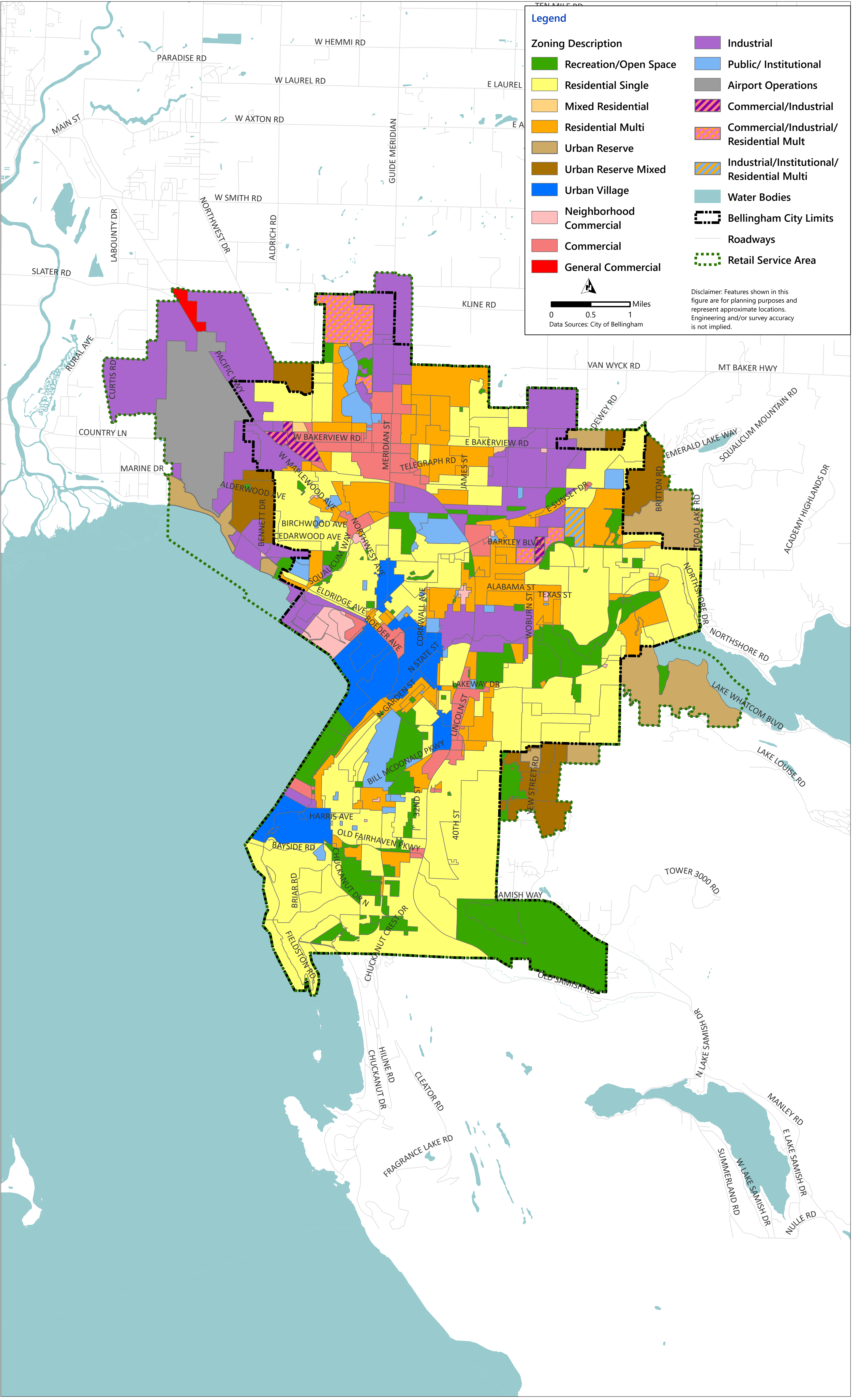


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Figure 4.1 Existing Zoning

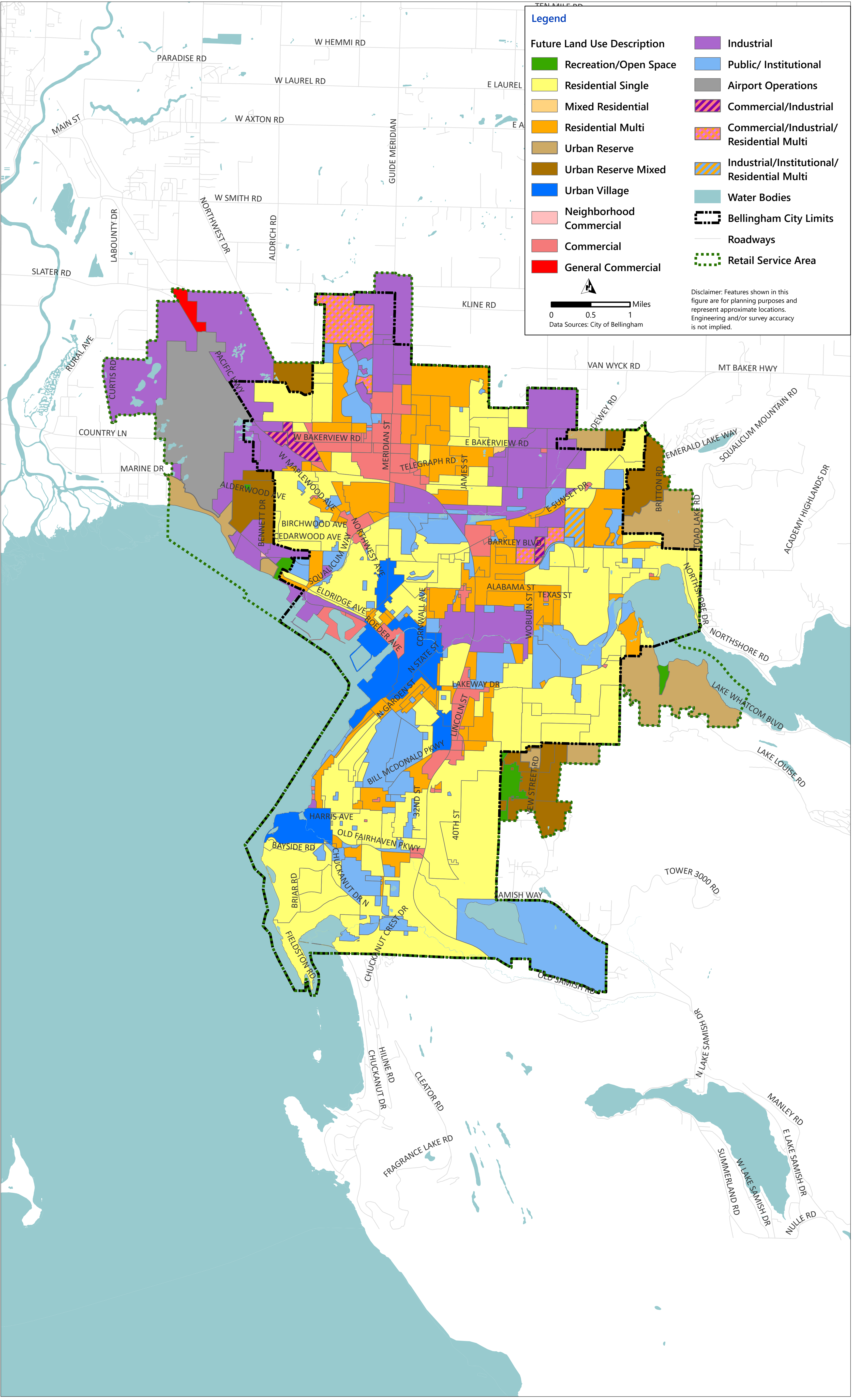

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Figure 4.2 Future Land Use

CITY OF BELLINGHAM
WATER SYSTEM PLAN

4.3.1 Historical Water Production

The City's source of water for its customers is the WTP. While the City did provide historical annual production values, it was verified in 2020 that the water meter at the WTP is inaccurate. In recent historical years, recorded authorized consumption values have been higher than production values measured at the WTP.

The City completed an assessment of their the WTP meter in 2020, and it was determined that issues with the meter readings are due to low flow velocities and piping layout. The current system layout is a 60-inch main that is reduced to a 48-inch pipeline where an electromagnetic insertion style flow meter is located. This flow meter is considered one of the most accurate for this size of pipeline. Further reductions of pipeline size would affect the ability to maintain storage levels at times of high demand. The typical recommended velocity range for this meter is 2-20 feet per second (ft/sec) according to the manufacturer. Multiple flow checks were completed on the meter, and it was found that flow velocities range from 0.4-2.0 ft/sec. Although multiple flow checks were completed, the City could not obtain repeatable data to allow for percentage corrections for production values. Moving forward, the City is working to solve its production metering issue at the WTP by testing new meters and working with suppliers to find a better meter that can accurately measure low flows.

For the sake of planning efforts, production values from the WTP were assumed to be 10 percent higher than the historical consumption values. This means that historical distribution system leakage (DSL) was assumed to be 10 percent for all years, and 10 percent in the future in all three demand scenarios since the City does not have sufficient historical data to estimate DSL accurately. Table 4.1 lists the estimated historical annual production from 2012 to 2022. As shown, the annual estimated production ranged from 2,181 MG in 2012 to a high of 3,391 MG in 2022.

4.3.1.1 Average Day Demand

ADD is defined as a water system's average daily demand for a year. To calculate ADD, the total water produced by the City over a year is divided by the number of days in the year. Table 4.1 and Figure 4.3 present ADD values from 2012 through 2022. The average ADD from 2018 to 2022 is 8.9 mgd.

Table 4.1 Historical Production

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Annual Production (MG)(1)	2,181	2,254	2,493	2,828	2,849	3,068	3,224	3,194	3,157	3,310	3,391
ADD (mgd)	5.96	6.17	6.83	7.75	7.78	8.41	8.83	8.75	8.63	9.07	9.27
MDD (mgd)	13.88	15.07	12.83	11.78	13.13	13.72	14.28	12.25	12.72	13.93	12.95
Date of MDD	8/16/2012	7/9/2013	7/15/2014	7/2/2015	8/18/2016	8/2/2017	7/12/2018	8/1/2019	8/17/2020	6/28/2021	7/27/2022
MDD/ADD Peaking Factor	2.3	2.4	1.9	1.5	1.7	1.6	1.6	1.4	1.5	1.5	1.4

Notes:
(1) The annual production values are estimated by assuming production to be 10% higher than historical consumption.

4.3.1.2 Maximum Day Demand

MDD values represent the largest amount of water produced in a single day in a given year, usually during the summer when irrigation use is highest. MDD must be determined to establish system requirements for reservoir capacity, supply capacity, and pump station discharge rates. The MDD and date of occurrence for each year since 2012 are shown in Table 4.1. As this table and Figure 4.3 show, MDD has fluctuated around 13.2 mgd since 2018.

The historical MDD to ADD peaking factor is also an important parameter used to determine future MDD projections. The City's average historical peaking factor is 1.5 since 2018.

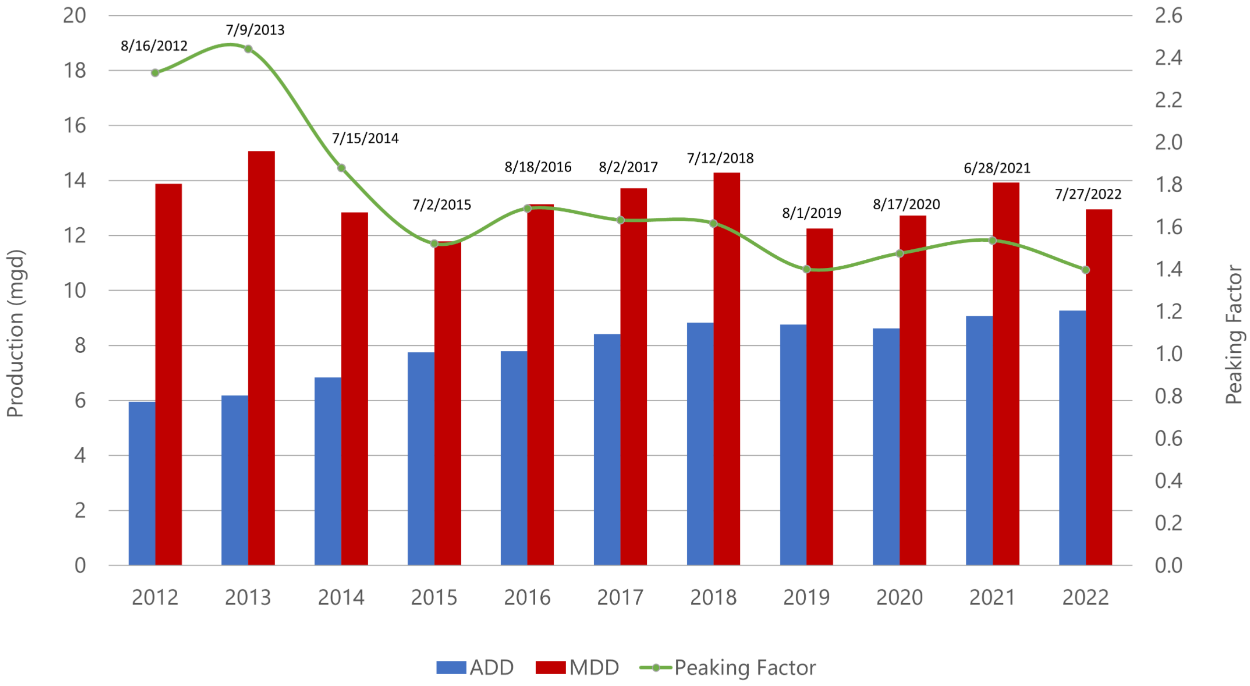

Figure 4.3 Historical Average and Maximum Day Water Production

4.3.2 Historical Customer Connections

From 2018 to 2022, the total number of the City's retail water service connections increased by 0.7 percent annually. By the end of 2022, the City provided water to 26,032 connections. Table 4.2 and Figure 4.4 show the historical number of connections per customer type. Figure 4.5 shows the average percent of connections by customer category from 2018 through 2022.

For this Plan, the City's nineteen customer classes were consolidated into the following 10 categories:

- **Single-Family Residential:** Single-Family homes accounted for 85 percent of customer connections in 2022. From 2018 through 2022, Single-Family Residential connections increased by 614 connections, which corresponds to roughly a 0.7 percent annual growth.
- **Multi-Family Residential:** Multi-Family housing accounted for about 5 percent of customer connections in 2022. Between 2018 and 2022, the number of Multi-Family Residential connections served by the City increased by 60. This corresponds to an annual growth rate of 1.2 percent.

- **Commercial:** Commercial accounted for seven percent of customer connections in 2022. From 2018 through 2022, Commercial connections increased by 22 connections, corresponding to a 0.3 percent annual growth.
- **Industrial:** Industrial accounted for less than one percent of customer connections in 2022 and has grown by only three connections since 2018.
- **Institution:** Institution combines three customer classes (Institution, School, and College). Institution connections accounted for less than 1 percent of connections in 2022. From 2018 through 2022, Institution connections grew by 13 connections.
- **Irrigation:** Irrigation consists of the City's Irrigation and between 2018 and 2022. Irrigation connections accounted for 1.6 percent of the system and grew by 20 connections.
- **Construction:** Construction connections account for less than 1 percent of customer connections in 2022 and totaled only 7 connections.
- **Public:** Public combines two customer classes (City and County). Public connections accounted for less than 1 percent of connections in 2022 and averaged only 64 connections between 2018 and 2022.
- **Water District:** The Water District connection category accounts for nine customers that the City contractually sells water to. The nine customers are: Lummi Tribal, Glen Cove, California, Deer Creek, Governor's Point, Montgomery Road, LWWSD, WD No. 2, and WD No. 7. The City also is contracted to supply water to Ferndale under emergency conditions.
- **Largest Consumers:** The City's 13 Largest Consumers were evaluated separately. Connections were subtracted out of the respective connection category to account for large consumers. The City's large consumers consist of 1 irrigation connection, 5 commercial connections, 3 industrial connections, 3 Multi-Family connections, and 1 public connection.

Table 4.2 Historical Number of Connections

Customer Type	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average Annual Growth Rate 2018 to 2022
Single-Family Residential(1)	6,079	6,229	10,243	14,059	16,302	18,886	21,444	21,624	21,785	21,893	22,058	0.7%
Multi-Family Residential	1,166	1,168	1,174	1,183	1,200	1,219	1,237	1,245	1,268	1,281	1,297	1.2%
Institutional	168	173	172	172	175	175	175	179	182	186	188	1.8%
Commercial	1,804	1,817	1,828	1,834	1,847	1,859	1,871	1,886	1,878	1,886	1,893	0.3%
Industrial	51	51	50	51	50	55	57	59	59	59	60	1.3%
Construction	1	1	1	1	1	1	2	2	2	2	7	36.8%
Public	72	73	72	73	71	70	71	75	76	78	82	3.7%
Irrigation	379	369	380	387	391	394	403	413	409	413	423	1.2%
Water District	10	10	10	10	10	10	10	10	10	10	11	2.4%
Largest Consumers	13	13	13	13	13	13	13	13	13	13	13	-
Total	9,743	9,904	13,943	17,783	20,060	22,682	25,283	25,506	25,682	25,821	26,032	0.7%

Notes:

(1) The large increase in single-family residential connections from 2013 to 2018 is due to the City's efforts to implement AMI metering for flat rate billed customers.

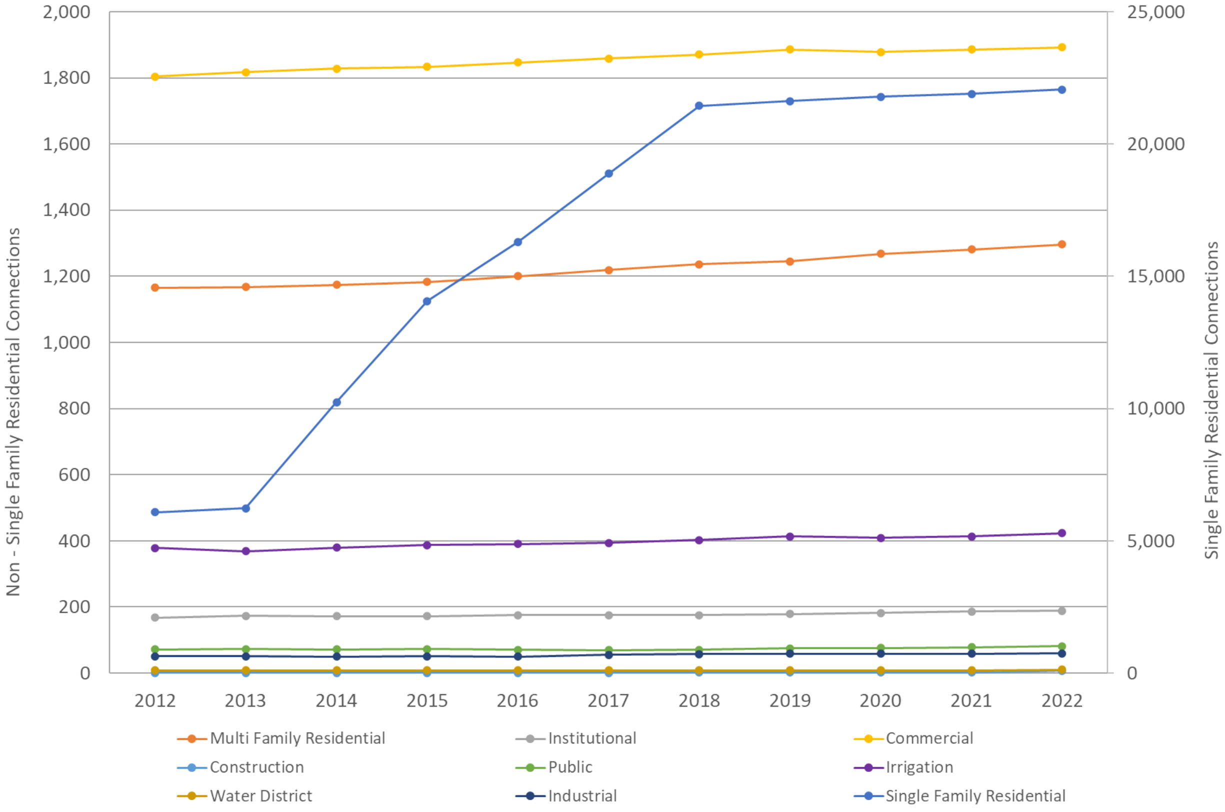

Figure 4.4 Historical Connections Trend by Customer Category

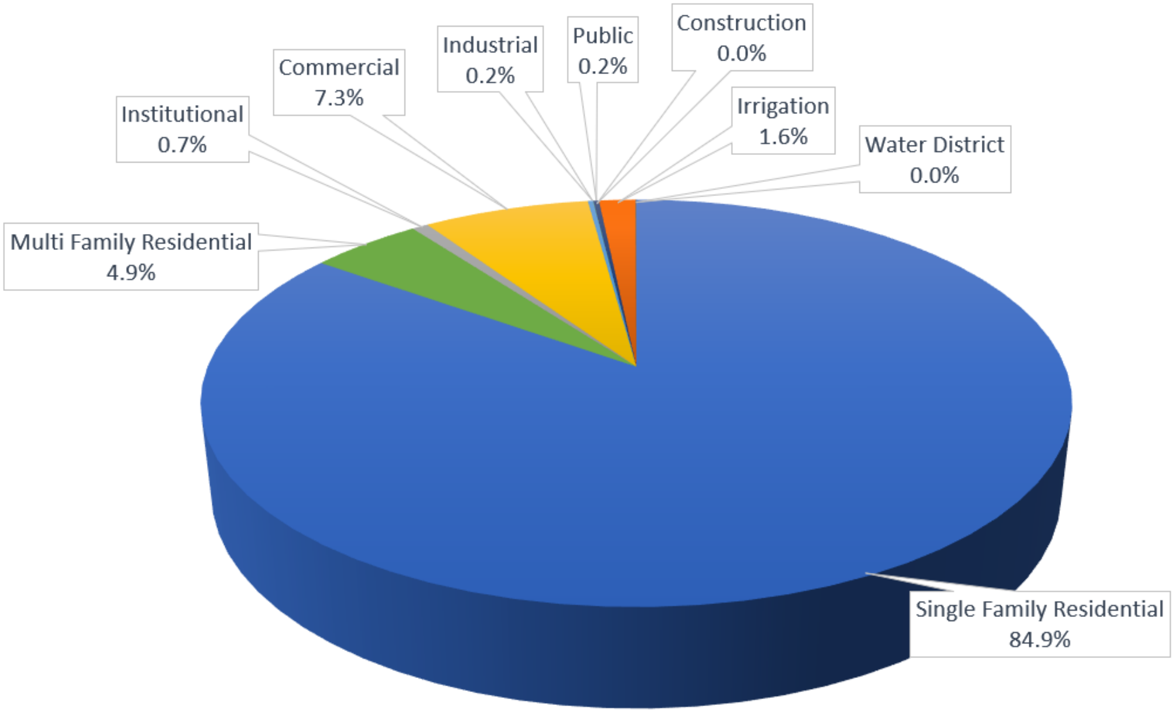

Figure 4.5 Percent of Connections by Customer Category

4.3.3 Historical Water Consumption

The City provided data on the monthly and annual water consumption of each customer class from 2012 to 2022. This data is presented in Table 4.3.

Although Single-Family Residential customers make up 85 percent of the City's connections, they consumed only 41 percent of total retail water sales. The Multi-Family Residential customers accounted for 20 percent of water use, meaning that a majority of the City's water sales consisted of residential water use.

Figure 4.6 shows that Commercial customers accounted for 15 percent of water sales and Industrial customers accounted for 7 percent. The City's 13 Largest Consumers alone accounted for 6 percent of water sales. Institutional customers accounted for two percent of water sales.

Figure 4.7 shows how consumption for each customer category changed between 2012 and 2022. Despite adding many new residential connections, Single-Family consumption grew very little over this time. As indicated by their annual consumption growth rates in Figure 4.8, Multi-Family, Public, and Water District had the most growth.

Table 4.3 Historical Consumption by Customer Category (mgd)

Customer Type	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Single-Family Residential	0.94	0.98	1.60	2.37	2.62	3.02	3.36	3.25	3.37	3.40	3.38
Multi-Family Residential	1.51	1.52	1.50	1.48	1.48	1.51	1.55	1.53	1.59	1.64	1.77
Institutional	0.24	0.26	0.25	0.25	0.24	0.23	0.23	0.23	0.13	0.14	0.22
Commercial	1.21	1.19	1.20	1.19	1.21	1.24	1.25	1.22	1.05	1.11	1.31
Industrial	0.42	0.51	0.52	0.58	0.38	0.44	0.47	0.57	0.61	0.79	0.43
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Public	0.09	0.11	0.07	0.09	0.08	0.09	0.08	0.09	0.08	0.09	0.10
Irrigation	0.30	0.29	0.31	0.36	0.38	0.35	0.38	0.38	0.31	0.35	0.34
Water District	0.29	0.28	0.27	0.26	0.25	0.31	0.28	0.27	0.32	0.30	0.33
Largest Consumers	0.42	0.48	0.48	0.47	0.44	0.45	0.43	0.42	0.39	0.42	0.56
Total Consumption	5.42	5.62	6.20	7.05	7.08	7.64	8.03	7.96	7.85	8.24	8.44

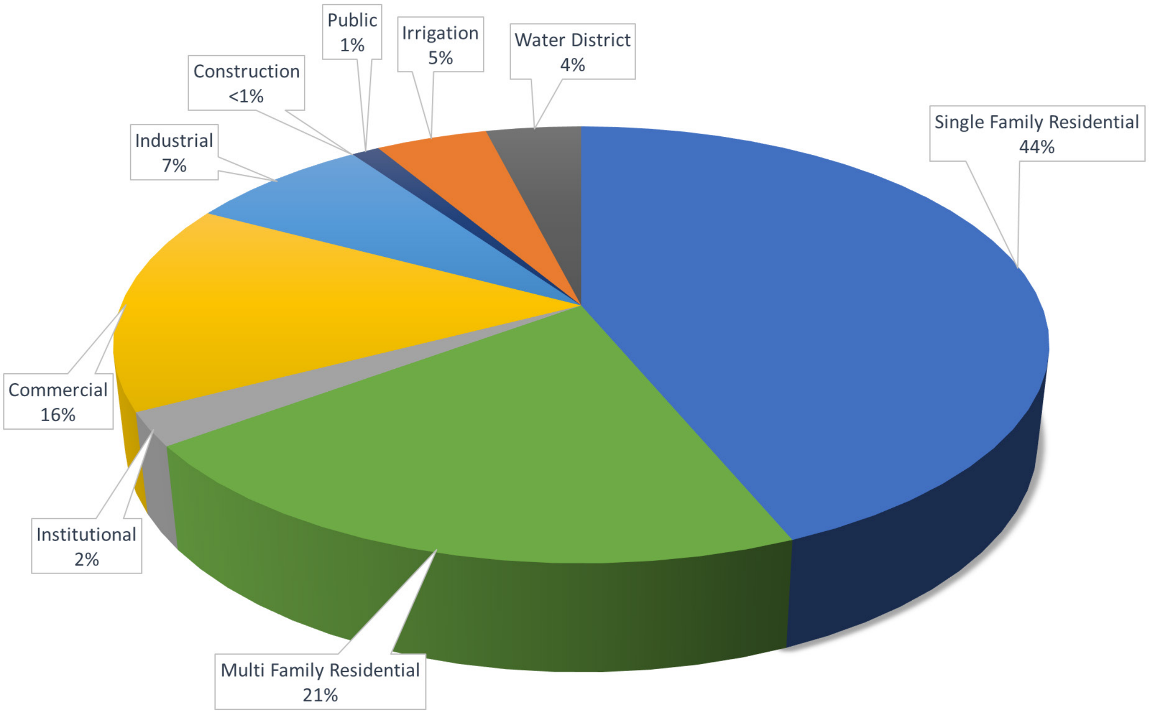

Figure 4.6 Percent of Consumption by Customer Category

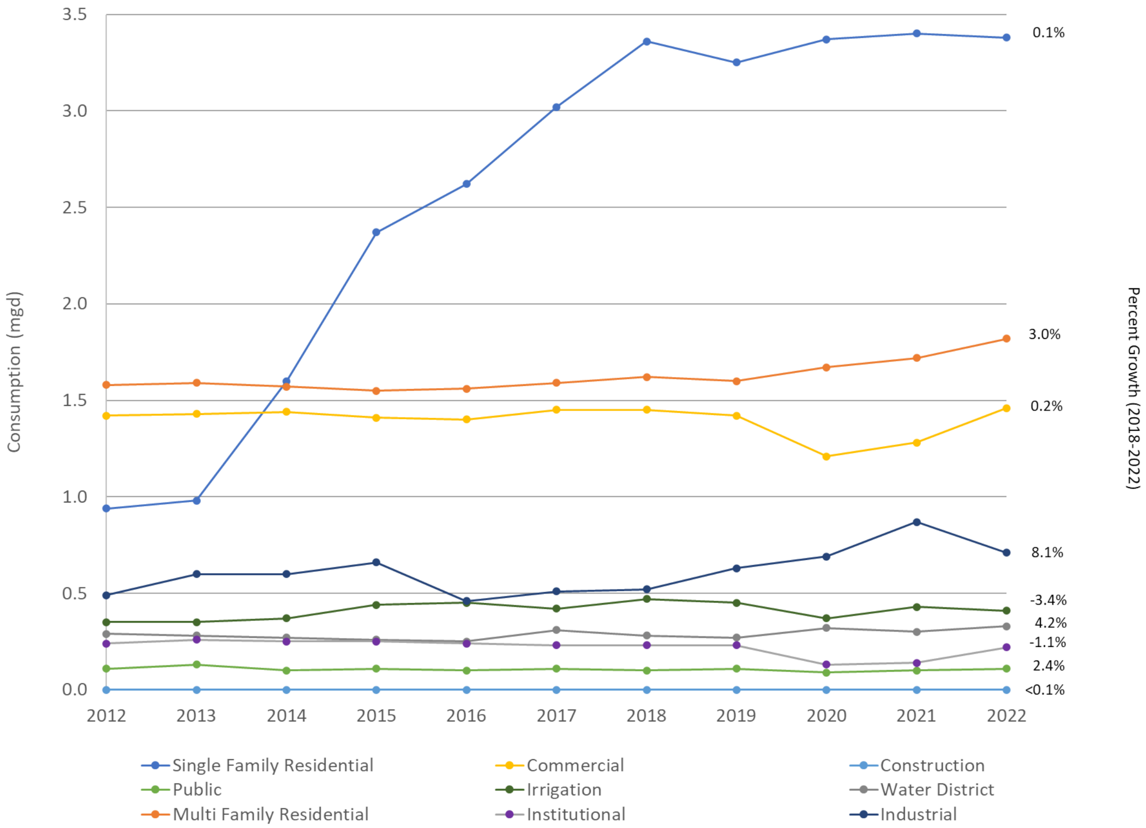

Figure 4.7 Historical Consumption Trend by Customer Category

4.3.3.1 Largest Consumers

To more accurately predict the magnitude and location of future demands, the City’s 13 Largest Consumers' consumption was evaluated separately from other customer categories. Each of these customers has an annual water demand exceeding 16,000 gpd. After reviewing the consumption data, this was a natural cutoff for large consumers.

The City contractually sells water to 10 Water Districts (includes the emergency supply contract with Ferndale). To predict the location and magnitude of each Water District future demand more accurately, consumption trends for these customers were also assessed individually. These 10 customers are accounted for within the Water District customer category and are not included within the largest consumers. The Water District projection methodology is outlined below in Section 4.5.3.

Figure 4.8 shows the historical consumption for these connections between 2012 and 2022. Figure 4.9 shows the locations of the City’s 13 Largest Consumers. Figure 4.10 shows the breakdown of large user consumption by customer type.

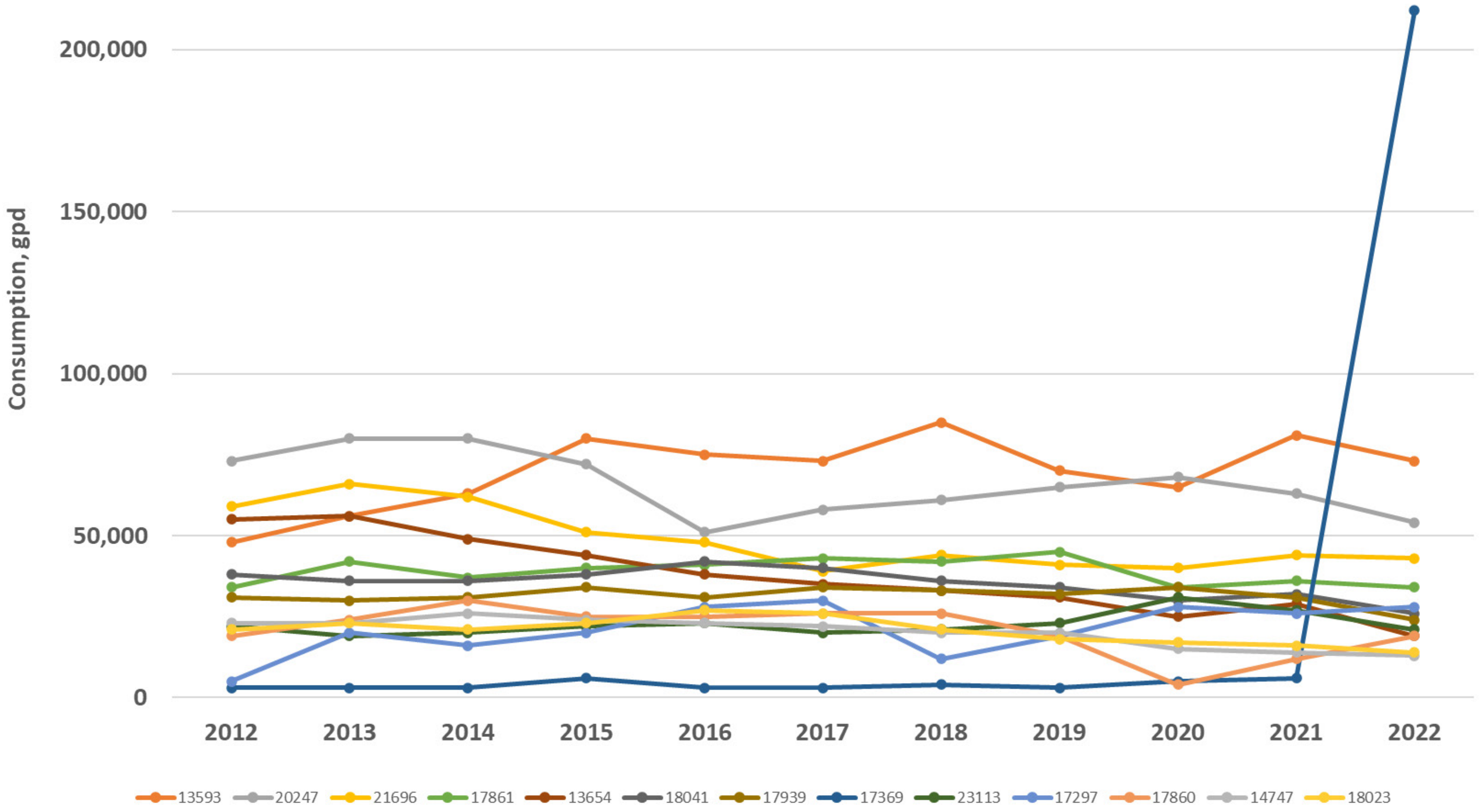

Figure 4.8 Largest Water Customers

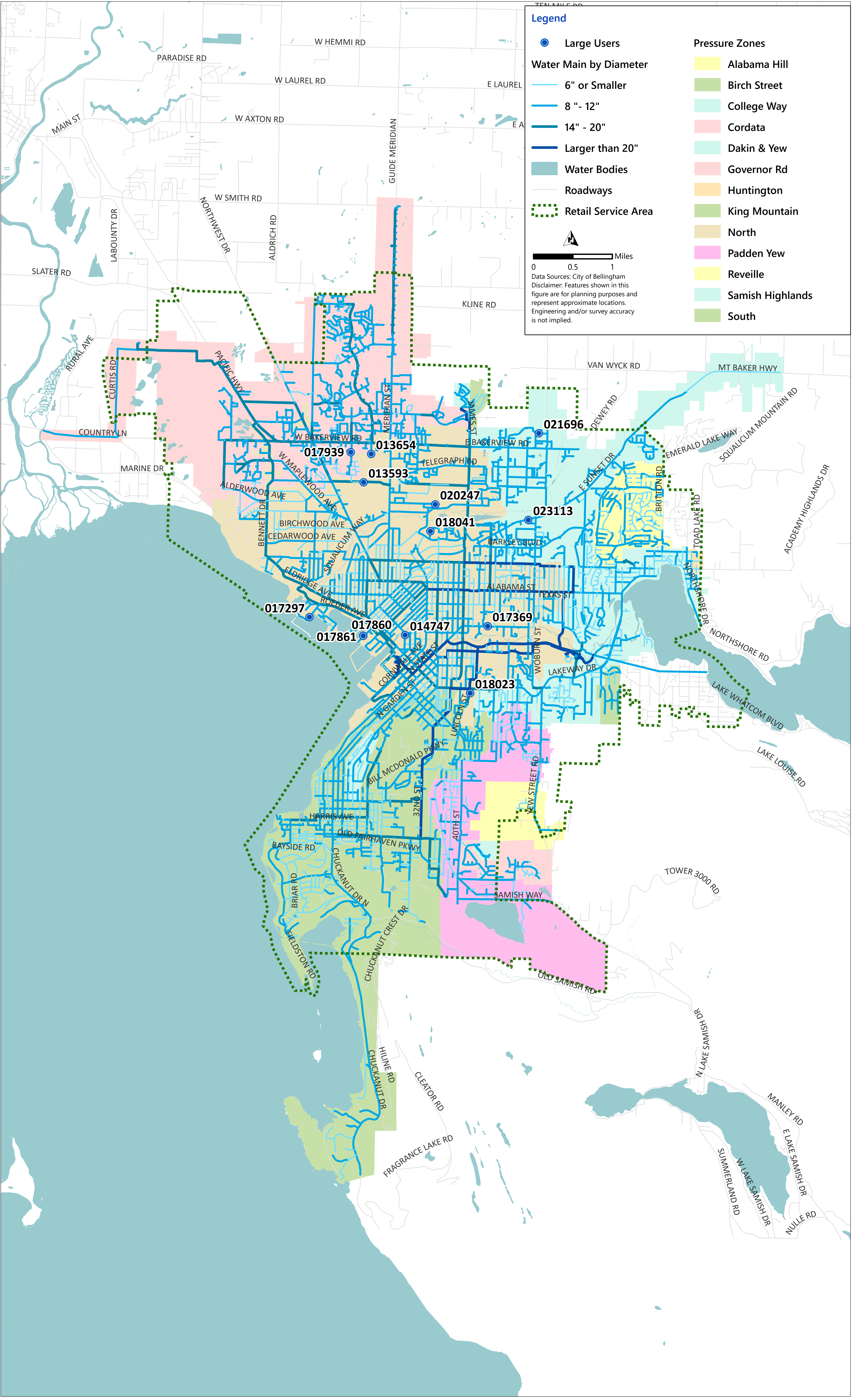

Figure 4.9 Historical Consumption by Largest Consumers

CITY OF BELLINGHAM
WATER SYSTEM PLAN

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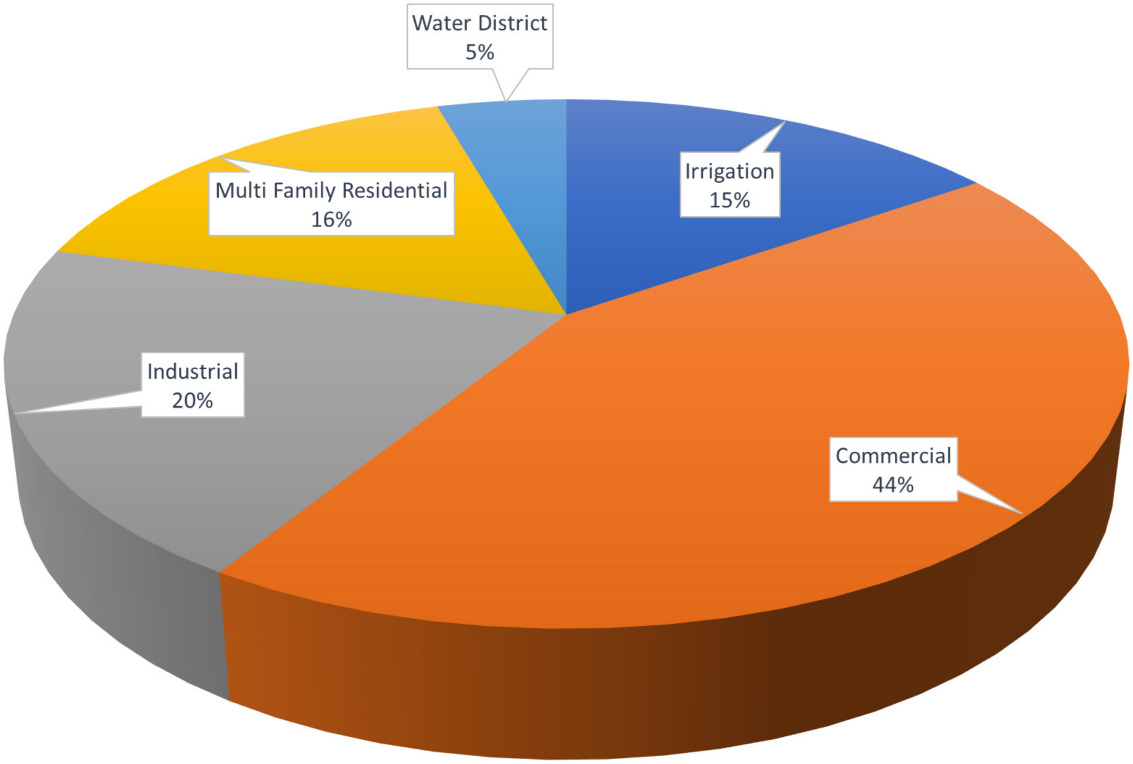

Figure 4.10 Historical Consumption Trend by Customer Category

4.3.3.2 Distribution System Leakage and Non-Revenue Water

DSL refers to water lost from the distribution system and includes both apparent and real losses. Apparent losses result from factors such as theft, meter inaccuracies, and data collection errors. Real losses, on the other hand, are physical losses from the system and include issues such as reservoir overflows, leaky valves and fittings, pinholes, and water main breaks. Since neither apparent nor real losses represent authorized water use, they are classified as DSL, even if they are not traditional “leaks.” DSL can be measured in terms of volume (e.g., gallons) or as a percentage of total production lost. Authorized but unmetered water use, such as water for filter backwash, street cleaning, distribution main flushing, dust control, and firefighting, does not fall under DSL if the use and quantities are properly documented.

Historical DSL values were estimated at 10 percent annually for planning purposes, in part due to the inaccurate readings from the water meter at the WTP. Table 4.4 provides an overview of estimated water production, authorized consumption, and DSL from 2012 to 2022. The leakage percentages in Table 4.4 differ from those reported to the Washington State DOH as they reflect planning estimates rather than reported figures.

4.3.4 Water Consumption per Connection

Table 4.5 shows annual water consumption per connection for each customer class. For planning and forecasting, individual demand is expressed as an Equivalent Residential Unit (ERU).

Table 4.4 Historical Distribution System Leakage

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total Production (gallons)	2,181,210,711	2,253,686,226	2,492,511,331	2,827,880,497	2,848,830,631	3,068,150,439	3,223,586,410	3,194,129,347	3,157,135,436	3,310,417,317	3,391,440,901
Total Authorized Consumption (gallons)	1,982,918,828	2,048,805,660	2,265,919,392	2,570,800,452	2,589,846,028	2,789,227,672	2,930,533,100	2,903,753,952	2,870,123,124	3,009,470,288	3,083,128,092
DSL (gallons)	198,291,883	204,880,566	226,591,939	257,080,045	258,984,603	278,922,767	293,053,310	290,375,395	287,012,312	300,947,029	308,312,809
DSL Percentage	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Rolling 3-Year Average DSL			10%	10%	10%	10%	10%	10%	10%	10%	10%

Table 4.5 Historical Consumption per Connection, gpd/Connection

Customer Type	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2018 – 2022 Average	ERUs per Connection
Single-Family Residential	155	157	156	169	161	160	157	150	155	155	153	154.0	1.0
Multi-Family Residential	1,295	1,301	1,278	1,251	1,233	1,239	1,253	1,229	1,254	1,280	1,365	1,276.2	8.3
Institutional	1,429	1,503	1,453	1,453	1,371	1,314	1,314	1,285	714	753	1,170	1,256.5	8.2
Commercial	671	655	656	649	655	667	668	647	559	589	692	630.9	4.1
Industrial	8,235	10,000	10,400	11,373	7,600	8,000	8,246	9,661	10,339	13,390	7,167	9,760.4	63.4
Construction	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Public	1,250	1,507	972	1,233	1,127	1,286	1,127	1,200	1,053	1,154	1,220	1,150.6 (1)	7.5
Irrigation	792	786	816	930	972	888	943	920	758	847	804	854.4	5.5
Water District	29,000	28,000	27,000	26,000	25,000	31,000	28,000	27,000	32,000	30,000	30,000	29,400.0	190.9

Notes:

(1) The Institutional 2018 – 2022 does not include the years 2020 and 2021 because these years show a noticeable decrease in consumption that is an outlier from the rest of the historical years. This is believed to be an effect of the Covid-19 pandemic, as most colleges were virtual attendance only during that time.

4.3.4.1 Equivalent Residential Units

An ERU is the amount of water consumed by a typical full-time Single-Family Residence. According to the WAC 246-290-010, non-residential customer water use is expressed as a multiple of Single-Family Residence ERU. In this case, consumption data from 2018 to 2022 was used to establish the "single-family residence" ERU.

To calculate ADD water use per ERU, the total annual volume of water consumed by Single-Family Residences is divided by the total number of active Single-Family Residential connections. The resulting value, also called the ERU planning value, is the average Single-Family Residence's annual water use per connection. To determine the number of ERUs used by other customer categories, the volume of water used by those customer categories is divided by the ERU value.

Table 4.5 shows each customer categories' average daily consumption per connection between 2012 and 2022. The Single-Family Residential average consumption volume was 154 gpd between 2018 and 2022. As shown in Figure 4.11, the City's ERU value stayed under 160 gpd the past five years.

The last column in Table 4.5 shows the average number of ERUs per connection for each customer category the City serves. This is calculated by dividing the consumption per connection by the ERU planning value.

The typical Multi-Family dwelling unit consumes 8.3 ERUs, meaning that a Multi-Family connection consumes 830 percent of the water of a typical Single-Family connection. Non-Residential connections use significantly more water than a typical Single-Family Residence, with a range of 4.1 to 190.9 ERUs. Table 4.6 lists each customer categories' number of ERUs between 2012 and 2022.

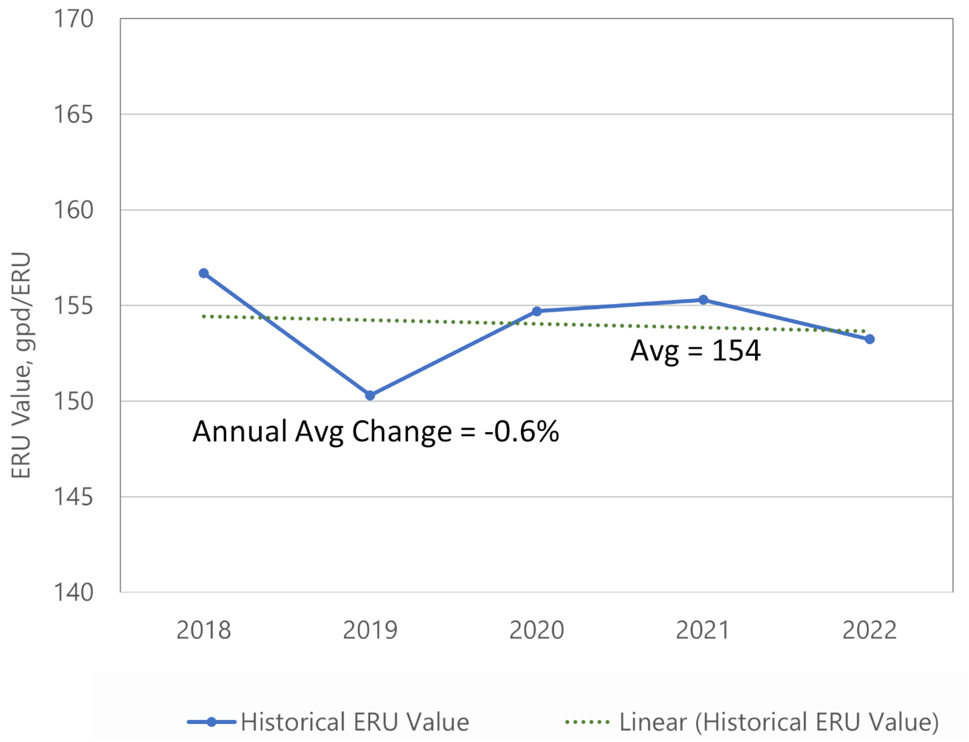

Figure 4.11 Historical ERU Value Trend

Table 4.6 Historical Number of ERUs by Customer Category

Customer Type	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Single-Family Residential	6,100	6,360	10,390	15,390	17,010	19,610	21,820	21,100	21,880	22,080	21,950
Multi-Family Residential	9,810	9,870	9,740	9,610	9,610	9,810	10,060	9,940	10,320	10,650	11,490
Institutional	1,560	1,690	1,620	1,620	1,560	1,490	1,490	1,490	840	910	1,430
Commercial	7,860	7,730	7,790	7,730	7,860	8,050	8,120	7,920	6,820	7,210	8,510
Industrial	2,730	3,310	3,380	3,770	2,470	2,860	3,050	3,700	3,960	5,130	2,790
Construction	0	0	0	0	0	0	0	0	0	0	0
Public	580	710	450	580	520	580	520	580	520	580	650
Irrigation	1,950	1,880	2,010	2,340	2,470	2,270	2,470	2,470	2,010	2,270	2,210
Water District	1,880	1,820	1,750	1,690	1,620	2,010	1,820	1,750	2,080	1,950	2,140
Largest Consumers	2,730	3,120	3,120	3,050	2,860	2,920	2,790	2,730	2,530	2,730	3,640
Total	35,200	36,490	40,250	45,780	45,980	49,600	52,140	51,680	50,960	53,510	54,810

4.4 Demographic Trends

To determine future demand for the City's retail service area, current and projected demographic trends were developed using two different sources:

- TAZ data from Whatcom County, which contains existing and forecasted population and employment numbers within its regional boundary.
- CPCDD data derived from Washington State's OFM Growth Management Program, which contains medium and high population forecasts.

The City's retail service area and pressure zone boundaries do not coincide with the TAZ and CPCDD boundaries, so population and employment forecasts were calculated within the service area using GIS techniques. As described in Section 4.5, the TAZ demographic trends were used in the Low scenario demand projections, while the CPCDD Medium and High growth projections were used in the Medium and High scenario demand projections, respectively. Tables 4.8 through 4.10 show the population and employment growth projections by pressure zone for each demand scenario.

As a part of the demand projections, the City estimated the percentage of the UGA that will be served during the planning horizons. This was used to adjust the CPCDD future population estimates to reflect more accurately the number of people the City expects to be serving in the long term. This population adjustment only affects the CPCDD population estimates, as the TAZ data were extrapolated using GIS techniques to only include the City's existing pressure zone boundaries. Table 4.7 details the estimated UGA served, and Tables 4.9 and 4.10 extrapolate the data to estimate the resulting population served projections for the planning horizons.

Table 4.7 Percent of City and UGA Served

	Estimated	Projected						
	2022	2025	2030	2035	2040	2045	2074	2124
Medium Scenario	94%	94%	94%	94%	95%	95%	98%	100%
High Scenario	94%	94%	94%	94%	95%	95%	98%	100%

Table 4.8 Low TAZ Projections by Pressure Zone

	2022 (Estimated)	2025	2030	2035	2040	2045
Employees						
Alabama Hill	230	234	240	248	255	264
Birch Street	7	7	7	7	7	7
College Way	245	267	302	337	372	407
Cordata	8,148	8,692	9,630	10,566	11,505	12,465
Dakin and Yew	8,158	8,544	9,207	9,871	10,534	11,207
Governor Road	3	3	3	3	3	3
Huntington	4	4	4	4	4	4
King Mountain	3	3	3	3	3	3
North	34,349	35,131	36,503	37,874	39,249	40,665
Padden Yew	219	229	247	265	283	301
Reveille	20	34	59	83	109	134
Samish Highland	0	0	0	0	0	0
South	6,558	6,983	7,705	8,432	9,159	9,896
Population						
Alabama Hill	3,651	3,687	3,749	3,811	3,873	3,937
Birch Street	178	204	246	289	331	374
College Way	1,004	1,013	1,030	1,048	1,066	1,085
Cordata	12,426	13,065	14,152	15,241	16,330	17,432
Dakin and Yew	13,525	14,050	14,942	15,844	16,741	17,655
Governor Road	265	270	280	289	299	309
Huntington	112	113	116	118	120	123
King Mountain	115	155	222	289	356	423
North	37,266	38,586	40,901	43,208	45,525	47,909
Padden Yew	3,414	3,585	3,881	4,175	4,472	4,773
Reveille	447	510	614	721	825	931
Samish Highland	121	124	128	132	136	141
South	24,602	25,316	26,548	27,787	29,020	30,289

Table 4.9 Medium CPCDD Projections by Pressure Zone

	2022 (Estimated)	2025	2030	2035	2040	2045
Employees						
Alabama Hill	230	234	240	249	261	273
Birch Street	7	7	7	7	7	7
College Way	245	267	302	339	381	421
Cordata	8,148	8,694	9,640	10,623	11,775	12,870
Dakin and Yew	8,158	8,545	9,217	9,924	10,781	11,571
Governor Road	3	3	3	3	3	3
Huntington	4	4	4	4	4	4
King Mountain	3	3	3	3	3	3
North	34,349	35,137	36,542	38,077	40,170	41,987
Padden Yew	219	229	247	266	289	311
Reveille	20	34	59	84	111	138
Samish Highland	0	0	0	0	0	0
South	6,558	6,984	7,713	8,477	9,374	10,217
Population						
Alabama Hill	3,651	3,692	3,764	3,849	3,988	4,095
Birch Street	178	204	247	292	341	389
College Way	1,004	1,014	1,034	1,059	1,098	1,129
Cordata	12,426	13,083	14,209	15,393	16,814	18,132
Dakin and Yew	13,525	14,068	15,003	16,002	17,238	18,364
Governor Road	265	271	281	292	308	322
Huntington	112	114	116	119	124	128
King Mountain	115	156	223	292	366	440
North	37,266	38,637	41,067	43,639	46,876	49,834
Padden Yew	3,414	3,589	3,897	4,217	4,604	4,964
Reveille	447	510	617	728	850	969
Samish Highland	121	124	128	133	140	146
South	24,602	25,349	26,655	28,064	29,881	31,507

Table 4.10 High CPCDD Projections by Pressure Zone

	2022 (Estimated)	2025	2030	2035	2040	2045
Employees						
Alabama Hill	230	238	253	270	292	314
Birch Street	7	7	7	7	8	8
College Way	245	272	317	367	426	485
Cordata	8,148	8,857	10,130	11,514	13,164	14,841
Dakin and Yew	8,158	8,705	9,685	10,756	12,053	13,343
Governor Road	3	3	3	3	3	4
Huntington	4	4	4	5	5	5
King Mountain	3	3	3	3	3	3
North	34,349	35,797	38,399	41,272	44,910	48,418
Padden Yew	219	233	260	288	324	358
Reveille	20	35	62	91	124	159
Samish Highland	0	0	0	0	0	0
South	6,558	7,115	8,105	9,188	10,480	11,782
Population						
Alabama Hill	3,651	3,761	3,955	4,172	4,459	4,722
Birch Street	178	208	260	316	382	449
College Way	1,004	1,033	1,087	1,147	1,228	1,301
Cordata	12,426	13,328	14,931	16,684	18,798	20,910
Dakin and Yew	13,525	14,332	15,765	17,344	19,272	21,177
Governor Road	265	276	295	317	345	371
Huntington	112	116	122	129	138	147
King Mountain	115	158	234	316	410	507
North	37,266	39,362	43,154	47,300	52,407	57,468
Padden Yew	3,414	3,657	4,095	4,571	5,148	5,725
Reveille	447	520	648	789	950	1,117
Samish Highland	121	126	135	144	157	169
South	24,602	25,825	28,010	30,418	33,407	36,333

Using the population and employment projections within the retail service area, an annual growth rate was calculated for each pressure zone. The population annual average growth rate (AAGR) was used to forecast future City water connections by pressure zone for the Single-Family Residential, Multi-Family Residential, and Irrigation customer categories, while the employment AAGR was used to forecast future City water connections by pressure zone for the Institutional, Public, Commercial, Industrial, and Construction customer categories. The TAZ Projection AAGRs were used for the low projection scenario, the Medium OFM Projection AAGRs were used for the medium projection scenario, and the High OFM Projection AAGRs were used for the high projection scenario. Table 4.11 through Table 4.13 show the AAGRs used for the three projection scenarios.

The Water District customer category number of connections was not projected to increase over time. It was assumed that the Water District number of connections would stay the same, and the demand projections for the Water Districts were evaluated separately using the historical consumption data, contractual amounts, and projections from the individual Water Districts' water system plans.

Table 4.11 Low TAZ Projection AAGRs by Pressure Zone

	2022-2025	2026-2030	2031-2035	2036-2040	2041-2045
Employees					
Alabama Hill	0.3%	0.6%	0.6%	0.5%	0.7%
Birch Street	0.0%	0.0%	0.0%	0.0%	0.0%
College Way	2.1%	2.5%	2.2%	2.0%	1.8%
Cordata	1.6%	2.1%	1.9%	1.7%	1.6%
Dakin and Yew	1.2%	1.5%	1.4%	1.3%	1.2%
Governor Road	0.0%	0.0%	0.0%	0.0%	0.0%
Huntington	0.0%	0.0%	0.0%	0.0%	0.0%
King Mountain	0.1%	0.2%	0.2%	0.2%	0.2%
North	0.6%	0.8%	0.7%	0.7%	0.7%
Padden Yew	1.2%	1.5%	1.4%	1.3%	1.3%
Reveille	14.5%	11.6%	7.1%	5.4%	4.2%
Samish Highland	0.0%	0.0%	0.0%	0.0%	0.0%
South	1.6%	2.0%	1.8%	1.7%	1.6%
Population					
Alabama Hill	0.3%	0.3%	0.3%	0.3%	0.3%
Birch Street	4.5%	3.9%	3.2%	2.8%	2.5%
College Way	0.3%	0.3%	0.3%	0.3%	0.3%
Cordata	1.7%	1.6%	1.5%	1.4%	1.3%
Dakin and Yew	1.3%	1.2%	1.2%	1.1%	1.1%
Governor Road	0.7%	0.7%	0.7%	0.7%	0.7%
Huntington	0.4%	0.4%	0.4%	0.4%	0.4%
King Mountain	10.5%	7.4%	5.4%	4.2%	3.5%
North	1.2%	1.2%	1.1%	1.0%	1.0%
Padden Yew	1.6%	1.6%	1.5%	1.4%	1.3%
Reveille	4.4%	3.8%	3.2%	2.8%	2.4%
Samish Highland	0.7%	0.6%	0.7%	0.7%	0.6%
South	1.0%	1.0%	0.9%	0.9%	0.9%

Table 4.12 Medium CPCDD Projection AAGRs by Pressure Zone

	2022-2025	2026-2030	2031-2035	2036-2040	2041-2045
Employees					
Alabama Hill	0.3%	0.6%	0.7%	0.9%	0.9%
Birch Street	0.0%	0.0%	0.1%	0.4%	0.2%
College Way	2.1%	2.5%	2.3%	2.4%	2.0%
Cordata	1.6%	2.1%	2.0%	2.1%	1.8%
Dakin and Yew	1.2%	1.5%	1.5%	1.7%	1.4%
Governor Road	0.0%	0.0%	0.1%	0.4%	0.2%
Huntington	0.0%	0.0%	0.1%	0.4%	0.2%
King Mountain	0.1%	0.2%	0.3%	0.5%	0.4%
North	0.6%	0.8%	0.8%	1.1%	0.9%
Padden Yew	1.2%	1.5%	1.5%	1.7%	1.4%
Reveille	14.5%	11.6%	7.2%	5.8%	4.4%
Samish Highland	0.0%	0.0%	0.1%	0.4%	0.2%
South	1.6%	2.0%	1.9%	2.0%	1.7%
Population					
Alabama Hill	0.4%	0.4%	0.4%	0.7%	0.5%
Birch Street	4.6%	3.9%	3.4%	3.2%	2.7%
College Way	0.3%	0.4%	0.5%	0.7%	0.6%
Cordata	1.7%	1.7%	1.6%	1.8%	1.5%
Dakin and Yew	1.3%	1.3%	1.3%	1.5%	1.3%
Governor Road	0.7%	0.7%	0.8%	1.1%	0.9%
Huntington	0.4%	0.5%	0.5%	0.8%	0.6%
King Mountain	10.5%	7.5%	5.5%	4.7%	3.7%
North	1.2%	1.2%	1.2%	1.4%	1.2%
Padden Yew	1.7%	1.7%	1.6%	1.8%	1.5%
Reveille	4.5%	3.9%	3.4%	3.2%	2.7%
Samish Highland	0.7%	0.7%	0.8%	1.0%	0.8%
South	1.0%	1.0%	1.0%	1.3%	1.1%

Table 4.13 High CPCDD Projection AAGRs by Pressure Zone

	2022-2025	2026-2030	2031-2035	2036-2040	2041-2045
Employees					
Alabama Hill	0.8%	1.2%	1.4%	1.5%	1.5%
Birch Street	0.5%	0.6%	0.7%	1.0%	0.8%
College Way	2.6%	3.2%	3.0%	3.0%	2.6%
Cordata	2.1%	2.7%	2.6%	2.7%	2.4%
Dakin and Yew	1.6%	2.2%	2.1%	2.3%	2.1%
Governor Road	0.5%	0.6%	0.7%	1.0%	0.8%
Huntington	0.5%	0.6%	0.7%	1.0%	0.8%
King Mountain	0.6%	0.8%	0.9%	1.2%	1.0%
North	1.0%	1.4%	1.5%	1.7%	1.5%
Padden Yew	1.6%	2.2%	2.1%	2.3%	2.1%
Reveille	15.1%	12.3%	7.9%	6.4%	5.1%
Samish Highland	0.5%	0.6%	0.7%	1.0%	0.8%
South	2.1%	2.6%	2.5%	2.7%	2.4%
Population					
Alabama Hill	1.0%	1.0%	1.1%	1.3%	1.2%
Birch Street	5.2%	4.6%	4.0%	3.8%	3.3%
College Way	1.0%	1.0%	1.1%	1.4%	1.2%
Cordata	2.4%	2.3%	2.2%	2.4%	2.2%
Dakin and Yew	2.0%	1.9%	1.9%	2.1%	1.9%
Governor Road	1.4%	1.4%	1.4%	1.7%	1.5%
Huntington	1.0%	1.1%	1.1%	1.4%	1.2%
King Mountain	11.2%	8.1%	6.2%	5.3%	4.4%
North	1.8%	1.9%	1.9%	2.1%	1.9%
Padden Yew	2.3%	2.3%	2.2%	2.4%	2.1%
Reveille	5.1%	4.5%	4.0%	3.8%	3.3%
Samish Highland	1.4%	1.3%	1.4%	1.7%	1.5%
South	1.6%	1.6%	1.7%	1.9%	1.7%

Water connections were projected by raising the City's existing number of water connections in each pressure zone by the applicable growth rate in Table 4.11 through Table 4.13. Tables 4.14 shows the number of connection projections for the planning years for each of the three demand scenarios, which will be then used to estimate the City's future water demand.

Table 4.14 Projected Number of Water Connections

Customer Type	2022	Low		Medium		High	
		2034	2044	2034	2044	2034	2044
Single-Family Residential	22,058	25,418	28,278	25,641	29,355	27,620	33,642
Multi-Family Residential	1,297	1,492	1,659	1,506	1,722	1,622	1,973
Institutional	188	225	258	226	266	242	304
Commercial	1,893	2,162	2,405	2,171	2,479	2,328	2,828
Industrial	60	67	73	67	76	72	86
Construction	7	9	10	9	10	9	12
Public	82	94	105	95	108	101	124
Irrigation	423	489	546	494	567	532	649
Water District	11	11	11	11	11	16	21
Largest Consumers	13	13	13	13	13	13	13
System-Wide	26,032	29,980	33,358	30,232	34,607	32,555	39,651

4.5 Water Demand Projections

Projecting future water demand is a key part of the water system planning process. Demand projections are used to identify the system improvements required for supply, pumping, storage, and piping infrastructure.

This section summarizes the ADD and MDD projections Carollo developed for the City's water system using historical water demand trends and the future demographic growth assumptions developed in Section 4.4. Demand projections are presented for three demand scenarios (Low, Medium, High) that represent a range in potential future demands.

Low, Medium, and High water demand projection scenarios were developed by adjusting various demand projection parameters:

- The Low assumes aggressive WUE measures, which represents the lowest future demands the City expects to experience.
- The Medium scenario is a planning case scenario predicted to most closely match the City's future demands.
- The High scenario assumes no intentional WUE and includes a potential future large user block, which represents the highest demands the City could experience.

The medium scenario was used for the modeling efforts and system analysis, which identifies deficiencies in future pumping, storage, and the distribution system analyses, as well as to size potential improvements to achieve the City's capacity criteria.

4.5.1 Demand Projection Methodology

For this analysis, water demand projections were developed utilizing the following steps for the Residential and Commercial customer types:

1. Increase historical number of water connections for each customer type (as shown in Table 4.2) by the applicable AAGRs from the demographic analysis (as shown in Tables 4.11 through 4.13). Table 4.14 shows the resulting connection projections.
2. Convert connection projections to ERU projections using the historical ERUs per connection (as shown in Table 4.5).
3. Convert the ERU projections to ADD projections using the demand projection parameters developed from historical data of the City's starting ERU planning value, DSL/Non-Revenue Water, Other Authorized Use, climate change impact, and largest consumer demand. City staff established demand projection parameters for Low, Medium, and High demand scenarios.
4. Apply the MDD to ADD peaking factor to convert ADD to MDD. Again, each demand scenario has its own peaking factor chosen by the City.

For the Water District customer category, historical consumption and contractual amounts were analyzed to create ADD projections for the Low, Medium, and High Scenario. Step 4 outlined above was used to convert ADD to MDD for the Water Districts as well.

Figure 4.12 also summarizes the steps outlined above.

4.5.2 Demand Projection Parameters

To calculate the City's future ADD and MDD, several important parameters were used:

- Starting ERU Value.
- ERU Annual Reduction.
- Water Loss.
- Climate Change Scenario.
- MDD to ADD Peaking Factor.
- Largest Consumer Demand.

For each of the above parameters, the City used historical data to establish Low, Medium, and High values, which were used to develop each of the demand projection scenarios. This information is summarized in Table 4.15 and discussed in further detail in the following sections.

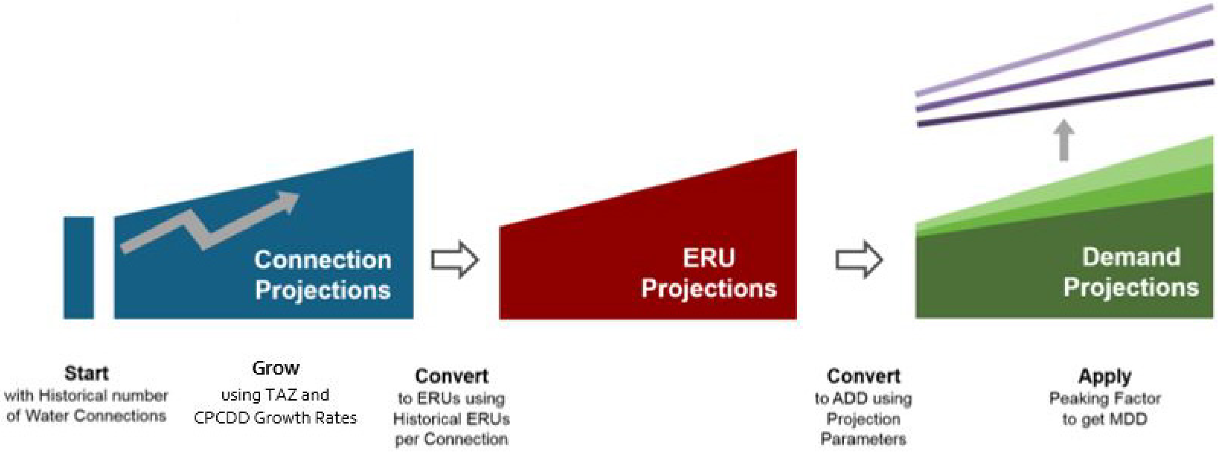

Figure 4.12 Demand Projection Methodology

Table 4.15 Demand Projection Parameters

Demand Projection Scenario	Low		Medium		High	
	Value	Notes	Value	Notes	Value	Notes
Starting ERU Value (gpd/ERU)	150	Historical Min	154	Historical Avg	169	Historical Max
ERU Annual Reduction	-		-		-	
Water Loss (Percent of Production)	10%	DOH Standard	10%	DOH Standard	10%	DOH Standard
Climate Change Scenario	RCP 4.5		RCP 8.5		RCP 8.5	
Average Annual Connections Growth Rate	LOW	TAZ Based Growth	MED	OFM Medium Growth	HIGH	OFM High Growth
Peaking Factor	1.4	Historical Min	1.5	Historical Average	1.6	Historical Max

Notes:
RCP - representative concentration pathway.

4.5.2.1 Starting ERU Value

The City selected a unique ERU value for each demand projection scenario. As mentioned before, the ERU value represents the consumption of a typical Single-Family household in gpd and is used to convert the number of ERU projected to ADD projections.

For the Low scenario, the City selected an ERU value of 150 gpd/ERU, which is the lowest historical value between 2018 and 2022. An ERU value of 154 gpd/ERU was selected for the Medium scenario, which corresponds to the historical average between 2018 and 2022, while the High scenario used an ERU value of 169, corresponding to the historical maximum ERU value between 2012 and 2022.

4.5.2.2 ERU Annual Reduction

The City decided to not include an ERU annual reduction value for any of the three demand scenarios. So, the ERU value does not change over the planning horizon.

4.5.2.3 Water Loss

The City's average water loss, including DSL and Non-Revenue Water, had to be estimated as no accurate historical data is currently available. 10 percent was used for all three of the demand scenarios.

4.5.2.4 Climate Change Scenario

According to climate change models, the Pacific Northwest will, in general, experience warmer, wetter winters and hotter, drier summers. To estimate the climate change's impact on the City's water demands, Carollo examined historical and projected maximum temperature results from the National Oceanic and Atmospheric Administration Climate Explorer. For the purpose of this Plan, two climate scenarios were used:

- RCP 4.5 - Assumes lower level of emissions.
- RCP 8.5 - Assumes higher level of emissions.

Over the past decade, emission trends have been tracking approximately between the RCP 4.5 and RCP 8.5 climate scenarios. A linear regression was used to compare the City's historical data to the two climate scenarios, which resulted in the growth rates shown in Table 4.16. The growth rates are an average increase in base demand over the decade. The climate change growth rates were only applied to residential and commercial projections.

Table 4.16 Predicted Increase in Demand from Baseline due to Climate Change

Year	RCP 4.5	RCP 8.5
2020 – 2029	3%	3%
2030 – 2039	4%	5%
2040 – 2049	5%	7%

4.5.2.5 MDD to ADD Peaking Factor

The City's historical minimum, historical average, and historical maximum MDD to ADD peaking factors from 2012 – 2022 were applied to the Low, Medium, and High scenarios, respectively. These values are presented above in Table 4.15.

4.5.2.6 Largest Consumer Demand

Using analyses of the City's historical consumption, Carollo developed individual demand projections for the City's 13 largest consumers, as shown in Table 4.17. Each of the largest consumers was assigned a starting demand and an annual growth rate dependent on the demand scenario (Low, Medium, and High). These values are also presented in Table 4.17.

The City also decided to include a future large consumer block for three potential new large users, which includes a Lummi Tribal Indian Nation development along Slater Road, Fish Hatchery, and the use of the old Georgia-Pacific (GP) pipeline. The Fish Hatchery and old GP pipeline potential demand was included only in the High demand scenario in the 20-yr planning horizon, while the Lummi Tribal development was included in the High demand scenario in the 10-yr planning horizon. The estimated demand is shown in Table 4.17.

Table 4.17 Largest Consumers Projections

Demand Projection Scenario	Low		Medium		High	
	Starting Demand (gpd)	Annual Growth Rate	Starting Demand (gpd)	Annual Growth Rate	Starting Demand (gpd)	Annual Growth Rate
013593 – irrig	48,000	1.1%	75,000	1.3%	85,000	1.9%
02047 – comm	51,000	0.6%	62,000	0.8%	80,000	1.4%
021696 – indust	39,000	2.0%	42,000	2.0%	66,000	2.0%
017861 – comm	34,000	0.6%	38,000	0.8%	45,000	1.4%
013654 – comm	19,000	0.6%	27,000	0.8%	56,000	1.4%
018041 – comm	26,000	0.6%	32,000	0.8%	42,000	1.4%
017939 – mfr	24,000	1.5%	31,000	1.7%	34,000	2.3%
017369 – indust	3,000	1.4%	4,000	1.4%	213,000	1.4%
023113 – mfr	19,000	1.2%	25,000	1.3%	31,000	2.0%
017297 – indust	5,000	1.4%	23,000	1.4%	30,000	1.4%
017860 – comm	4,000	0.6%	16,000	0.8%	30,000	1.4%
018023 – mfr	14,000	1.1%	17,000	1.3%	27,000	1.9%
014747 - county	13,000	0.6%	16,000	0.8%	26,000	1.4%
Future Potential Large Users						
Lummi Tribal Development					300,000	-
Fish Hatchery					2,300,000	-
Old Georgia-Pacific Pipeline					16,900,000	-

Notes:
comm - commercial; indust - industrial; irrigc - irrigation commercial; mfr - manufacturing.

4.5.3 Water Districts

Water District demand projections were completed using the historical consumption data, contractual amounts, and projections from the individual Water Districts' system plans. Table 4.18 lists the 10 Water Districts that the City serves, along with their annual contractual amounts, which were provided by the City.

Table 4.18 Water District Contract Obligations

Existing Water Service Obligation	Contract and/or Account Numbers	Contract Term(2)	Quantity of Water Contracted - Use Verbiage From Contract	Maximum Amount of Water Contracted Per Year in Units Used in Contracts	Maximum Amount of Water Contracted Converted to mgd	Pressure Zone
Lummi Tribal Interlocal Water Service Agreement	COB account # 020769	Executed 03-02-1990 No expiration.	Up to a max of 1,000 gpm of uninterrupted daily potable water service at minimum of 30 psi.	525,600,000 gallons per year.	1.44	Cordata
Ferndale Emergency Intertie	COB contract # 2018 0371	Executed 07-11-2018 No expiration.	Duration not to exceed 60 days(3). Max allowed by pipeline size is 7,000 gpm. (7,000 gpm = 10.08 mgd x 60days = 604.8 mgd).	604,800,000 gallons per year.	10.08	Cordata
Glen Cove (1)	COB account # 017371	Executed 07-14-1952 No expiration.	None listed - 20 residential connections.	1,452,700 gallons per year.	0.004	Dakin and Yew
California Interlocal Agreement(1)	COB account # 022734	Executed 12-01-1993 No expiration.	None listed - 4 residential properties.	290,540 gallons per year.	0.0008	South
Deer Creek Agreement(1)	COB contract #2005-0231	Executed 06-03-2005 No expiration.	None listed - Total number of parcels = 170.	12,347,950 gallons per year.	0.0338	Cordata
Governors Point Wholesale Water Service Agreement (1)	COB contract #2018-0568	Executed 08-11-2018 No expiration.	None listed - 16 new residences and two supplemental non-residential connections.	1,307,430 gallons per year.	0.0036	South
Montgomery Road(1)	Unable to locate contract Account #022206		7 residential connections.	508,445 gallons per year.	0.0014	King Mountain
LWWSD Water Supply Service Agreement	COB account #'s 017925 and 020504	Executed 05-13-1970 No expiration.	Minimum of 150gpm domestic and 750 gpm fire flow at a minimum of 26 psi at each location.	946,080,000 gallons per year.	2.592	Dakin and Yew
WD No. 2 Interlocal Agreement	COB contract # 1997-0440	Executed 12-01-1997 No expiration.	Up to a max of 1100 gpm at minimum of 20 psi.	578,160,000 gallons per year.	1.584	Cordata, North
WD No. 7 Interlocal Agreement	COB account # 027049	Executed 04-13-1993 No expiration.	Up to a max of 500 gpm at a minimum of 20 psi.	262,800,000 gallons per year.	0.72	Alabama Hill, Dakin and Yew
Total (4)	-	-	-	2,328,547,065 gallons per year.	6.3796	-

Notes:
(1) The noted contracts above did not specify a maximum contracted water usage. An ERU value of 199 gpd per connection and/or potential connection was used.
(2) Execution dates and expiration dates or if there is no expiration date.
(3) Ferndale Agreement language states, "'Short Term' or 'Temporary' shall mean a limited time period of short duration not to exceed 60 calendar days."
(4) Ferndale Emergency Intertie is not included in the Total row calculations because it was not included in demand projections.

For the medium demand scenario, projections were based on a combination of the estimated ADD and MDD values from individual Water District plans, as well as the contractual maximum values. Table 4.19 presents the estimated ADD and MDD demands for the Deer Creek, WD No. 2, WD No. 7, and LWWSD Water System Plans. Remaining water district demand was estimated using historical consumption data and contractual maximum values. As noted in Table 4.18, the Montgomery Rd contract could not be located, and the projected demand exceeded the estimated contractual maximum value, so the projected demand value was used for the medium scenario.

For the high demand scenario, the higher value between the projected demand and the contractual maximum value was used. Table 4.20 shows the Water District demand projections by pressure zone. Although Ferndale is listed in Table 4.18, it was excluded from demand projections as it serves as an emergency-only intertie.

WD No. 2 and WD No. 7 both have connections in multiple pressure zones. For WD No. 2, demand was evenly split between the Cordata and North pressure zones. For WD No. 7, demand was distributed 95 percent to the Alabama Hill zone and 5 percent to the Dakin and Yew zone.

Table 4.19 Water District Demand Estimates

	2034 ADD (gpd)	2034 MDD (gpd)	2044 ADD (gpd)	2044 MDD (gpd)
Deer Creek (1)	164,000	319,000	236,000	461,000
WD No. 2 (2)	151,100	330,100	153,400	334,900
WD No. 7 (3)	135,400	297,600	144,900	318,500
LWWSD (4)	21,000	70,000	25,000	216,000

Notes:
(1) Source: Deer Creek Water Association Water System Plan (July 2023).
(2) Source: Whatcom County Water District 2 Water System Plan (2023).
(3) Source: Whatcom County Water District 7 Water System Plan (June 2021).
(4) Source: Lake Whatcom Water and Sewer District Water Comprehensive Plan (June 2018).

Table 4.20 Water District ADD Demand Projections (gpd)

Pressure Zone	Water Districts	Low		Medium		High	
		2034	2044	2034	2044	2034	2044
Alabama Hill	WD No. 7	111,244	118,250	130,200	139,700	360,000	360,000
Cordata	WD No. 2, Deer Creek, Lummi Tribal	163,599	192,891	163,599	192,891	2,265,830	2,265,830
Dakin and Yew	WD No. 7, Glen Cove, LWWSD	18,220	20,915	30,180	34,180	2,955,980	2,955,980
King Mountain	Montgomery Road	11,035	16,912	11,035	16,912	11,035	16,912
North	WD No. 2	44,887	51,255	75,550	76,700	792,000	792,000
South	California, Governor's Point	2,032	2,281	4,378	4,378	4,378	4,378

In order to calculate MDD projections for the Water Districts, the same methodology outlined in Section 4.5.1 was used. An MDD to ADD peaking factor was only applied to the Water Districts without contract instantaneous limits. For Deer Creek, WD No. 2, WD No. 7, and LWWSD, the estimated MDD values in Table 4.19 were used in the medium scenario.

4.5.4 Untreated Water Users

In addition to the potable water system, the City supplies untreated water to six customers. For the low, medium, and high demand scenarios the historical 2018 – 2022 average consumption values for the first five customers listed in Table 4.21 was used as the starting demand. For the Lake Padden Golf Course, the 2023 irrigation average was used as the starting demand for all three demand scenarios. Additionally, no growth was applied to the untreated water users. The demand from the untreated water customers does not have a significant effect on the overall system demands. Table 4.21 shows the untreated water user projections. Similar to the Water Districts, the same methodology outlined in Section 4.5.1 was used for MDD projections.

Table 4.21 Untreated Water User Projections

Demand Projection Scenario	Low		Medium		High	
	Starting Demand (gpd)	Annual Growth Rate	Starting Demand (gpd)	Annual Growth Rate	Starting Demand (gpd)	Annual Growth Rate
14840	0.1	0.0%	0.1	0.0%	0.1	0.0%
30405	250.2	0.0%	250.2	0.0%	250.2	0.0%
30407	51.8	0.0%	51.8	0.0%	51.8	0.0%
32437	0.4	0.0%	0.4	0.0%	0.4	0.0%
33601	0.5	0.0%	0.5	0.0%	0.5	0.0%
Lake Padden Golf Course	90,520	0.0%	90,520	0.0%	90,520	0.0%
Total	**90,823**	**0.0%**	**90,823**	**0.0%**	**90,823**	**0.0%**

4.5.5 ERU Projections

When converting projected number of accounts to ADD, the first step is to convert these number of accounts into a number of ERUs. To calculate the projected number of ERUs for the retail water service area, the projected number of accounts shown in Table 4.14 were multiplied by the number of ERU per connection shown in Table 4.5. Table 4.22 shows the ERU projections for each demand projection scenario.

These ERU projections include ERUs that correspond to water loss (DSL and Other Authorized Use), which were calculated by dividing the ADD projections of water loss by the ERU values in gpd/ERU shown in Table 4.11. Section 4.5.6 below describes how ADD projections for DSL and Other Authorized Use were calculated.

Table 4.22 ERU Projections - Planning Demand Projection Scenario

Demand Projection Scenario	Low			Medium			High		
Customer Category	2022	2034	2044	2022	2034	2044	2022	2034	2044
Single-Family Residential	22,600	25,418	28,278	22,337	25,321	28,991	22,475	27,107	33,020
Multi-Family Residential	11,014	12,372	13,751	10,887	12,327	14,099	10,955	13,196	16,059
Institutional	1,573	1,835	2,107	1,553	1,814	2,139	1,561	1,933	2,425
Commercial	7,904	8,863	9,862	7,832	8,794	10,041	7,869	9,371	11,383
Industrial	3,860	4,245	4,645	3,831	4,220	4,737	3,849	4,496	5,370
Construction	0	0	0	0	0	0	0	0	0
Public	624	704	786	618	698	800	621	744	907
Irrigation	2,407	2,716	3,029	2,378	2,705	3,105	2,393	2,896	3,537
Water District	2,007	2,340	2,683	1,955	1,955	2,694	1,781	1,781	37,806
Large Consumers	2,034	2,254	2,503	2,681	3,018	3,403	4,599	7,168	121,714
DSL and Other Authorized Use	6,017	6,773	7,554	6,023	6,785	7,817	6,252	7,664	25,857

Notes:

(1) ERU values were not used to develop the projections for the large consumers. The ERU values for the large consumers shown in this table were calculated by dividing the projected ADD by the ADD ERU values.

4.5.6 Average and Maximum Day Projections

To calculate the ADD projections for each customer category, the ERU projections were multiplied by the ERU values in gpd/ERU unique to each demand projection scenario and customer category, as shown in Table 4.15. To establish total ADD projections, non-revenue water consumption, including Other Authorized Use and DSL, was added using Low, Medium, and High assumptions. Finally, for each demand projection scenario, MDD projections were established by multiplying ADD projections by the appropriate MDD to ADD peaking factor.

Table 4.23 shows ADD projections for Low, Medium, and High demand scenarios for each customer category, while Table 4.25 shows the same projections by pressure zone. Figure 4.13 shows a chart of the system-wide demand projections.

The City's ADD is projected to be between 10.2 and 20 mgd in 2034, for the Low and High scenarios respectively. By 2044, ADD is estimated to be between 11.3 mgd and 44 mgd, for the Low and High scenarios respectively. The Medium scenario predicts 10.7 mgd in 2034 and 12.2 mgd in 2044.

In 2044, MDD is estimated to be between 15.7 mgd and 68.3 mgd, for the Low and High scenarios respectively, as shown in Table 4.24. The Medium scenario predicts 18.9 mgd. These demands are the basis for the water supply strategy of Chapter 6 and the distribution system analysis of Chapter 7. Table 4.26 shows these MDD projections by pressure zone. The demographic and demand forecast in Appendix K shows detailed demand projections by year.

Table 4.23 ADD Projections by Customer Category (mgd)

Demand Projection Scenario	Low Projected ADD (mgd)			Medium Projected ADD (mgd)			High Projected ADD (mgd)		
Customer Category	2022	2034	2044	2022	2034	2044	2022	2034	2044
Single-Family Residential	3.4	3.8	4.3	3.5	4.0	4.6	3.9	4.7	5.7
Multi-Family Residential	1.7	1.9	2.1	1.7	1.9	2.2	1.9	2.3	2.8
Institutional	0.2	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.4
Commercial	1.2	1.3	1.5	1.2	1.4	1.6	1.4	1.6	2.0
Industrial	0.6	0.6	0.7	0.6	0.7	0.7	0.7	0.8	0.9
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Public	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Irrigation	0.4	0.4	0.5	0.4	0.4	0.5	0.4	0.5	0.6
Water District	0.3	0.4	0.4	0.3	0.4	0.5	0.3	6.4	6.4
Large Consumers	0.3	0.3	0.4	0.4	0.5	0.5	0.8	1.2	20.6
DSL and Other Authorized Use	0.9	1.0	1.1	0.9	1.1	1.2	1.1	2.0	4.4
Total Potable	**9.0**	**10.2**	**11.3**	**9.4**	**10.7**	**12.2**	**10.7**	**20.0**	**44.0**
Untreated Water Users	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**
Total Supply	**9.1**	**10.3**	**11.4**	**9.5**	**10.8**	**12.3**	**10.8**	**20.1**	**44.1**

Table 4.24 MDD Projections by Customer Category (mgd)

Demand Projection Scenario	Low Projected MDD (mgd)			Medium Projected MDD (mgd)			High Projected MDD (mgd)		
Customer Category	2022	2034	2044	2022	2034	2044	2022	2034	2044
Single-Family Residential	4.8	5.4	6.0	5.2	6.0	6.8	6.2	7.5	9.2
Multi-Family Residential	2.3	2.6	2.9	2.6	2.9	3.3	3.0	3.7	4.5
Institutional	0.3	0.4	0.4	0.4	0.4	0.5	0.4	0.5	0.7
Commercial	1.7	1.9	2.1	1.8	2.1	2.4	2.2	2.6	3.2
Industrial	0.8	0.9	1.0	0.9	1.0	1.1	1.1	1.2	1.5
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Public	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.3
Irrigation	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.8	1.0
Water District	0.3	0.4	0.4	0.3	0.9	1.3	0.3	8.2	8.2
Large Consumers	0.4	0.5	0.5	0.6	0.7	0.8	1.3	2.0	32.9
DSL and Other Authorized Use	1.3	1.4	1.6	1.4	1.6	1.8	1.7	3.2	7.0
Total Potable	**12.5**	**14.1**	**15.7**	**13.9**	**16.3**	**18.9**	**17.0**	**29.9**	**68.3**
Untreated Water Users	**0.13**	**0.13**	**0.13**	**0.14**	**0.14**	**0.14**	**0.15**	**0.15**	**0.15**
Total Supply	**12.7**	**14.2**	**15.8**	**14.1**	**16.5**	**19.1**	**17.2**	**30.0**	**68.5**

Table 4.25 ADD Projections by Pressure Zone (mgd)

Pressure Zone	Low Projected ADD (mgd)			Medium Projected ADD (mgd)			High Projected ADD (mgd)		
	2022	2034	2044	2022	2034	2044	2022	2034	2044
Alabama Hill	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.7	0.8
Birch Street	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1
College Way	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cordata	1.2	1.4	1.6	1.2	1.5	1.7	1.3	4.4	4.8
Dakin and Yew	1.3	1.5	1.7	1.3	1.5	1.8	1.5	5.1	5.5
Governor Road	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Huntington	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King Mountain	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.1
North	4.0	4.4	4.8	4.2	4.7	5.3	5.0	6.7	29.2
Padden Yew	0.3	0.3	0.4	0.3	0.3	0.4	0.3	0.4	0.5
Reveille	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1
Samish Highland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South	1.7	1.9	2.1	1.8	2.0	2.3	2.0	2.3	2.8
Total Potable	**9.0**	**10.2**	**11.3**	**9.4**	**10.7**	**12.2**	**10.7**	**20.0**	**44.0**
Untreated Water Users	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**
Total Supply	**9.1**	**10.3**	**11.4**	**9.5**	**10.8**	**12.3**	**10.8**	**20.1**	**44.1**

Table 4.26 MDD Projections by Pressure Zone (mgd)

Pressure Zone	Low Projected MDD (mgd)			Medium Projected MDD (mgd)			High Projected MDD (mgd)		
	2022	2034	2044	2022	2034	2044	2022	2034	2044
Alabama Hill	0.5	0.5	0.5	0.5	0.7	0.8	0.6	1.0	1.0
Birch Street	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
College Way	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cordata	1.6	1.9	2.2	1.8	2.3	2.8	2.1	5.6	6.3
Dakin and Yew	1.8	2.1	2.3	2.0	2.4	2.9	2.4	8.2	8.8
Governor Road	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Huntington	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King Mountain	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1
North	5.6	6.1	6.7	6.3	7.1	8.0	8.0	10.3	46.2
Padden Yew	0.4	0.5	0.5	0.4	0.5	0.6	0.5	0.6	0.8
Reveille	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1
Samish Highland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South	2.4	2.7	3.0	2.6	3.0	3.4	3.1	3.7	4.5
Total Potable	**12.5**	**14.1**	**15.7**	**13.9**	**16.3**	**18.9**	**17.0**	**29.9**	**68.3**
Untreated Water Users	**0.13**	**0.13**	**0.13**	**0.14**	**0.14**	**0.14**	**0.15**	**0.15**	**0.15**
Total Supply	**12.7**	**14.2**	**15.8**	**14.1**	**16.5**	**19.1**	**17.2**	**30.0**	**68.5**

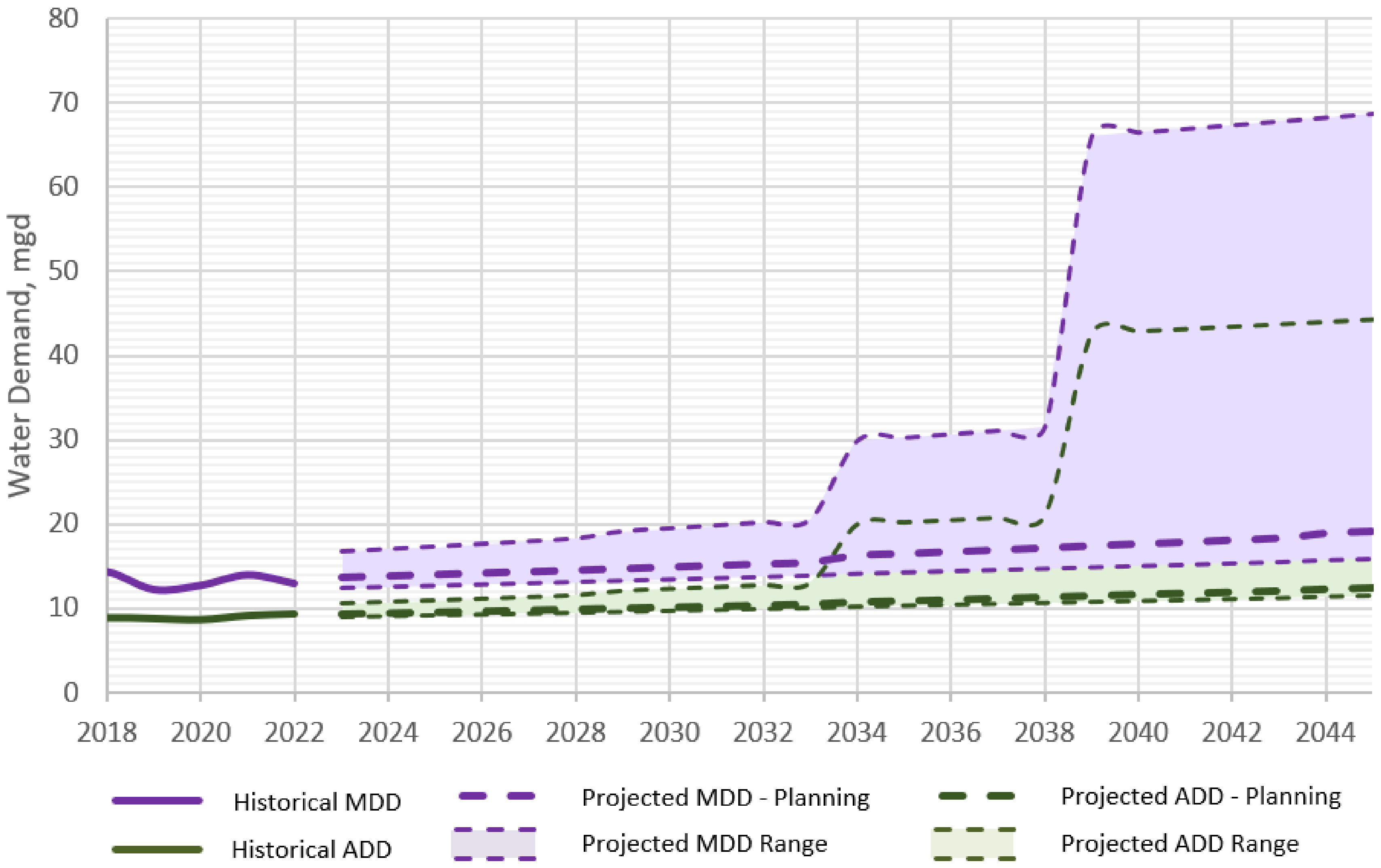

Figure 4.13 Projected Water Demands

CHAPTER 5 WATER USE EFFICIENCY AND CONSERVATION

5.1 Introduction

In 2003, the Municipal Water Law was passed to address the increasing demand on Washington's water resources. As part of this law, the state implemented the WUE Rule, which requires all municipal water suppliers to use water more efficiently in exchange for guaranteed, flexible water rights to help meet future demands.

The City's conservation program began in the 1990s in recognition of Bellingham's specific needs as they relate to ensuring adequate water supply. In general, the City's conservation program objective is to maintain current City-wide per capita daily consumption and to keep the City-wide water demand equal to or below City population growth rate. In order to do this, Bellingham has implemented the following measures:

- Toilet retrofit program for single-family residence water utility customers.
- Toilet retrofit program for multi-family residence water utility customers.
- Toilet retrofit program for commercial water utility customers.
- Develop and implement 6th-grade water conservation education program.
- Door hanger campaign for lawn watering.
- Evaluate and develop high-efficiency fixture program.
- Develop future water rate structures with an emphasis on water conservation.
- Upgrade City parks to high-efficiency irrigation systems.
- Continue public outreach measures.

In addition to these specific measures, the City has abundant information on indoor and outdoor water conservation on their website as well as access to free water conservation kits. The City's current 2025-2035 WUE Program can be found in Appendix L.

This chapter presents the City's current and proposed actions to comply with conservation planning requirements and to promote using water efficiently. This discussion follows the Washington State DOH guidelines established in the WUE Guidebook (revised January 2017), which replaces the former Conservation Planning Requirements (March 1994).

5.2 Metering and Leak Detection Programs

5.2.1 Source Meters

Diversion flows from the Nooksack River are metered in the pipeline downstream from the diversion structure. Flows at the City's WTP are also metered, including the volume of water required for filter backwashing. Finally, Bellingham meters flows from the chlorine contact time (CT) reservoirs into the distribution system.

As discussed in Chapter 4, it was verified in 2020 that the gravity flow meter at the CT reservoir, Whatcom Falls Reservoir II, is inaccurate. The City recently installed service meters that provide a verifiable consumption value that has been higher than production values measured at the WTP. The meter was installed in 2016 by Bainbridge Associates and is an FPI-Mag insertion-style flow meter. The City is working to solve its production metering issue at the WTP by testing new meters and working with suppliers to find a better meter that can accurately measure low flows. The assessment the City completed on the gravity flow meter is located in Appendix N.

As a result of this meter inaccuracy, the City does not have sufficient data to estimate historical DSL. For the sake of planning efforts, production values from the WTP were assumed to be 10 percent higher than the historical consumption values.

5.2.2 Service Meters

Between June 1, 2012 and April 2017, approximately 14,299 residential flat-rate customers were converted to metered accounts to complete the metering requirements under the Municipal Water Law. The work to complete this project included installation and assembly of 7,311 meter boxes and a total of 60,596 total staff hours.

Since 2019, the City has started implementing advanced metering infrastructure (AMI) to track customer water usage. Recent data shows approximately 22,787 City customers have received their AMI meters, which represents 85 percent of the system. AMI eliminates the need for manual meters reads and wirelessly transmits flow data. This has helped inform and improve the City’s water conservation efforts and leak detection program. AMI also helps track more dynamic customer water usage data, which has allowed the City to start a high water use notification program. The City’s high water use notification program is detailed below in Section 5.4.2.

5.2.3 Leak Detection Program

Bellingham has been operating a leak detection program on its water system since 1994. As part of routine protocol, all distribution system valves are exercised and tested on a regular schedule, and repairs done as needed. The City has a meter maintenance crew and meter testing facilities to facilitate this process. Meters 3 inches and larger are tested annually, and meters 1.5 to 2 inches are tested every five years. As mentioned above, the installation of AMI has also improved the City’s leak detection program.

The City has established leak detection zones to prioritize areas of the system that contain water mains that are older and more prone to leaks to conform to state water accountability measures. When the origin of a leak is determined to be on a City water main, Bellingham repairs the leak at its own cost in a timely manner. If the leak is determined to be on the property owner's water service line, it is the responsibility of the property owner to repair the leak.

5.3 Previous Water Use Efficiency Program

The 2020-2024 WUE program was very successful. With the coordinated efforts across multiple city departments and dozens of staff, all WUE requirements were accomplished and the following established goal was met:

- Goal - Keep average peak day demand (PDD) between June 1 and August 31 to 14 mgd or less during the 2020-2024 program period.

The average PDD between June and August over the five-year program period was 12.95 mgd, well under the goal of 14 mgd or less, as shown in Figure 5.1. During the 2014-2019 program period, an equivalent graph to Figure 5.1 showed a trend of increasing PDD. However, over the 2020-2024 program period, the City curbed that slight increase and maintained a steadier PDD, aside from the summer of 2021. With that said, there are opportunities for improved summer conservation measures during the next program period, namely a focus on outdoor water conservation during the drier summer months.

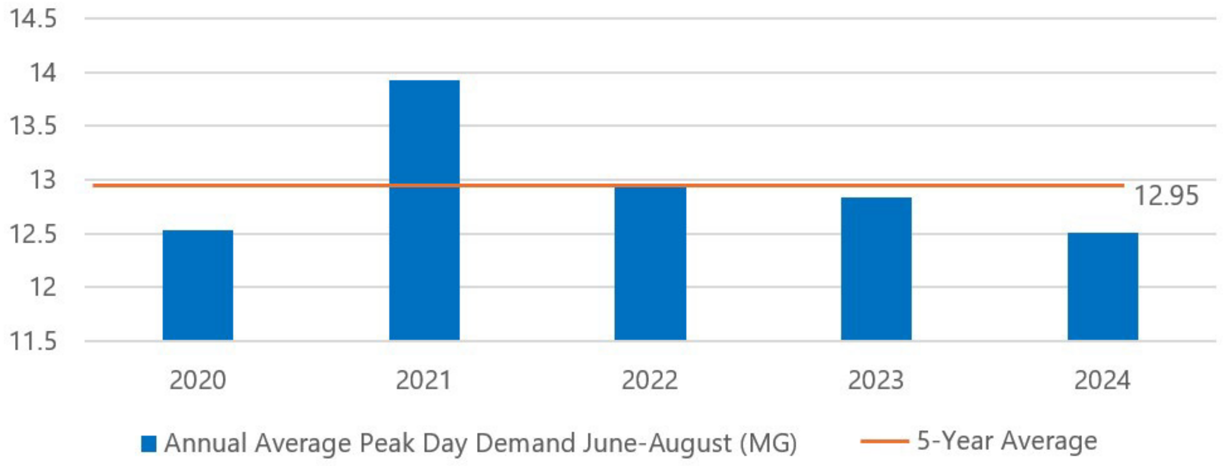

Figure 5.1 PDD During Summer Months Between 2020-2024 with 5-Year Average

The 2020-2024 WUE Program outlined nine measures to achieve the overarching goal of maintaining a PDD under 14 mgd during summer months. Three of these measures were completed and resulted in substantial water savings. The completed measures and their savings are presented in Table 5.1.

Table 5.1 Measures and Savings between 2020-2024

Measure	Estimated Total Water Savings, 2020-2024 (gallons)
Single-Family Rebates	631,008
Multi-Family Direct Install Program	98,670
Commercial Rebates and Direct Install Program	1,431,163
Total Estimated Water Savings	2,062,171

The 2020-2024 Program made progress towards achieving the goals of its other six measures as well. The City transitioned to billing customers monthly instead of bi-weekly. Community education and engagement programs continued to increase awareness and understanding of water conservation. To address high consumption during summer months, the City published an Irrigation System Best Management Practices guide and installed smart meters to notify consumers of higher-than-normal consumption, which is usually indicative of a leak. And while the industrial rebate program was not initiated during this program period, it has been incorporated into the City's 2025-2035 WUE Program.

5.4 2025-2035 Water Use Efficiency Program

Staff reviewed the outcomes from the 2020-2024 program to determine the goal and measures for the 2025-2035 program. As outlined above, the 2020-2024 program measures effectively maintained a PDD less than 14 mgd, and curbed the upward trend observed in summer PDD over the years of 2017-2019. Since lowering the average indoor baseline provides even more room for summer demand influx, the 2025-2035 program period will focus on reducing single-family residential consumption.

The 2025-2035 WUE Program goal is to keep consumption below 154 gallons per day per single-family residential account. This goal closely reflects the City's predicted future consumption, based on demand projections, projected growth rates, and historical consumption. By maintaining a daily consumption of 154 gallons per single-family residence, the City will lower their indoor baseline and meet remaining demand.

In February 2025, the City held two community outreach events to share the 2025-2035 Water Use Efficiency Program with the public. Invitations to attend were posted on the City's Engage Bellingham page, social media, and the weekly Friday news release. During the second meeting, members of the Water Resources Advisory Board (WRAB) unanimously approved the adoption of the 2025-2035 WUE Program report after requesting some clarification and providing feedback. The record of public engagement and comment is included in the 2025-2035 WUE Program report in Appendix L and the Record of Public Engagement in Appendix M.

5.4.1 Program Monitoring

In an effort to monitor the effects of its Conservation Program, the City reviews demand and consumption data compiled annually as part of the WUE rule, as well as the DOH-required water system plan update cycle. As part of the WUE rule, the City must show progress towards increasing conservation and reducing distribution system leakage by 10 percent each year.

5.4.2 2025-2035 Program Measures

The City's nine water conversation measures for the 2025-2035 WUE Program, as well as their estimated water savings, are detailed in the following sections.

5.4.2.1 Measure 1 - Continue Single-Family Residential Rebate Program

Based on the results of a cost-benefit analysis, the single-family residential rebate program will continue. Water assessments will continue to be provided by a reputable local contractor to verify eligibility for rebates.

- Estimated savings: 750,000 gallons per year.
- Estimated budget: $30,000.
- Implementation schedule: Ongoing.

5.4.2.2 Measure 2 - Continue Multi-Family Residential Rebate Program

Based on the results of a cost-benefit analysis, the multi-family residential rebate program will continue. Water assessments will continue to be provided by a reputable local contractor to verify eligibility for rebates and complete direct installs of faucet aerators, showerheads, and spray nozzles.

- Estimated savings: 750,000 gallons per year.
- Estimated budget: $30,000.
- Implementation schedule: Ongoing.

5.4.2.3 Measure 3 - Continue Commercial and Institutional Rebate Program

Based on the results of a cost-benefit analysis, the commercial and institutional rebate program will continue. Water assessments will continue to be provided by a reputable local contractor to verify eligibility for rebates and complete direct installs of faucet aerators, shower heads and spray nozzles.

- Estimated savings: 2,000,000 gallons per year.
- Estimated budget: $30,000.
- Implementation schedule: Ongoing.

5.4.2.4 Measure 4 - Continue High-Water Use Notification Program

With the installation of smart meters, the City's water department was able to initiate a high-water use notification program. The remotely read meters report constant data points and are therefore able to quickly detect higher-than-normal water consumption, which usually indicates a leak.

During the 2025-2035 program period, the Water Distribution Division will explore ways to estimate the amount of water savings incurred annually through the high-water use notification program.

- Estimated savings: Unknown.
- Estimated budget: Unknown.
- Implementation schedule: Tracking and reporting process in place by 2027.

5.4.2.5 Measure 5 - Evaluate Water Billing Rates to Promote Conservation

Customers are currently charged a flat rate for service, plus a volume fee for each unit of water used. With the adoption of this WUE program, the rate structure will be evaluated, and adjustments will be made in order to promote water conservation.

5.4.2.6 Measure 6 - Continue Direct-Install Toilet and Fixtures Program for Low-Income Households

A direct-install program was initiated in 2024, providing assessment and installation of water-saving fixtures to income-qualifying households. This work will continue to be provided by a reputable local contractor.

- Estimated savings: 100,000 gallons per year.
- Estimated budget: $45,000.
- Implementation schedule: Ongoing.

5.4.2.7 Measure 7 - Continue Community Education and Engagement Programs

To continue the focus on indoor and outdoor water conservation, current education and outreach programs will continue, including water-saving device giveaways.

- School-based education:
    - Continue to work with local schools to provide water conservation education.
- Outdoor water conservation education:
    - Continue to provide outdoor water conservation education to all customers. This may include demonstration projects, general education, tabling at community events, workshops or advertising.
- Water-saving device giveaways:
    - Continue to engage community members with water-saving device giveaways. The City will give away low-cost devices to City water customers, including hose timers, repair kits, moisture meters, rain gauges, hose nozzles, faucet aerators, and low-flow showerheads.
- New utility billing software:
    - The City's new utility billing software will be used to help educate customers about water conservation.
- Additional customer education opportunities:
    - Additional opportunities to educate customers will be used, such as bus ads, bill inserts, print media, Pickford Film Center ads, etc.

5.4.2.8 Measure 8 - Explore Updates to the City's Development Code for Irrigation and Required Fixture Counts

The City will explore development code requirements that could reduce the size of the water service required for irrigation. There is an opportunity to update irrigation standards with conservation in mind and options will be explored over the next five years.

5.4.2.9 Measure 9 - Evaluate and Reduce Water Consumption the City's Operating and Maintenance Procedures

The Water Distribution Division of Public Works continues to efficiently and effectively maintain the flow of water to our customers. Practices such as the annual flushing will continue to improve over time and can lead to reduced water consumption. For example, in 2024, 10,966,400 gallons of water were used in for annual flushing. Staff will work to reduce this amount through improved processes and staff training.

5.5 Regional Conservation Programs

Bellingham participates in regional and local partnerships and is a member of the following organizations that address water conservation issues:

- AWWA.
- Partnership for Water Conservation (PWC).
- Lake Whatcom Management Program.
- WaterSense.
- Whatcom Water Alliance.
- Whatcom Watersheds Info Network.

CHAPTER 6 WATER SUPPLY STRATEGY

6.1 Introduction

This supply evaluation describes the City's of sources of supply and existing water rights, summarizes the purchased water supply, and makes recommendations for future supply facilities. The study was done to evaluate current and future water resources to identify deficiencies and propose improvements. The improvements identified in this chapter are summarized in the Capital Improvements Plan (CIP) in Chapter 10.

6.2 Existing Supply Sources

The water supply for the City's treated water system and wholesale customers is exclusively sourced from Lake Whatcom and the Middle Fork of the Nooksack River. A transmission line takes water from Lake Whatcom to the City-owned-and-operated WTP. This treatment plant is the sole supply of potable water for the City's distribution system. Figure 6.1 outlines the location of the City's water supply sources, the Retail Service Area, and the WTP's location. Figure 6.2 shows the intake piping from Lake Whatcom to the WTP.

Lake Whatcom is the City's primary historic water source. The intake in Lake Whatcom was constructed in 1940, it consists of an intake tower that pulls water from below the water surface. Water is then conveyed through a tunnel to a Screenhouse, and then to the WTP via a 66-inch diameter pipeline.

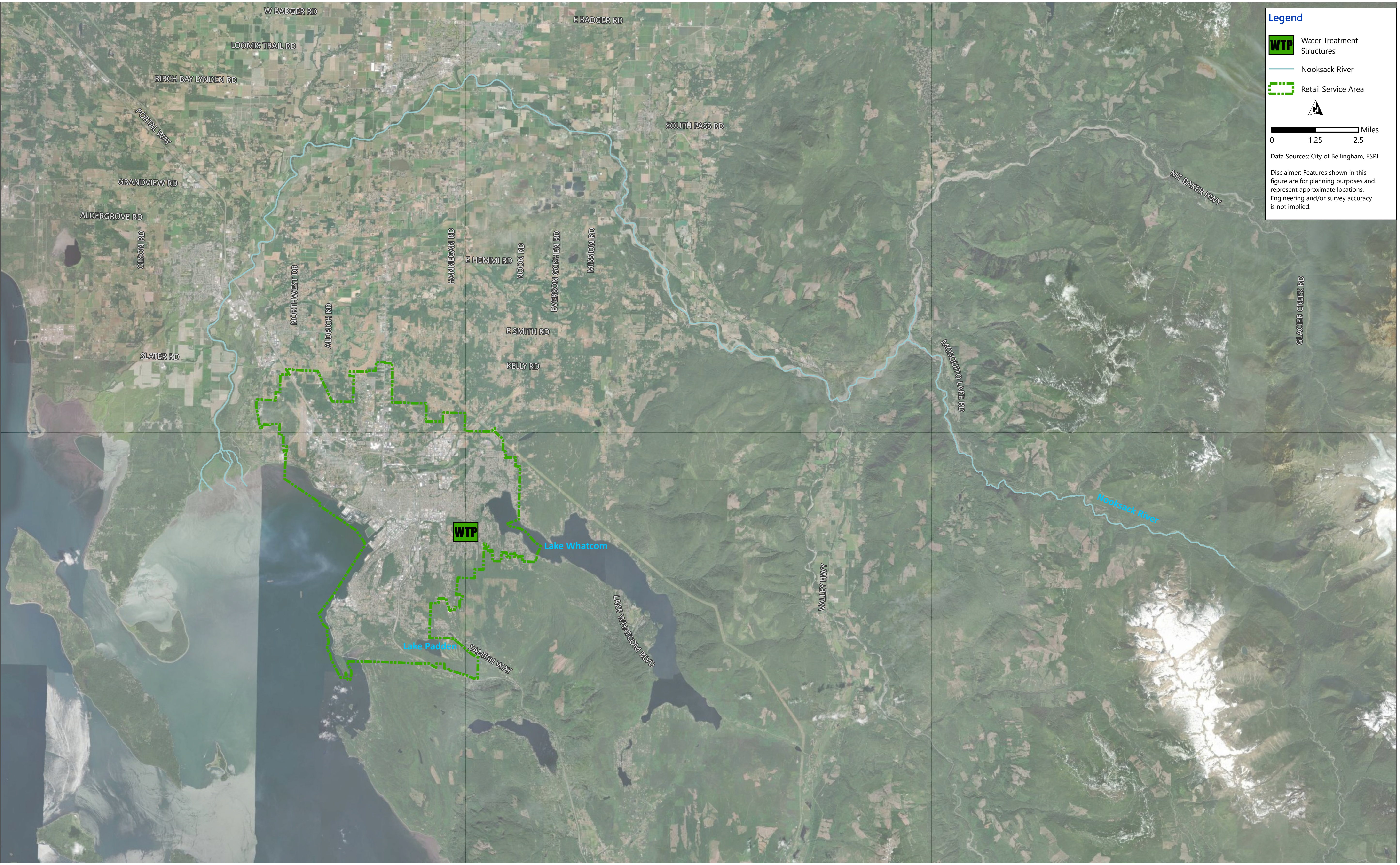

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Figure 6.1 Water Supply Sources

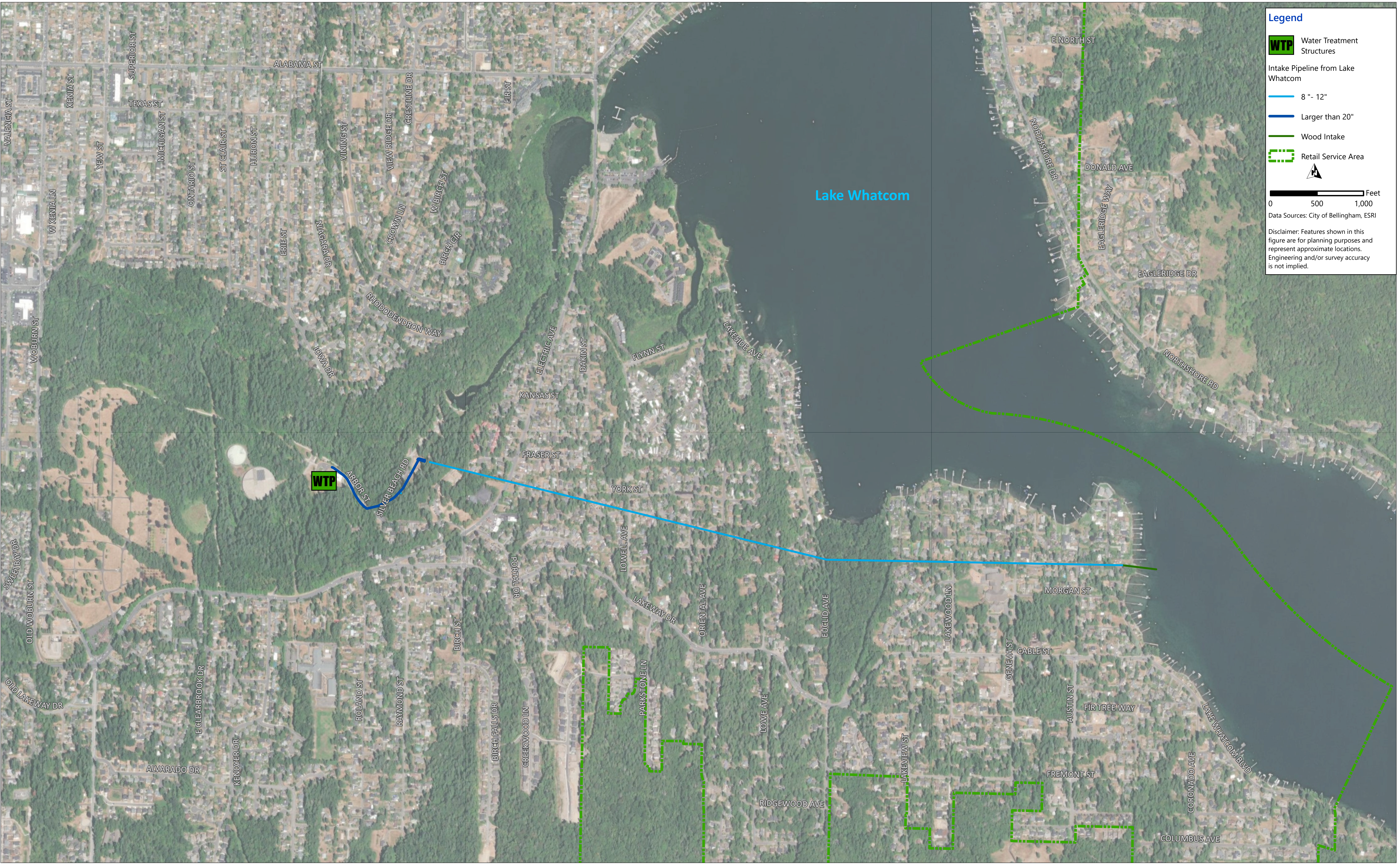

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Figure 6.2 Water Treatment Supply
CITY OF BELLINGHAM
WATER SYSTEM PLAN

6.2.1 Water Rights

The following section discusses the City's water rights, permits, claims, and applications in the context of the City's current water usage and projected needs. The City's water rights, together with all other water rights in the Nooksack Basin, are subject to the basin-wide adjudication of water rights for Water Resource Inventory Area 1 (WRIA 1), Whatcom County Superior Court Docket No. 24-2-80000-37. As the adjudication progresses, the City may gain additional information about its rights and may update these sections of the Plan accordingly.

The City has water rights for the beneficial use of water from Lake Whatcom, the Middle Fork Nooksack River, Lake Padden, Ruby Creek and Silver Creek. The City's Lake Whatcom and Nooksack municipal water rights are currently the sole source of supply for the City's municipal domestic and industrial water system. The City also contracts to supply water to local water districts from the Lake Whatcom and Middle Fork Nooksack River sources. The City's municipal water supply place of use is described in Chapter 2. The City's water rights have undergone several revisions over the years, reflecting the development of the City's water system. The City uses these water rights for a multitude of beneficial purposes in support of the City's drinking water supply needs and other municipal purposes as both the treated and untreated water. A summary of the City's water rights and a comparison of those rights with current and future demand are presented in Figure 6.3 Water Rights Self-Assessment Form below. Figure 6.3 does not include potential future demand stemming from the WRIA 1 adjudication. Copies of the City's water right certificates and claims are located in Appendix O.

Lake Whatcom is a primary source of supply for the City, supplemented by diversions from the Middle Fork Nooksack River into Lake Whatcom, as discussed in the following sections.

6.2.1.1 Lake Whatcom

Lake Whatcom is a naturally occurring waterbody with an outlet to Whatcom Creek. Lake Whatcom provides water service to approximately 26,000 service connections or 100,000 residents. The City, Lake Whatcom Water and Sewer District, and seven additional water districts under contract with the City withdraw water for municipal purposes from Lake Whatcom. In addition, the lake is the source of sanitary flow for Whatcom Creek and supplies water to the Whatcom Falls Fish Hatchery. The City has partnered with Whatcom County and Lake Whatcom Water and Sewer District to implement the Lake Whatcom Management Program, a joint effort to protect Lake Whatcom.

Water supply withdrawals from Lake Whatcom are limited by a restriction on the maximum elevation of the lake's water level. The City's outlet structure is at elevation 308.6 mean seal level (MSL). However, a June 8, 1953 Superior Court Order enjoins the City from raising or holding the lake's elevation above elevation 314.94 MSL. These physical and legal restrictions limit the maximum storage capacity in the lake to about 29,700 acre-feet of water. But not all of that volume is available to the City as other users (e.g. water districts, exempt and surface right holders) also take water from the lake. In addition, for over 40 years, the City has operated the Lake Whatcom outlet so that water elevations remain on average above elevation 310 feet MSL, although this may change in the future as management of the lake becomes more complex.

The City has two water right certificates and a perfected claim for water from Lake Whatcom. The surface water rights claim was filed on June 12, 1974; this claim is now assigned water rights number S1-146016CL.

The claim is for continuous use of 82 mgd or 127 cubic feet per second (cfs), for annual total of approximately 92,000 acre-feet per year (afy). The priority dates for this claim were secured by the City's predecessor towns of Whatcom and New Whatcom. The claims' priority dates for this water right are 1883 (from the Town of Whatcom) and 1894 (from the Town of New Whatcom).

The City also holds a water rights certificate for the storage of 20,000 afy in Lake Whatcom; this water right is now assigned the water right number R1-CV1-P23 with a priority date of March 9, 1937. In addition, the City holds a water rights certificate for the use of Lake Whatcom water in the amount of 10 cfs for the purpose of maintaining flow in Whatcom Creek for sanitary purposes; the water right is now assigned the water right number S1-*04371CWRIS with a priority date of April 6, 1937.

The Lake Whatcom water rights are perfected for municipal use. These municipal purpose water rights are exempt from relinquishment for nonuse pursuant to RCW 90.14.140(2)(d), the "municipal water supply" exemption.

Water from Lake Whatcom is treated and used for municipal purposes throughout the City's direct retail and wholesale service areas, and Lake Whatcom is the City's primary source of water supply. These wholesale service areas are described in this Water System Plan in Chapter 4. Water is also continuously diverted from Lake Whatcom by the City and delivered untreated for industrial, irrigation and municipal purposes, with quantities up to 53 mgd.

6.2.1.2 Middle Fork of the Nooksack

Water diverted from the Nooksack is a critical part of the City's water supply. Water from the Middle Fork is conveyed through a tunnel/pipeline to Lake Whatcom.

The City holds two water right certificates for diversions from the Middle Fork Nooksack Both of these certificates have the same priority date of October 6, 1954. Certificate S-00547C grants rights for 125 cfs (81 mgd) from the Middle Fork of the Nooksack River at the City's diversion dam. The second water right, Certificate 1508515, grants a change in the purpose of use for Certificate S-00547C by adding power generation. The city's power generation authority is limited by the new certificate to "only when water is being transported for the purposes of municipal supply, industrial and domestic supply."

For several decades the City has engaged in multiple efforts and programs to improve stewardship of water resources and fish habitat in the Nooksack Basin. The City is not required to comply with the instream flow requirements on the Middle Fork because City water rights predate the rule. However, the City has voluntarily complied with Ecology's instream flow rule by limiting times water is diverted. Ecology's minimum in-stream flow requirements are listed in Table 6.1.

Table 6.1 Minimum In-Stream Flows for the Middle Fork of the Nooksack River

Period	Minimum In-Stream Flow (cfs/mgd)
August 1 to January 31	275 / 178
February 1 to May 14	380 / 246
May 15 to May 31	450 / 291
June 1 to July 14	575 / 372
July 14 to July 31	400 / 372

United States Geological Survey (USGS) stream flow records indicate that up to the mid-1900s, the minimum in-stream flow in the vicinity of the diversion dam was 164 cfs (106 mgd). The City has been collecting more recent stream flow data that reflect current conditions. The lowest flow recorded by the City is 94 cfs (61 mgd) during August 1996. This flow would indicate that there are times in the year when in-stream flows are less than Ecology's' instream flow requirements. Hydraulic model simulations of natural flows conducted for the City document that natural flows in the Middle Fork cannot meet Ecology's adopted instream flows.

The City was one of five initiating governments that began the 2514 Watershed Pl Process for the Nooksack Basin (WRIA 1). The City is an active participant in this effort.

In 2022, the City completed the Middle Fork Nooksack River Fish Passage Project, which restructured the City's intake to allow for removal of an old dam, long considered a fish passage barrier. The City has a robust habitat restoration program, which includes many projects to protect and restore fish habitat in the streams inside city limits.

In addition to the voluntary operational constraints, diversion from the Middle Fork Nooksack River is structurally limited because the hydraulic capacity of the transmission facilities from the diversion is 116 cfs.

6.2.1.3 Lake Padden, Silver Creek, and Ruby Creek

Lake Padden provided a water supply to portions of the City in the early 1900s. The City acquired three water rights associated with Lake Padden from Fairhaven City Water and Power in 1926 with the intent of using these water rights for municipal, and industrial purposes. As a result, the City holds three legacy water rights held for the purposes of municipal use: Certificate 2008, 2009, and 2118. Two of these certificated water rights are surface diversions and one is a storage right.

Certificate 2008 authorizes a diversion from Silver Creek to Lake Padden of up to 2.0 cfs. It has a priority date of January 14, 1930. Certificate 2009 also has a priority date of January 14, 1930 and authorizes a diversion from Ruby Creek to Lake Padden of up to an additional 2.0 cfs, for a total of up to 4.0 cfs into Lake Padden. Certificate 2118 authorizes the City to store 780 acre-feet per year Lake Padden as storage for municipal supply. Certificate 2118 has priority date of October 14, 1933. Lake Padden has been used for municipal purposes with recorded diversions of at least 4.0 cfs.

6.2.1.4 Assessment of Existing and Forecasted Water Rights

This section provides explanatory details for the numbers presented in the Water Right Self-Assessment Form consistent with DOH requirements. The characteristics of the individual certificates and claims are listed with brief clarifications as necessary to address ambiguities. Copies of the actual certificates and claim are included in Appendix O.

A summary of the certificates and claims that relate to Lake Whatcom and the Middle Fork is outlined here:

- Lake Claim S1-146016CL and Middle Fork Certificate S-00547C are additive.
- Lake Claim S1-146016CL and Lake Storage Cert. R1-CV1-P23 are not additive.
- Middle Fork Certificate S-00547C and Middle Fork Certificate 1508515 are not additive.
- Cert. S1-*04371CWRIS does not appear to be an extension of or granted by any other Certificate or Claim.
- Certificate R1-CV1-P23 is not an extension, grant or outcome of Middle Fork Certificate S-00547C.

Therefore, based on the calculations set forth in the Water Rights Self-Assessment Form, the total water available for municipal withdrawal by the City is:

- 192,730 afy.
- 62.5 annual billion gallons.
- 174.6 mgd.

The drivers of change between the current source production and the treated water supply 10- and 20-year forecasted productions are increasing demands within the City's retail service areas, population growth, waterfront redevelopment, expected new interties to the City’s water system from adjacent water systems and increasing demand on existing interties, including growth in demand on the Lummi Tribal intertie. Additionally, a new fish hatchery proposed for development and future use of the old GP pipeline are expected to contribute demand in the next 20 years, which will require approximately 19.2 mgd of untreated water from the City’s municipal supply. This estimated demand is outlined in further detail in Chapter 4 - Water Demand Forecast. The City also anticipates that the WRIA 1 adjudication may reduce or eliminate water available to junior rights holders who will then look to municipal water supply to meet their needs.

6.2.2 Treatment Capacity

The WTP’s existing infrastructure is, overall, in good condition. The WTP has six filters and the reliable treatment capacity is dependent on the filtration rate at which the plant is operated. For the purposes of the water supply strategy, filtration rates of 5 gallons per minute per square foot (gpm/sf) and 6 gpm/sf were both considered. These filtration rates correspond to effective filtration capacities of 20 mgd and 24.2 mgd, respectively. This assumes five of the six filters are being operated. The plant has a 36 mgd theoretical hydraulic design capacity that is also shown in the supply analysis.

Mouse-over any link for more information. Click on any link for more detailed instructions.

Water Right Permit, Certificate, or Claim # *If water right is interruptible, identify limitation in yellow section below	WFI Source # If a source has multiple water rights, list each water right on separate line	Existing Water Rights Qi= Instantaneous Flow Rate Allowed (GPM or CFS) Qa= Annual Volume Allowed (Acre-Feet/Year) This includes wholesale water sold				Current Source Production – Most Recent Calendar Year Qi = Max Instantaneous Flow Rate Withdrawn (GPM or CFS) Qa = Annual Volume Withdrawn (Acre-Feet/Year) This includes wholesale water sold				10-Year Forecasted Source Production (determined from WSP) This includes wholesale water sold but excludes future demand that may be prompted by the WRIA 1 adjudication.				20-Year Forecasted Source Production (determined from WSP) This includes wholesale water sold but excludes future demand that may be prompted by the WRIA 1 adjudication.			
		Primary Qi Maximum Rate Allowed	Non-Additive Qi Maximum Rate Allowed	Primary Qa Maximum Volume Allowed	Non-Additive Qa Maximum Volume Allowed	Total Qi Maximum Instantaneous Flow Rate Withdrawn	Current Excess or (Deficiency) Qi	Total Qa Maximum Annual Volume Withdrawn	Current Excess or (Deficiency) Qa	Total Qi Maximum Instantaneous Flow Rate in 10 Years	10-Year Forecasted Excess or (Deficiency) Qi	Total Qa Maximum Annual Volume in 10 Years	10-Year Forecasted Excess or (Deficiency) Qa	Total Qi Maximum Instantaneous Flow Rate in 20 Years	20-Year Forecasted Excess or (Deficiency) Qi	Total Qa Maximum Annual Volume in 20Years	20-Year Forecasted Excess or (Deficiency) Qa
1. 2008	Silver Creek	2.0 cfs (1)		Not specified (1,107 af/yr imputed)													
2. 2009	Ruby Creek	2.0 cfs(1)		Not specified (1,107 af/yr imputed)													
3. 2118	Lake Padden	Not Specified (2)		780 af/yr		0.4 cfs(9)		101 af/yr(7)		0.4 cfs	-	101 af/yr		0.4 cfs	-	101 af/yr	
4. R1-CV1-P23	Lake Whatcom	Not specified (3)			20,000 af/yr												
5. S1-*04371CWRIS	Lake Whatcom	10.0 cfs		Not Specified(4) (7,240 af/yr imputed)													
6. S-00547C	MF Nooksack	125 cfs		Not Specified(5) (90,496 af/yr imputed)													
7. 1508515(6)	MF Nooksack		125 cfs														
8. S1-146016CL	Lake Whatcom	82 mgd (127 cfs)		92,000 af/yr		20 cfs(10)		10,407 af/yr(8)		46 cfs	-	22,404 af/yr		105.8 cfs		49,287 af/yr	
	Treated					20 cfs		10,407 af/yr(8)		46 cfs		22,403 af/yr		58.3 cfs		27,780 af/yr	
	Untreated					0.4 cfs		101 af/yr		0.4 cfs		102 af/yr		47.9		21,608 af/yr	
	TOTAL	270.14 cfs		192,730 af/yr		20.4 cfs	249.7 cfs	10,508 af/yr	182,222 af/yr	46.4 cfs	223.74 cfs	22,505 af/yr	170,225 af/yr	106.2 cfs	163.9 cfs	49,388 af/yr	143,342 af/yr

Figure 6.3 Water Rights Self-Assessment Form

Notes:

(1) Certificate limits diversion to 2.0 cfs from October 1 to July 1 and 0.2 cfs from July 1 to October 1. Imputed annual acre-feet would be 1,107 acre-feet.

(2) Peak withdrawals from Lake Padden were 4.71 cfs.

(3) Peak withdrawals from Lake Whatcom for municipal potable, non-potable industrial uses and Whatcom Creek sanitary purposes have been 106 cfs.

(4) Notice of water right application for this certificate indicated the diversion would be continuous. Continuous (annual) diversion of 10 cfs would impute to 7,240 acre-feet.

(5) Water right certificate limits withdrawals based on a minimum instream flow of "…between 10 and 15 cfs. (The exact figure to be determined by study.)"

(6) This certificate is for a change in purpose to add hydropower.

(7) This is the 2023 value produced from Lake Padden.

(8) The treated existing production value is estimated based on 2022 customer consumption plus 10 percent because of a faulty production meter at the Water Treatment Plant.

(9) This is the max month 2023 value produced from Lake Padden.

(10) This value is the 2022 max day demand, which occurred July 27th.

6.3 Water Use Projections

This section summarizes the water use projections listed in Chapter 4 - Water Demand Forecast. Table 6.2 shows ADD and MDD projections for the Low, Medium, and High demand scenarios for the total distribution system (excluding demand prompted by the WRIA 1 adjudication).

Table 6.2 Water Demand Projections Summary

	Low Scenario			Medium Scenario			High Scenario		
Customer Category.	2024	2034	2044	2024	2034	2044	2024	2034	2044
ADD (mgd).	9.0	10.2	11.3	9.4	10.7	12.2	10.7	20.0	44.0
MDD (mgd).	12.5	14.1	15.7	13.9	16.3	18.9	17.0	29.9	68.3

Figure 6.4 and 6.5 present the system supply versus ADD and MDD projections, respectively. Projections from Table 6.2 are presented in both figures. According to these projections, the City's water rights are adequate to meet anticipated needs throughout the planning horizon of this Plan and through the next 100 years.

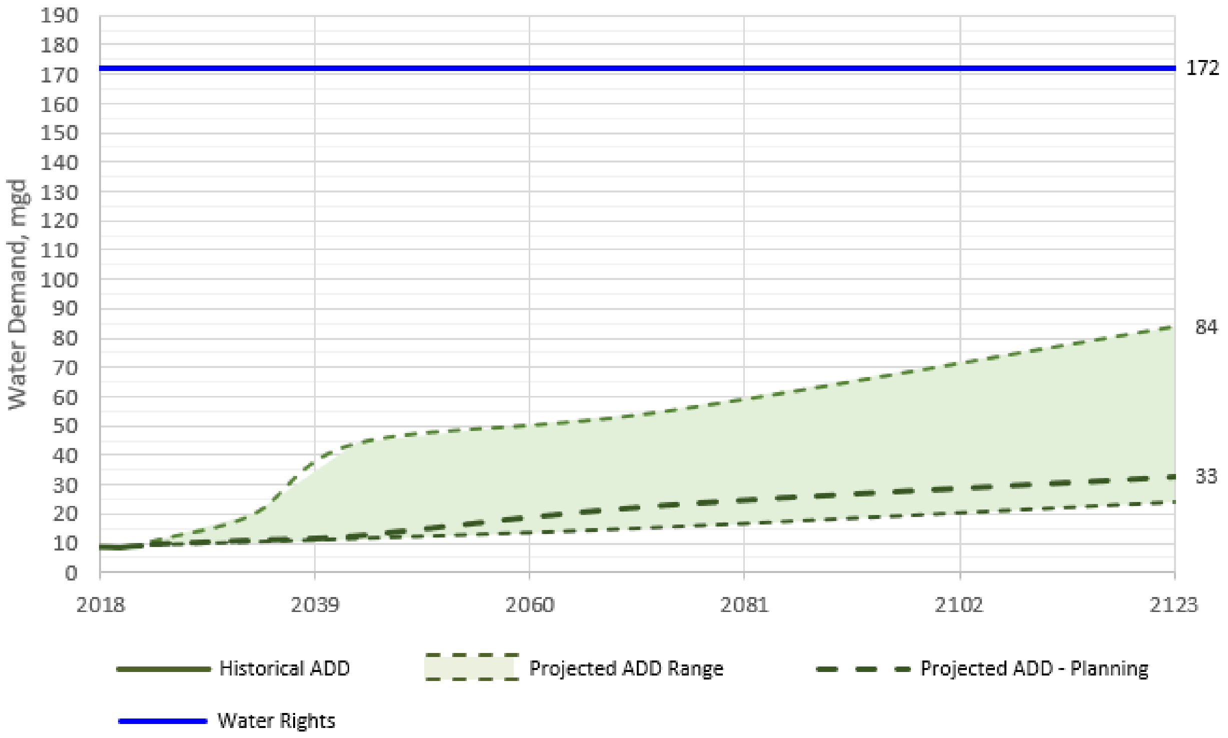


Figure 6.4 Long Range ADD Projections Versus Water Rights

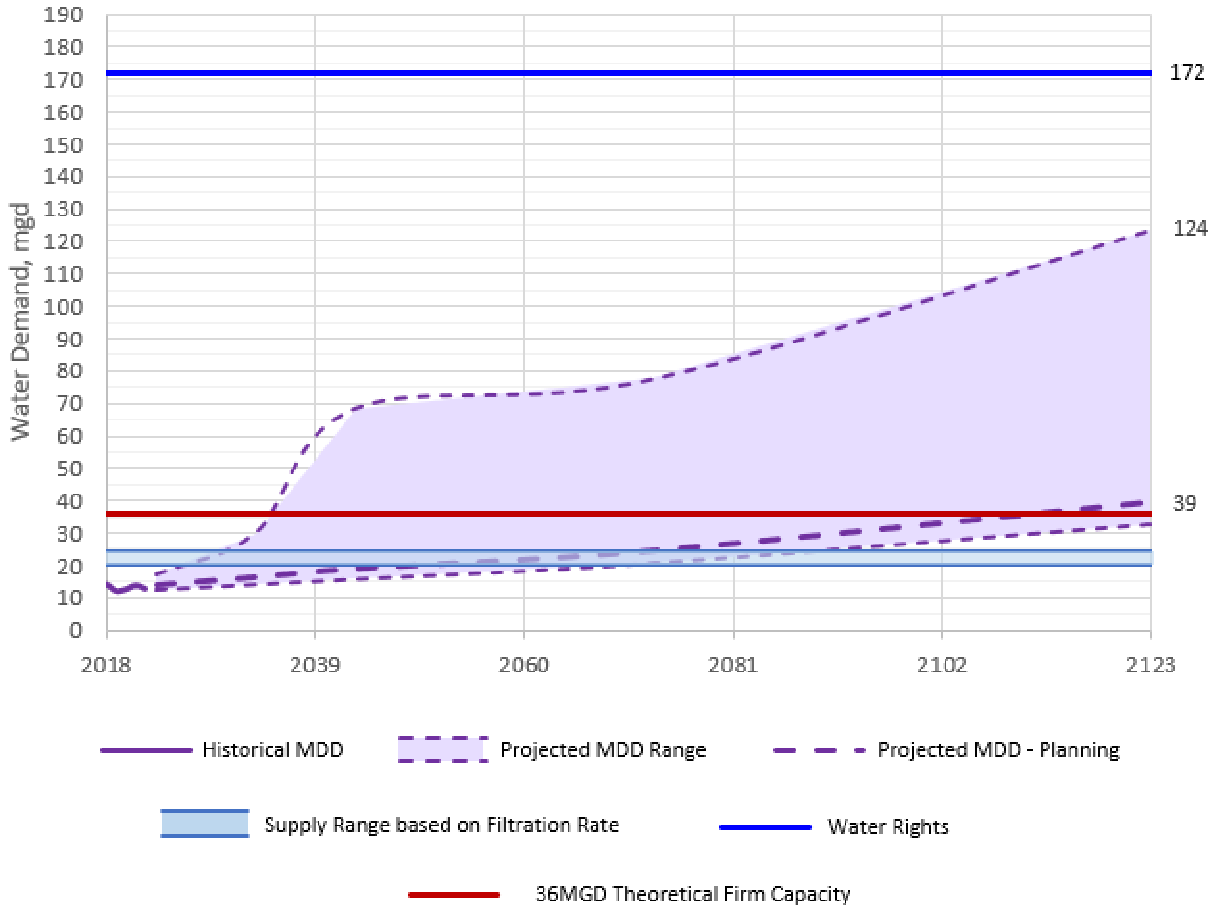


Figure 6.5 Long Range MDD Projections Versus Water Rights

6.4 Water Supply Strategy

Based on the comparison between water rights and MDD, the City has sufficient water rights to meet projected demand (excluding demand prompted by the WRIA 1 adjudication) through the next 100 years, even for the High demand scenario. The comparison between WTP supply shows there will be some need to expand the physical supply range based on current filtration rates. WTP capacity may require expansion in subsequent years, depending on the following demand scenarios:

- High Demand Scenario: MDD will reach both the current WTP supply range and theoretical capacity between the 10 and 20-year scenarios. That is to say these will be reached by 2034 and 2044 respectively.
- Medium Demand Scenario: The WTP supply range is adequate through 2044, and expansion will need to be considered in the 2050s.
- Low Demand Scenario: The WTP supply range is adequate through 2044, and expansion will need to be considered in the 2070s.

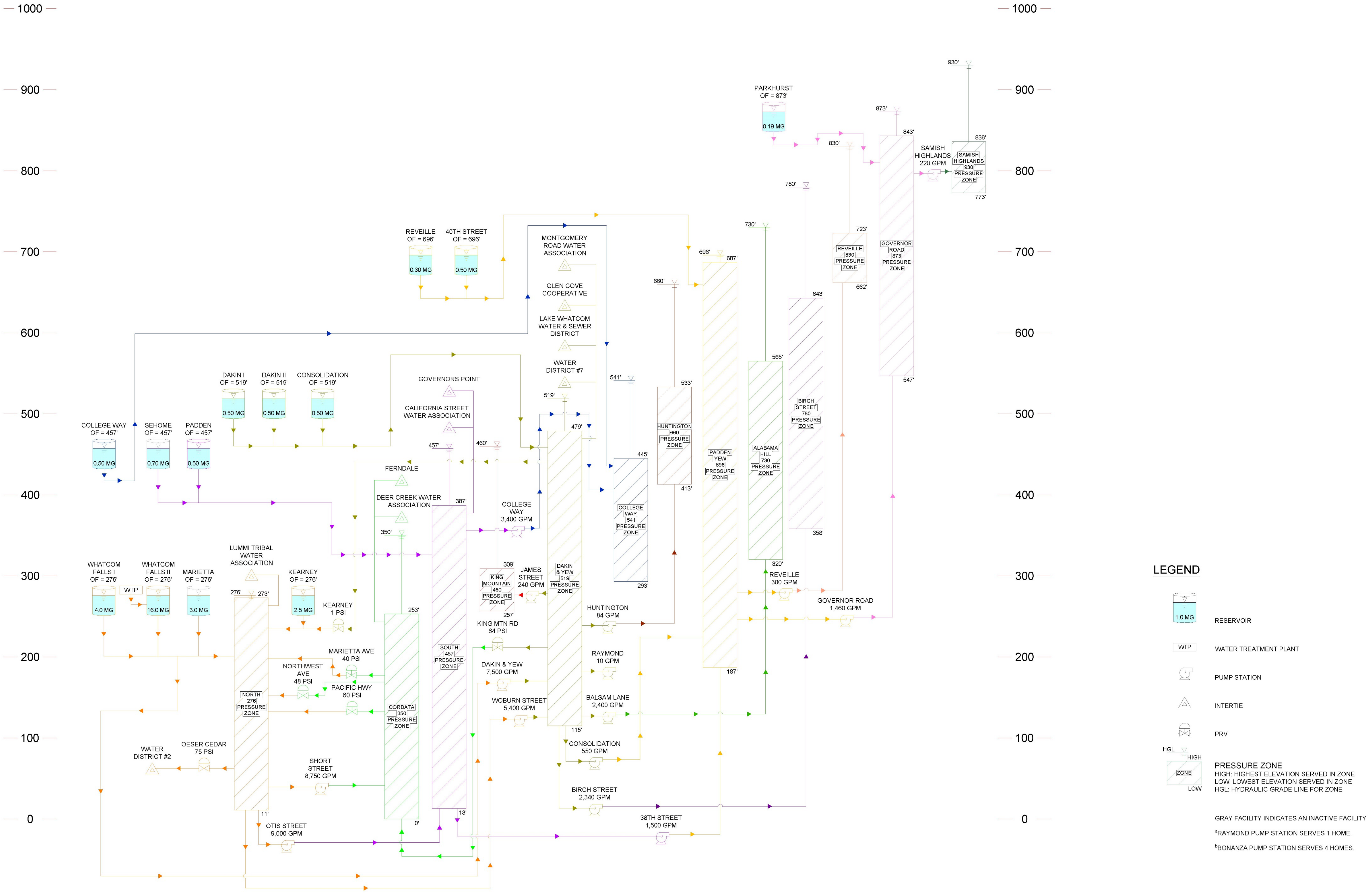
Due to the low likelihood of demands increasing at the High demand scenario for the next 10 years, no projects are recommended to increase the WTP capacity for this Plan. The water supply strategy for the City should be reconsidered during the next Plan when demands have further developed.

CHAPTER 7 DISTRIBUTION SYSTEM ANALYSIS

7.1 Introduction

This chapter summarizes potential future system deficiencies in the City’s water distribution network and offers recommended improvements to the system. Carollo evaluated the capacity of the pipeline network using the City’s updated and calibrated hydraulic model. The hydraulic model development and calibration technical memorandum created by Carollo is located in Appendix P. Desktop evaluations of the storage tanks and pump stations capacities were conducted in Microsoft Excel. The flow paths from the treatment plant through the distribution system pressure zones, pumps, storage, and to wholesale customers is shown Figure 7.1, illustrated by the hydraulic profile used for the system analysis. Improvements identified in this chapter are summarized in the CIP in Chapter 10.

The analysis presented in this Chapter is organized by first identifying issues in pumping zones via desktop analysis and then discussing pump station recommendations. Sections 7.2.1 and 7.2.2 outline the low pressure issues identified through the hydraulic model for peak hour demand (PHD) and Fire Flow conditions. Recommendations are then described to address low pressure issues under both conditions. Section 7.4 outlines the storage deficits determined through desktop analysis. A phased approach to addressing storage deficits is described subsequently, assuming all pumping and low pressure/dead storage issues have been fixed. The Chapter finishes with a summary of all distribution system recommendations that will be included in the CIP.



GRAY FACILITY INDICATES AN INACTIVE FACILITY

ªRAYMOND PUMP STATION SERVES 1 HOME.

ᵇBONANZA PUMP STATION SERVES 4 HOMES.

Figure 7.1 Hydraulic Profile

7.2 Distribution System Model Analysis

The calibrated InfoWater Pro model of the City's distribution system was used to analyze the system for future planning years, and projected system demands were added for the medium scenario for the 2034 and 2044 planning years. The hydraulic model was used to evaluate typical system conditions during diurnal operations and for fire flow availability.

Preliminary analysis showed the distribution system is sensitive to the development of water district demands. If the full contractual amount of water district demands is assumed, the Cordata Zone would experience significant low-pressure issues. The City believes receiving the full contractual amount of water district demands is unlikely and assumed intermediate demand projections for water districts in the 20-year timeframe of this Plan.

7.2.1 System Criteria

7.2.1.1 Peak Hour Flow Criteria

Chapter 5 discussed system policies and criteria in detail. Key parameters evaluated by the model included system pressure criteria during normal operations and fire flow testing of the system.

During normal operations, the minimum pressure as set by the DOH during MDD at PHD was 30 psi at the service meter. DOH velocity criteria is to keep pipeline velocities below 8 ft/sec.

The City's goal is to provide a maximum of 100 psi at the service meter and keep pipeline velocities below 8 ft/sec during peak hour flows (PHF).

7.2.1.2 Fire Flow Criteria

Fire flows are typically the largest flows a system experiences and often a major factor in pipeline sizing and network configurations. Using the InfoWater Pro fire flow test feature, the hydraulic model evaluated the fire capabilities at all hydrants in the system. Specifically, it systematically simulated a fire at each model node representing a fire hydrant for each of the planning years. All system nodes with service connections were tested for a minimum pressure of 20 psi during the point fire demands. Fire flow demands were allocated based in the land use nearest the hydrant and the following assumptions per land use class:

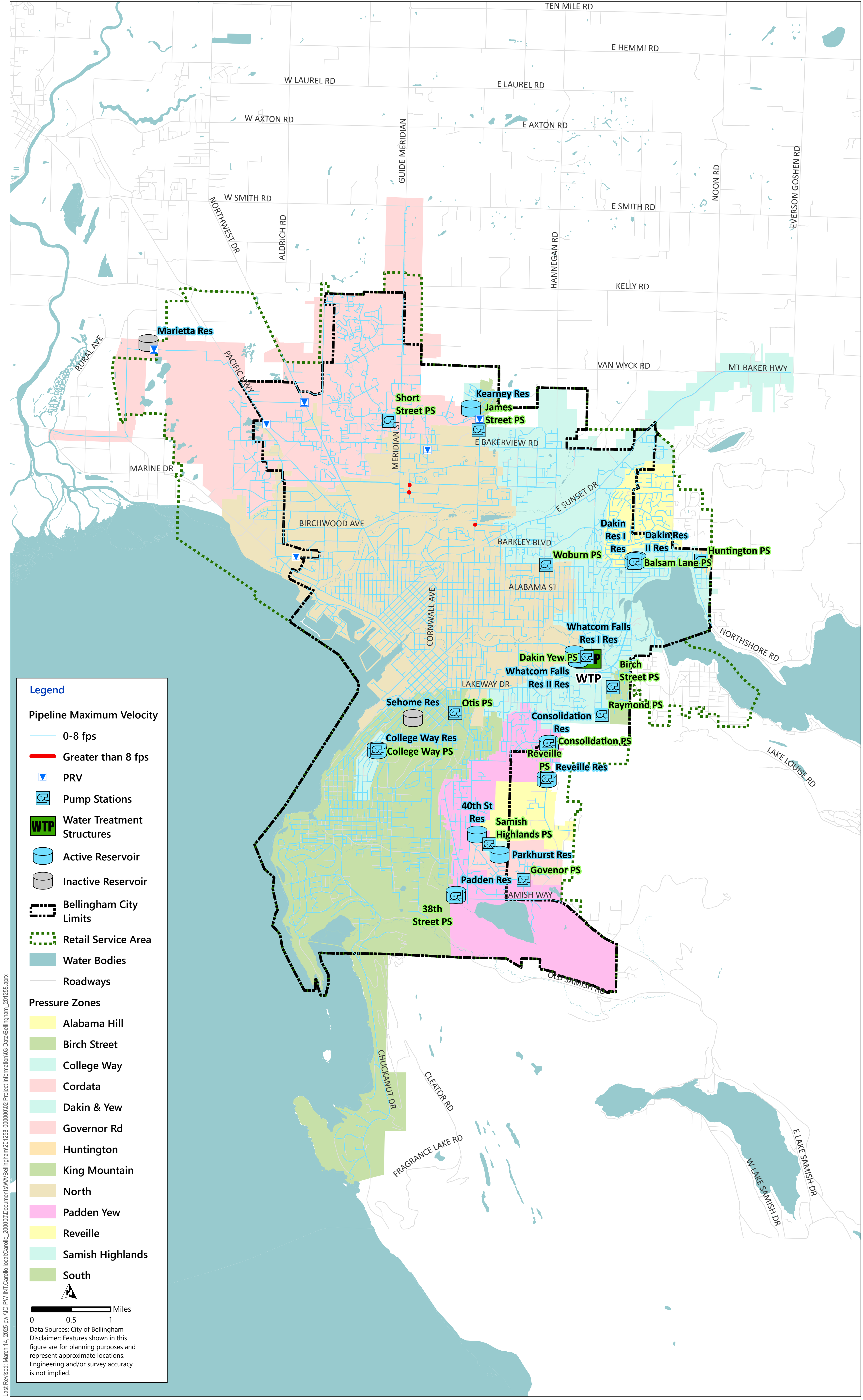
- Single-Family Residential: 750 gpm.
- Multi-Family Residential: 1,500 gpm.
- Institutional: 2,000 gpm.
- Commercial: 2,500 gpm.
- Industrial: 3,500 gpm.

7.2.2 Peak Hour Flow Evaluation

7.2.2.1 Velocity Results

The model was run in extended period simulation (EPS) for 1 week at ADD and MDD to evaluate general pressure-system conditions for the 2034 and 2044 planning years. This approach allows the sources, pumps, and tanks to operate as their SCADA and controls are set.

Max modeled velocities are shown in Figure 7.2. There are two segments of pipeline exceeding 8 ft/sec. Both are planned to be upsized as a part of fire flow improvements and risk based RUL improvements, discussed in Chapter 9.



Data Sources: City of Bellingham
Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

Figure 7.2 2044 Maximum Pipe Velocity

7.2.2.2 Pressure Results

The same model run described in Section 7.2.2.1 was run to evaluate pressure results. Using the criteria presented in the preceding section, the hydraulic model provides both maximum pressures and minimum pressures under ADD and PHD conditions, respectively.

Figures 7.3 and 7.4 show the minimum pressures for 2034 and 2044 MDDs, respectively.

As seen in Figure 7.4, many low pressures exist in the system. Some of the pressure zones cover large elevation ranges, leading to low pressures at high elevations. The City identified some locations where homes are supplied by individual booster pumps stations. No projects are recommended for such areas.

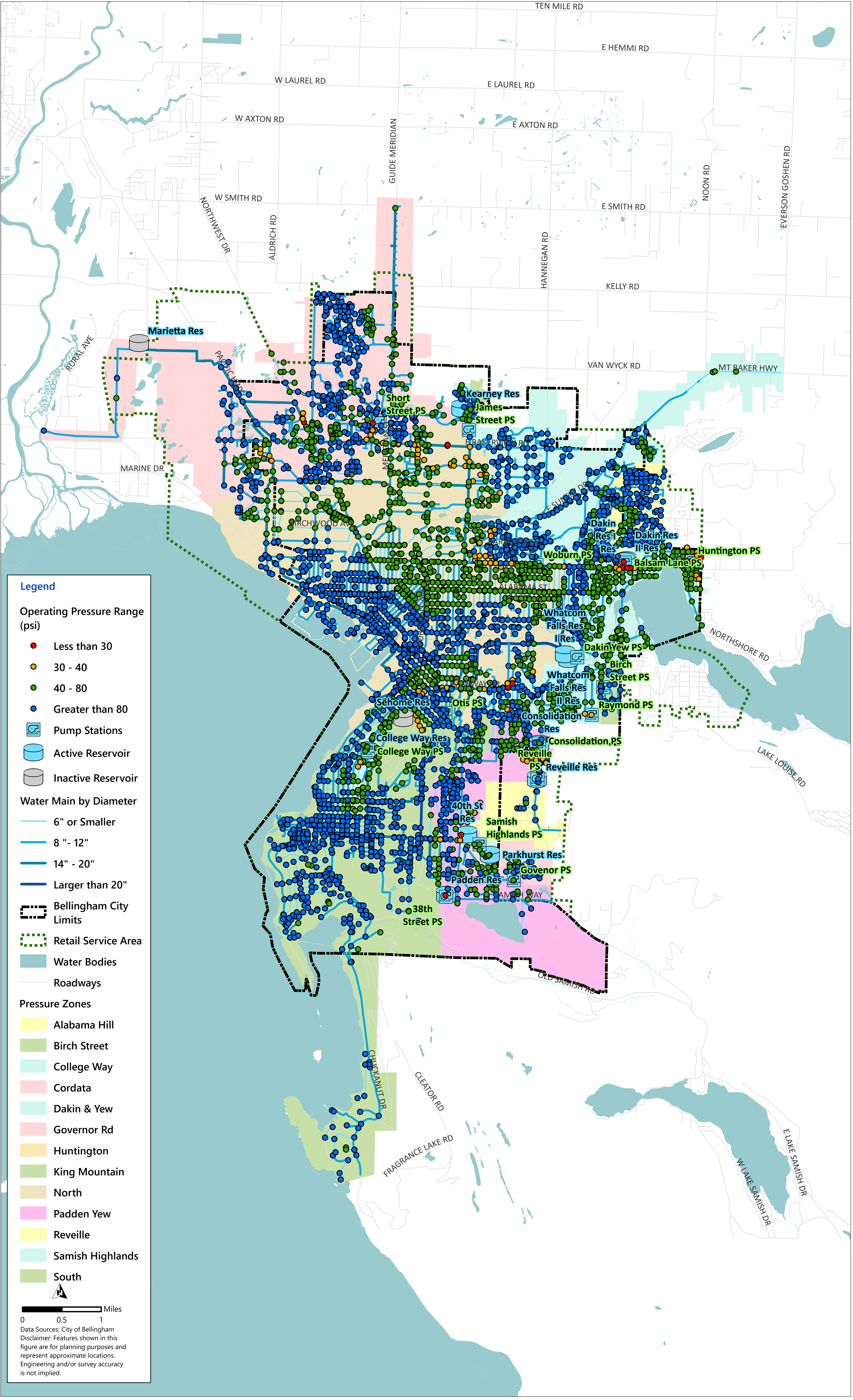
7.2.2.3 High Elevation Customer and Low Pressure Recommendations

This section offers recommendations to meet the deficiencies identified in the previous Section, 7.2.1. Improvements for high elevation customers involve modifying pressure zone boundaries. Each of the recommended improvements requires a further site-specific and project-level engineering analysis before implementation. Figure 7.5 outlines the location of all the low pressure customers under MDD conditions in 2044. The projects to fix these pressure issues are outlined and named in the figure. Each project would entail adjusting pressure zone delineation such that the low pressure customers are served by an adjacent higher zone. These projects are summarized in Table 7.1.

Table 7.1 Low Pressure Area Improvement Projects

Low Pressure Area	CIP Name	Original PZ	Revised PZ	Improvement Type
Area 1	PZ 1	North	Cordata	Pressure zone rezoning.
Area 2	PS 5	North	Cordata	Individual booster pump station.
Area 3	PZ 2	North	Cordata	Pressure zone rezoning.
Area 4	N/A(1)	King Mountain	New King Mountain 630	N/A
Area 5	PS 6	South	Alabama Hill	Individual booster pump station.
Area 6	PS 7	North	Dakin and Yew	Individual booster pump station.
Area 7	N/A(1)	South	Padden Yew	N/A
Area 8	PS 8	Padden Yew	Reveille	Individual booster pump station.

Notes:
(1) No CIP Project was recommended when pressures could not be field verified. These areas are flagged in the model and assumed to be served off a higher zone in the field.
LF - linear feet, N/A - not applicable; PS - pump station.



Data Sources: City of Bellingham
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Figure 7.3 2034 MDD - Minimum Pressures

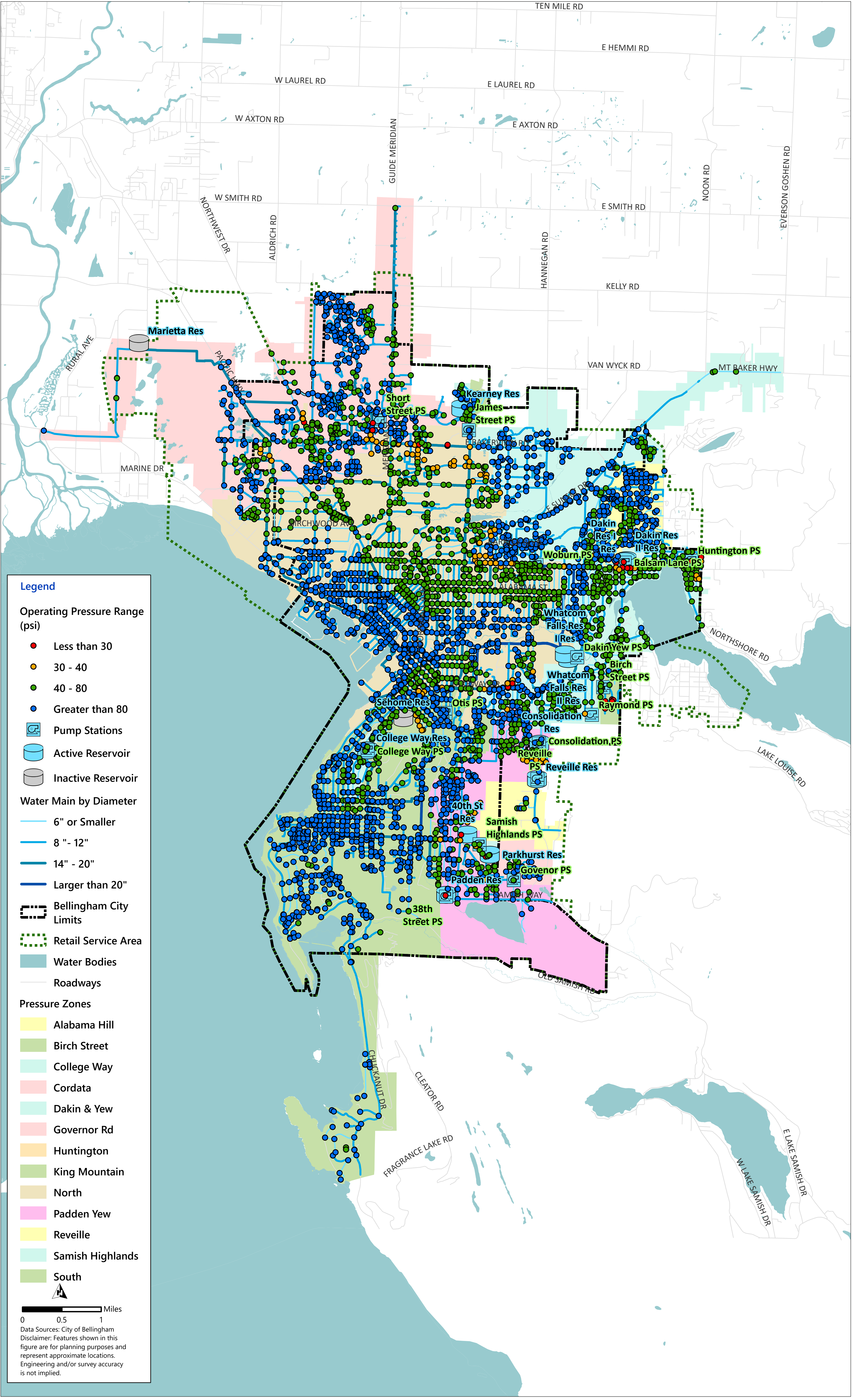

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Figure 7.4 2044 MDD - Minimum Pressures

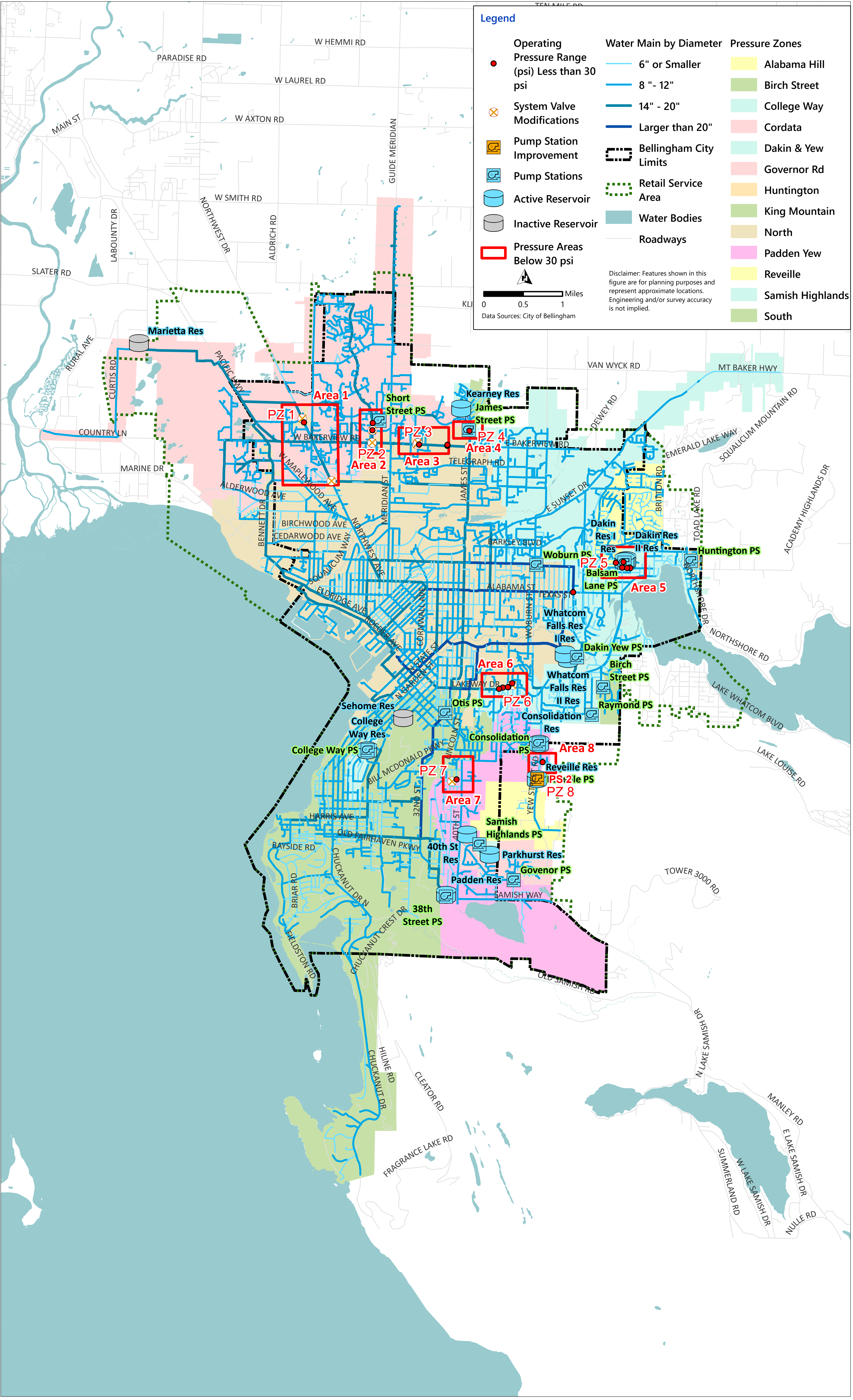

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Figure 7.5 Recommendations to Address Minimum Pressures

7.2.3 Fire Flow Evaluation

7.2.3.1 Fire Flow Results

Figure 7.6 shows the nodes that do and do not meet the criteria from the fire flow analysis in 2034 and Figure 7.7 the nodes that do and do not meet the criteria from the fire flow analysis in 2044.

7.2.3.2 Fire Flow Recommendations

This Section outlines the recommendation to address all the fire flow deficiencies predicted in the hydraulic model. Fire flow deficiencies are junctions where the pressure dropped below 20 psi when simulating a fire at their location. Fire flow recommendations are bundled into three different types of projects:

- P-1 - General program to address dead end deficiencies.
- P-2 - General program to address single-family residential dead end deficiencies.
- Individual projects to address fire flow deficiencies.

Figure 7.8 outlines both programmatic recommendations, P-1 and P-2. This figure also shows the extent and location of individual upsizing and looping projects.

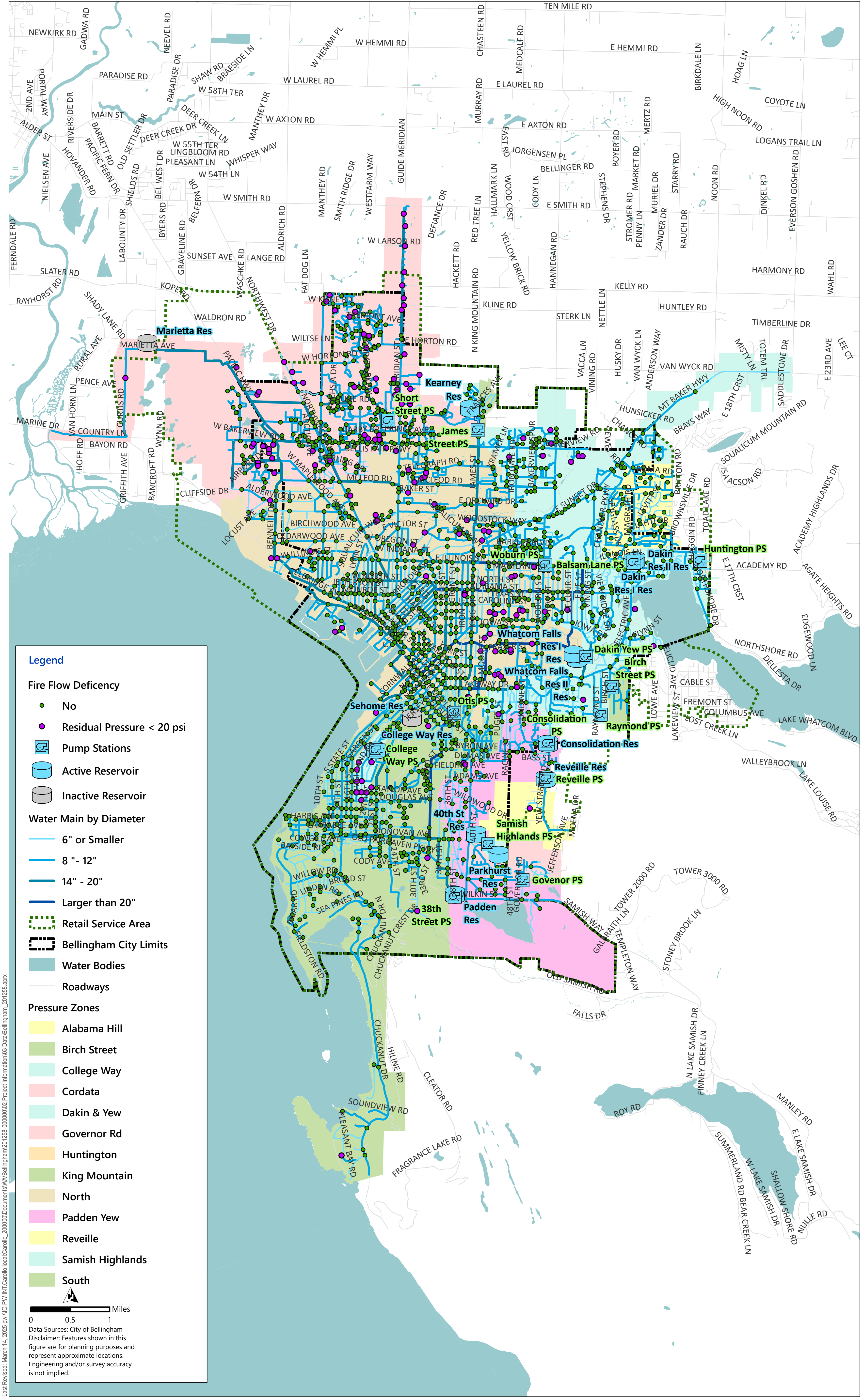

Figure 7.6 2034 MDD + FF - Fire Flow Deficiencies

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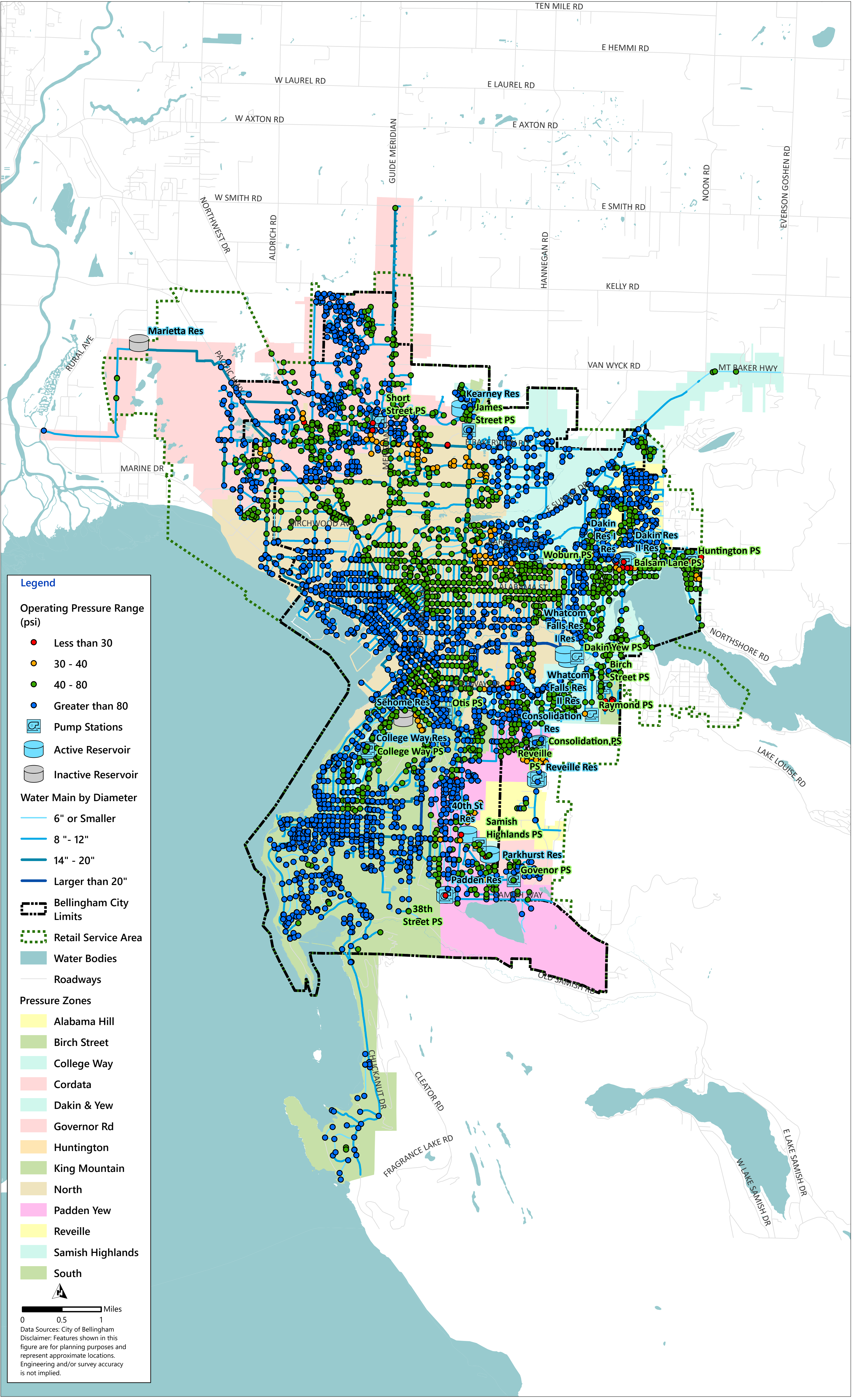

Figure 7.7 2044 MDD - Minimum Pressures

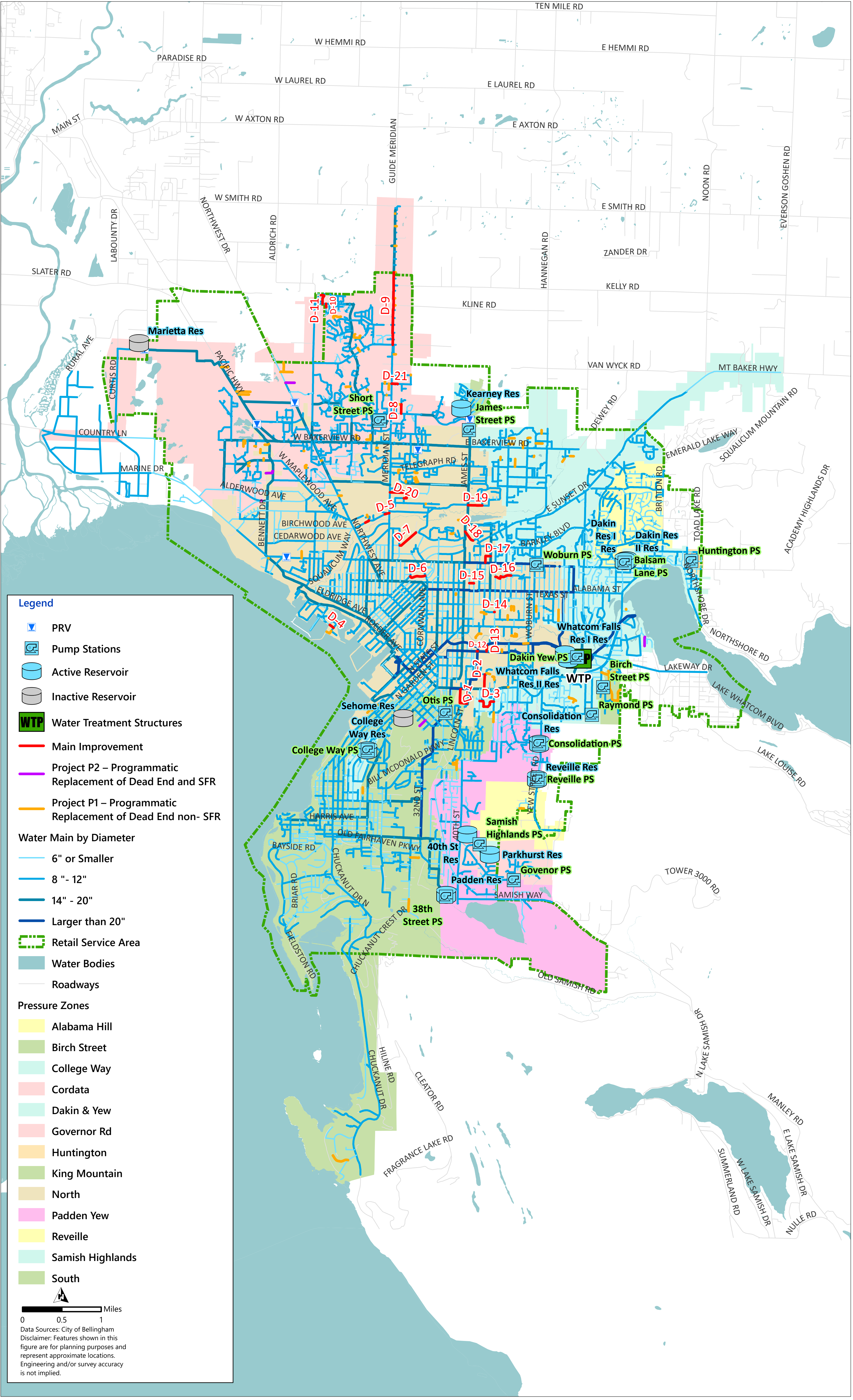

Figure 7.8 Fire Flow Recommendations

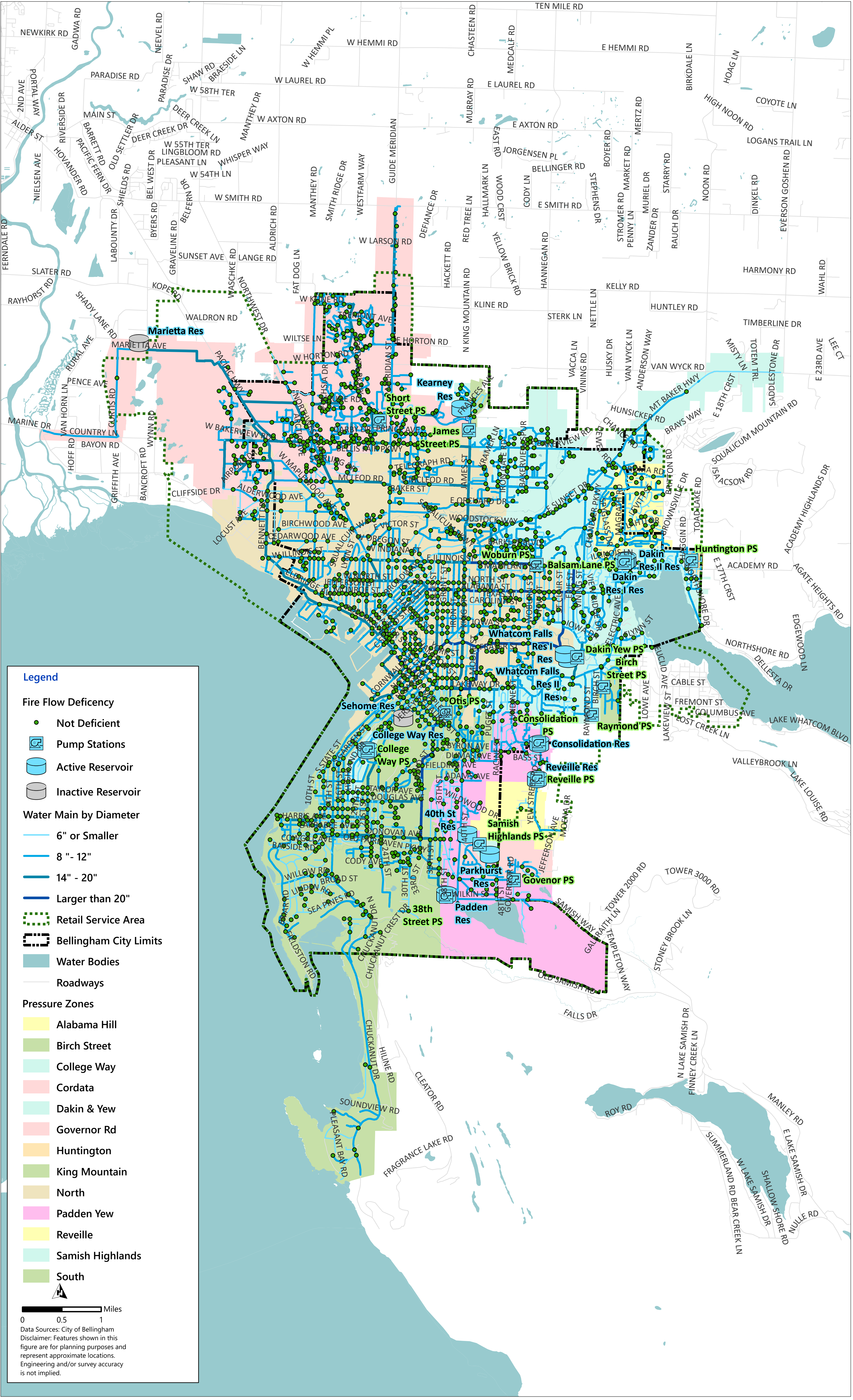

Figure 7.9 2044 MDD + FF After Recommendations

7.3 Pumping Analysis

To evaluate pump station capacities, the City's water distribution system was divided into 12 different pumping areas containing 15 total pump stations. Figure 7.10 outlines the location of the storage areas within the distribution system. Table 7.2 describes the relationship between pumping areas and pump stations. Pumping areas are defined as open or closed zones.

Open zones are ones with adequate equalizing storage, so the pump stations are only required to supply the MDD of the pumping area.

Closed zones are areas that are supplied solely through a pump station; therefore, the pump station is required to supply the PHD and fire flow.

Table 7.2 Pumping Area Summary

Pumping Area	Pump Stations Included	Open or Closed?
Dakin and Yew	Dakin and Yew and Woburn Street	Open
South	Otis Street	Open
Padden Yew	Consolidation and 38th St	Open
Governor Road	Governor Road	Open
College Way	College Way	Closed
King Mountain	James Street	Closed
Cordata	Short Street	Closed
Birch Street	Birch Street	Closed
Alabama Hill	Balsam Lane	Closed
Reveille	Reveille	Closed
Huntington	Huntington	Closed
Samish Highlands	Samish Highlands	Closed

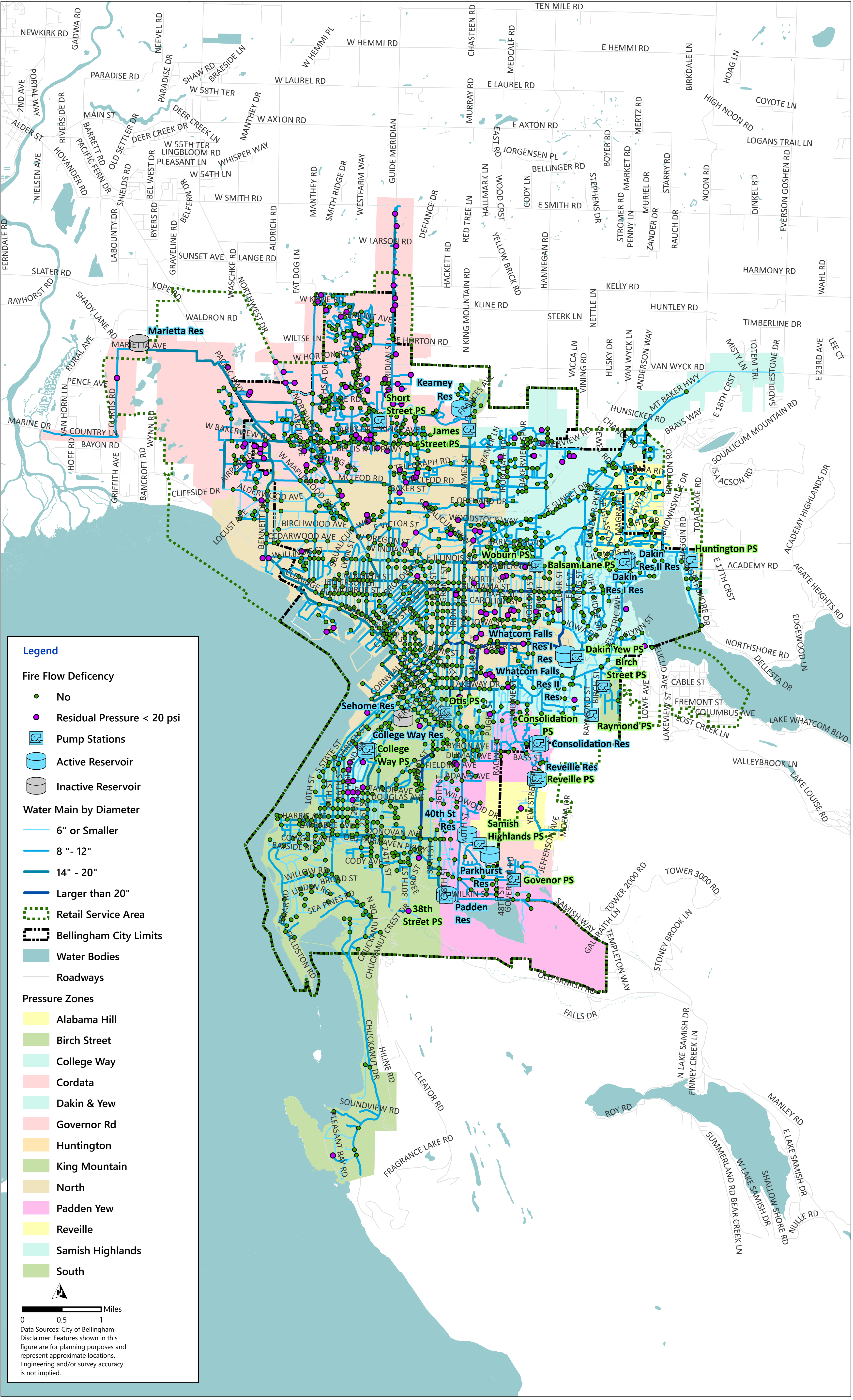

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Figure 7.10 2044 MDD + FF - Fire Flow Deficiencies

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7.3.1 Dakin and Yew Pumping Area

The Dakin and Yew pumping area is an open zone that includes two pump stations: Dakin and Yew and Woburn Street, which contain nine pumps in total. Dakin and Yew has five pumps with a capacity of 1,500 gpm each. Woburn hosts four pumps, two each have a 2,000 gpm capacity, and the other two each have 700 gpm capacities. This pumping area serves the Dakin and Yew pressure zone. Table 7.3 shows the projected demands for the 2024, 2034, and 2044 scenarios compared to the total reliable capacity, with generators, and the total reliable pumping firm capacity, with the largest pump offline. The Dakin and Yew pumping area pump stations provide adequate capacity for all planning year scenarios.

Table 7.3 Dakin and Yew Pumping Area Evaluation

Dakin and Yew 519	2024	2034	2044
Total Demand (gpm)	2,194	2,687	3,215
Total Reliable Capacity (gpm)	12,900	12,900	12,900
Total Reliable Firm Capacity (gpm)	10,900	10,900	10,900
Surplus/Deficit (gpm)	8,706	8,213	7,685

7.3.2 South Pumping Area

The South pumping area is an open zone that includes one pump station, Otis Street, which houses four pumps. Two pumps each have a capacity of 3,500 gpm and the other two have capacities of 1,000 gpm each. This pumping area serves the South pressure zone. Table 7.4 shows the projected demands for the 2024, 2034, and 2044 scenarios compared to the total reliable pumping firm capacity, with the largest pump offline. The Otis Street pump station has adequate capacity for all planning year scenarios.

Table 7.4 South Pumping Area Evaluation

South 457	2024	2034	2044
Total Demand (gpm)	2,278	2,597	2,979
Total Reliable Capacity (gpm)	9,000	9,000	9,000
Total Reliable Firm Capacity (gpm)	5,500	5,500	5,500
Surplus/Deficit (gpm)	3,222	2,903	2,521

7.3.3 Padden Yew Pumping Area

The Padden Yew pumping area is an open zone including two pump stations: Consolidation and 38th Street, which contain a total of four pumps. Consolidation has one pump with a capacity of 550 gpm while 38th Street has three pumps with capacities of 500 gpm. This pumping area serves the Padden Yew pressure zone. Table 7.5 shows the projected demands for the 2024, 2034, and 2044 scenarios compared to the total reliable pumping firm capacity, with the largest pump offline. The Padden Yew pumping area pump stations have adequate capacity for all planning year scenarios.

Table 7.5 Padden Yew Pumping Area Evaluation

Padden Yew 696	2024	2034	2044
Total Demand (gpm)	396	479	569
Total Reliable Capacity (gpm)	2,050	2,050	2,050
Total Reliable Firm Capacity (gpm)	1,500	1,500	1,500
Surplus/Deficit (gpm)	1,104	1,021	931

7.3.4 Governor Road Pumping Area

The Governor Road pumping area is an open zone that includes one pump station, Governor Road, which has three pumps. One pump has a 1,100 gpm capacity while the other two pumps have capacities of 180 gpm each. This pumping area serves the Governor Road pressure zone. Table 7.6 shows the projected demands for the 2024, 2034, and 2044 scenarios compared to the total reliable pumping firm capacity, with the largest pump offline. The Governor Road pump station has adequate capacity for all planning year scenarios.

Table 7.6 Governor Road Pumping Area Evaluation

Governor Road 873	2024	2034	2044
Total Demand (gpm)	69	76	83
Total Reliable Capacity (gpm)	1,460	1,460	1,460
Total Reliable Firm Capacity (gpm)	360	360	360
Surplus/Deficit (gpm)	291	284	277

7.3.5 College Way Pumping Area

The College Way pumping area is a closed zone that includes one pump station, College Way, which contains six pumps. The first pair of pumps have capacities of 600 gpm each, the second pair have capacities of 1,000 gpm each, and the final two each have capacities of 100 gpm. This pumping area serves the College Way pressure zone. Table 7.7 shows the projected demands for the 2024, 2034, and 2044 scenarios compared to the total reliable pumping firm capacity, with the largest pump offline. This table shows the College Way pump station has adequate capacity for all planning year scenarios.

Table 7.7 College Way Pumping Area Evaluation

College Way 541	2024	2034	2044
Total Demand (gpm)	2,083	2,094	2,094
Total Reliable Capacity (gpm)	3,400	3,400	3,400
Total Reliable Firm Capacity (gpm)	2,400	2,400	2,400
Surplus/Deficit (gpm)	317	306	306

7.3.6 King Mountain Pumping Area

The King Mountain Pumping Area is a closed zone that includes one pump station, James Street, housing two pumps. Each pump has a capacity of 120 gpm. This pumping area serves the King Mountain PZ. Table 7.8 shows the projected demands for the 2024, 2034, and 2044 scenarios compared to the total reliable pumping firm capacity, with the largest pump offline. Fire flows in this zone are supplied by Dakin and Yew Pressure Zone and are not included in the total demand for the King Mountain Pumping area. The James Street pump station has adequate capacity for all planning year scenarios.

Table 7.8 King Mountain Pumping Area Evaluation

King Mountain 530	2024	2034	2044
Total Demand (gpm)	31	62	94
Total Reliable Capacity (gpm)	240	240	240
Total Reliable Firm Capacity (gpm)	120	120	120
Surplus/Deficit (gpm)	89	58	36

7.3.7 Cordata Pumping Area

The Cordata pumping area is a closed zone that has one pump station, Short Street, containing seven pumps. Two of the pumps have a capacity of 2500 gpm each while the other five have capacities of 750 gpm each. This pumping area serves the Cordata pressure zone. Table 7.9 shows the projected demands for the 2024, 2034, and 2044 scenarios compared to the total reliable pumping firm capacity, with the largest pump offline. The Short Street pump station has inadequate capacity for the 2044 scenario. No recommendations are planned for the Short Street pump station because the City plans to retire it and only use it for backup fire flow pumping during the 20 year planning horizon when the new King Mountain improvements get implemented.

Table 7.9 Cordata Pumping Area Evaluation

Cordata 350	2024	2034	2044
Total Demand (gpm)	5,341	5,893	6,413
Total Reliable Capacity (gpm)	8,750	8,750	8,750
Total Reliable Firm Capacity (gpm)	6,250	6,250	6,250
Surplus/Deficit (gpm)	909	357	-163

7.3.8 Birch Street Pumping Area

The Birch Street pumping area is a closed zone that with a single pump station, Birch Street, which contains four pumps. One pump has a capacity of 90 gpm, two pumps have capacities of 575 gpm each, and the last pump has a capacity of 1,100 gpm. This pumping area serves the Birch Street pressure zone. Table 7.10 shows the projected demands for the 2024, 2034, and 2044 scenarios compared to the total reliable pumping firm capacity, with the largest pump offline. The Birch Street pump station has adequate capacity for all planning year scenarios.

Table 7.10 Birch Street Pumping Area Evaluation

Birch Street 780	2024	2034	2044
Total Demand (gpm)	802	823	854
Total Reliable Capacity (gpm)	2,340	2,340	2,340
Total Reliable Firm Capacity (gpm)	1,240	1,240	1,240
Surplus/Deficit (gpm)	438	417	386

7.3.9 Alabama Hill Pumping Area

The Alabama Hill pumping area is a closed zone that includes one pump station, Balsam Lane, which contains four pumps. Each pump at this station has a capacity of 600 gpm. This pumping area serves the Alabama Hill pressure zone. Table 7.11 shows the projected demands for the 2024, 2034, and 2044 scenarios compared to the total reliable pumping firm capacity, with the largest pump offline. The Balsam Lane pump station has inadequate reliable firm capacity for all planning year scenarios.

Table 7.11 Alabama Hill Pumping Area Evaluation

Alabama Hill 730	2024	2034	2044
Total Demand (gpm)	2,051	2,228	2,332
Total Reliable Capacity (gpm)	2,400	2,400	2,400
Total Reliable Firm Capacity (gpm)	1800	1800	1800
Surplus/Deficit (gpm)	-251	-428	-532

7.3.9.1 Alabama Hill Pumping Area Recommendation - Project PS-1

The Alabama Hill pumping area has an insufficient pumping capacity and fire flow capacity in each scenario. Replacing or updating two of the Balsam Lane pumps to 1,200 gpm capacity fire pumps will solve the current and future fire flow problems.

7.3.10 Reveille Pumping Area

The Reveille pumping area is a closed zone that includes one pump station, Reveille, which has two pumps. One pump has a capacity of 100 gpm, and the other pump has a 200 gpm capacity. This pumping area serves the Reveille pressure zone. Table 7.12 shows the projected demands for the 2024, 2034, and 2044 scenarios compared to the total reliable pumping firm capacity, with the largest pump offline. This table shows the Reveille Pumping Area pump station has inadequate capacity for all scenarios.

Table 7.12 Reveille Pumping Area Evaluation

Reveille 830	2024	2034	2044
Total Demand (gpm)	1,542	1,573	1,604
Total Reliable Capacity (gpm)	300	300	300
Total Reliable Firm Capacity (gpm)	100	100	100
Surplus/Deficit (gpm)	-1,442	-1,473	-1,504

7.3.10.1 Reveille Pumping Area Recommendations - Project PS-2

The Reveille pumping area has significant fire flow deficiencies in each scenario. If the area served by the Reveille pump station is annexed into the City, additional pumping capacity will be needed. Two additional 1,500 gpm capacity fire pumps should be constructed to mitigate these fire flow and pump capacity issues. As discussed in Section 7.4.2.3, the Reveille pump station will be used to fill the future Upper Yew Reservoir. At this time fire flow will be served off the tank and the additional capacity added to the station will be sufficient to fill the new tank.

7.3.11 Huntington Pumping Area

The Huntington pumping area is a closed zone with one pump station, Huntington, which contains two pumps. Each pump at this station has a capacity of 42 gpm. This pumping area serves the Huntington pressure zone. Table 7.13 shows the projected demands for the 2024, 2034, and 2044 scenarios compared to the total reliable pumping firm capacity, with the largest pump offline. This table shows the Huntington Pumping Area pump station has inadequate capacity for all scenarios.

Table 7.13 Huntington Pumping Area Evaluation

Huntington 660	2024	2034	2044
Total Demand (gpm)	760	760	760
Total Reliable Capacity (gpm)	84	84	84
Total Reliable Firm Capacity (gpm)	42	42	42
Surplus / Deficit (gpm)	-718	-718	-718

7.3.11.1 Huntington Pumping Area Recommendations - Project PS-3

The Huntington pumping area currently has inadequate fire flow in each scenario. The area served by the Huntington pump station is within City limits, additional pumping capacity is required. Two additional 700 gpm fire pumps are recommended to solve the fire flow deficiencies in the zone.

7.3.12 Samish Highlands Pumping Area

The Samish Highlands pumping area is a closed zone that includes one pump station, Samish Highlands, which contains two pumps. Each pump at this station has a capacity of 110 gpm. This pumping area serves the Samish Highland pressure zone. Table 7.14 shows the projected demands for the 2024, 2034, and 2044 scenarios compared to the total reliable pumping firm capacity, with the largest pump offline. This table shows the Samish Highlands Pumping Area pump station has inadequate capacity for all scenarios.

Table 7.14 Samish Highlands Pumping Area Evaluation

Samish Highlands 980	2024	2034	2044
Total Demand (gpm)	760	760	760
Total Reliable Capacity (gpm)	220	220	220
Total Reliable Firm Capacity (gpm)	110	110	110
Surplus / Deficit (gpm)	-650	-650	-650

7.3.12.1 Samish Highlands Area Recommendations - Project PS-4

The Samish Highlands pumping area demonstrates fire flow deficiencies in each scenario. The area served by the Samish Highlands pump station is within City limits, additional pumping capacity is necessary. The construction of two additional 550 gpm fire flow pumps would resolve these fire flow issues in the zone.

7.4 Storage Analysis

To evaluate storage capacities, the City's water distribution system was divided into five different storage areas containing 13 total pressure zones. Figure 7.11 outlines the location of the storage areas, delineated based on existing pressure zones, and the Retail Service Area, the 20 year service area boundary, within the distribution system. Table 7.15 describes the relationship between pressure zones and storage areas.

Table 7.15 Storage Area

Storage Areas	Pressure Zones
Governor Road	Governor Road and Samish Highlands
Padden Yew	Padden Yew and Reveille
Dakin and Yew	Dakin and Yew, Huntington, and Alabama Hill, Birch Street, and King Mountain
South	South and College Way
North	North and Cordata

The City's reservoir storage requirements depend on the water system's configuration, seasonal and daily variations in water-use patterns, and the reliability of various water system components. The following section describes the components of storage, summarizes the existing system's capacity to meet the storage needs of each operational area, and makes recommendations to address any identified storage deficits.

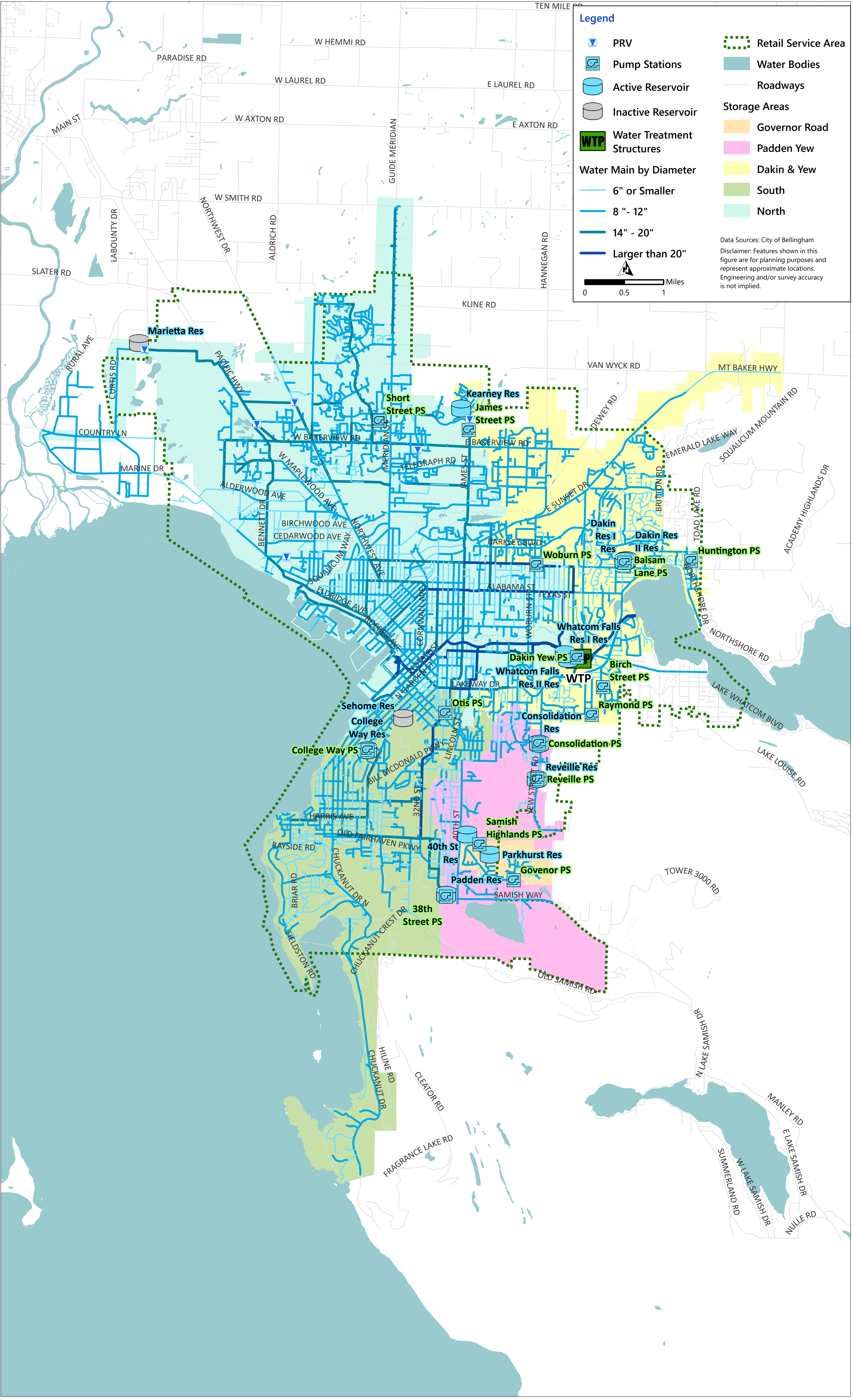

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Figure 7.11 Storage Areas

7.4.1 Components of Storage

Water storage volumes are composed of five components:

- Operational storage.
- Equalizing storage.
- Fire-suppression storage (FSS).
- Standby storage (SS).
- Dead storage.

The City combines Fire and Standby into a single band for planning, i.e. nesting. Figure 7.12 schematically shows these components.

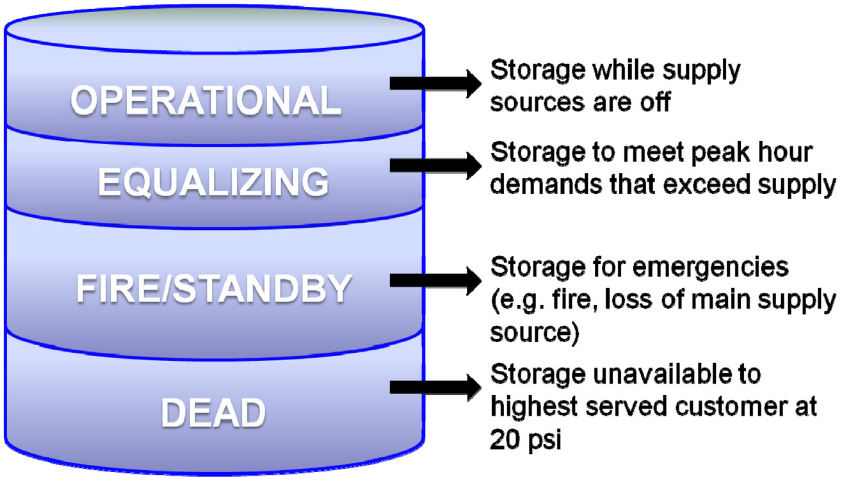

Figure 7.12 Illustration of Storage Components

7.4.1.1 Operational Storage

Operational storage is the volume of water used on a day-to-day basis to supply the water system while the sources of supply are in the "off" position. This volume is dependent on the settings of the water level sensors controlling the pumps and is designed to prevent the pump motors from excessive starts and stops (cycling).

Summarized in Table 7.16, the operational storage volume for the City's reservoirs was determined from the wintertime settings provided by the City and set up within the hydraulic model.

Table 7.16 Operational Storage Volumes

Reservoir	Storage Area	Operational Band (feet)	Total Volume (MG)	Operational Storage (MG)	Percent of Total Storage
Dakin I	Dakin and Yew	5	0.54	0.12	38%
Dakin II	Dakin and Yew	5	0.50	0.14	46%
Consolidation	Dakin and Yew	5	0.53	0.12	38%
Whatcom Falls I	North	6	4.08	1.42	44%
Whatcom Falls II	North	6	11.73(1)	4.32	34%

Reservoir	Storage Area	Operational Band (feet)	Total Volume (MG)	Operational Storage (MG)	Percent of Total Storage
Kearney	North	7	2.48	0.70	32%
Padden	South	6	0.51	0.12	44%
College Way	South	3.5	0.58	0.08	36%
Reveille	Padden Yew	4	0.35	0.06	17%
40th St	Padden Yew	6	0.57	0.13	35%
Parkhurst	Governor Road	8	0.18	0.04	23%
Total			**22.06**	**6.13**	**28%**

Note:
(1) Assumes 4.1 MG are saved for treatment plant operations.

7.4.1.2 Equalizing Storage

Equalizing storage is the total volume needed to satisfy the peak hourly demands (PHD) that exceed the supply system's capacity. The WAC 246-290-253 requires that equalizing storage be provided for peak demands.

Equalizing volume requirements were calculated for each reservoir using the following equation using the storage area demands and are summarized in Table 7.17.

$$150 \text{ min} \times (PHD - MDD)$$

PHD was calculated using the individual pressure zone peaking factors determined from the AMI data, in Chapter 4.

Table 7.17 Equalizing Storage Volumes

Storage Area	2024 Equalizing Volume (MG)	2034 Equalizing Volume (MG)	2044 Equalizing Volume (MG)
Dakin and Yew	0.14	0.17	0.20
North	0.42	0.49	0.56
South	0.14	0.16	0.18
Padden Yew	0.02	0.03	0.04
Governor Road	0.01	0.01	0.01
Total	**0.72**	**0.85**	**0.98**

7.4.1.3 Standby Storage and Fire-Suppression Storage

Standby Storage volumes are required to supply reasonable system demands during a system emergency, such as the disruption of the water supply caused by a transmission pipeline or equipment failure, power outage, valve failure, or other system interruptions (as discussed in Chapter 5). Table 7.18 shows the required standby storage capacity for each operational area.

The DOH Water System Design Manual recommends a minimum standby storage volume of no less than 200 gallons per Equivalent Residential Unit (ERU). The City decided to use a more conservative calculation of two times ADD, which is consistent with the last Plan, and approximately 1.55 times more water than the DOH minimum quantity.

Table 7.18 Standby Storage Volumes

Storage Area	2034 Standby Storage Volume (MG)	2044 Standby Storage Volume (MG)
Dakin and Yew	4.13	4.74
North	12.30	14.03
South	4.07	4.62
Padden Yew	0.78	0.94
Governor Road	0.12	0.16
Total	**21.39**	**24.47**

Fire flow demand is the quantity of water required for firefighting as defined by applicable water system criteria and fire codes. Firefighting often places the largest demands on a water system because a high volume of water must be supplied over a short time period. Such demands require each component of the system to operate at optimal condition. The following fire flow requirement assumptions were used per land use type:

- Single-Family Residential: 750 gpm (2 hours).
- Multi-Family Residential: 1,500 gpm (2 hours).
- Institutional: 2,000 gpm (2 hours).
- Commercial: 2,500 gpm (2 hours).
- Industrial: 3,500 gpm (3 hours).

Water systems must have storage reservoirs that can meet fire flow requirements while maintaining a level of 20 psi throughout the distribution system. Table 7.19 outlines the required maximum fire flow, duration, and FSS volume for each operational area.

Table 7.19 Required Maximum Fire Flow

Storage Area	Required Fire Flow (gpm)	Required Duration (hours)	Required FSS (MG)	Land Use Type
Dakin and Yew	3,500	3	0.63	Industrial
North	3,500	3	0.63	Industrial
South	2,500	2	0.30	Commercial
College Way	2,000	2	0.24	Institutional
Padden Yew	2,500	2	0.30	Commercial
Governor Road	2,500	2	0.30	Commercial

The City plans for single emergency at time per storage area. Either standby storage or fire-suppression storage, whichever volume is smaller, can be excluded from each zone's total storage requirement (this is also known as "nested" storage). Table 7.20 outlines the nested standby storage and fire-suppression storage requirements for each operational area.

Table 7.20 Nested Standby Storage and Fire-Suppression Storage

Operational Area	Volume (MG)			Controlling Factor (FSS or SS)		
	2024	2034	2044	2024	2034	2044
Dakin and Yew	3.56	4.13	4.74	SS	SS	SS
North	10.81	12.30	14.03	SS	SS	SS
South	3.60	4.06	4.62	SS	SS	SS
Padden Yew	0.63	0.78	0.94	SS	SS	SS
Governor Road	0.35	0.35	0.35	FSS	FSS	FSS

7.4.1.4 Dead Storage

Dead storage volume is the volume at the bottom of the storage tank that cannot reliably be used because it is physically too low to be withdrawn from the tank or, if withdrawn from the tank, would result in water pressures in the distribution system below the acceptable criteria of 20 psi during a fire or emergency situation. Storage volume is considered dead if it is located below the outlet pipeline and cannot be used because of system's hydraulic limitations.

Customer elevations are the major cause of dead storage. Figure 7.11 shows the highest customer elevation served by each storage area, at risk of causing dead storage.

Table 7.21 summarizes the dead volume calculations for each reservoir. Section 7.4.2 outlines the recommendations to mitigate these low pressure issues for high elevation customers.

Table 7.21 Reservoir Dead Storage(1)

Reservoir	Storage Volume (MG)	Maximum Elevation Served (feet)	Available Storage at 20 psi (MG)	Percent Available at 20 psi (%)	Available Storage at 30 psi (MG)	Percent Available at 30 psi (%)
Dakin I	0.54	463	0.24	44%	0.00	0%
Dakin II	0.50	463	0.27	54%	0.00	0%
Consolidation	0.53	463	0.24	45%	0.00	0%
Whatcom Falls I	4.08	206	4.08	22%	0.16	4%
Whatcom Falls II	15.83	206	15.83	17%	0.50	3%
Kearney	2.48	206	2.36	15%	0.01	3%
Padden	0.51	375	0.51	100%	0.26	51%
College Way	0.58	461	0.18	31%	0.06	10%
Reveille	0.35	619	0.35	100%	0.12	34%
40th St	0.57	619	0.57	100%	0.17	31%
Parkhurst	0.18	758	0.18	100%	0.18	100%

Notes:

(1) There are customers in the Padden and Yew Storage Area with higher service elevations than the one listed. These properties have their own individual pumps; therefore, they are not included in the group of customers with the highest elevations in that service area.

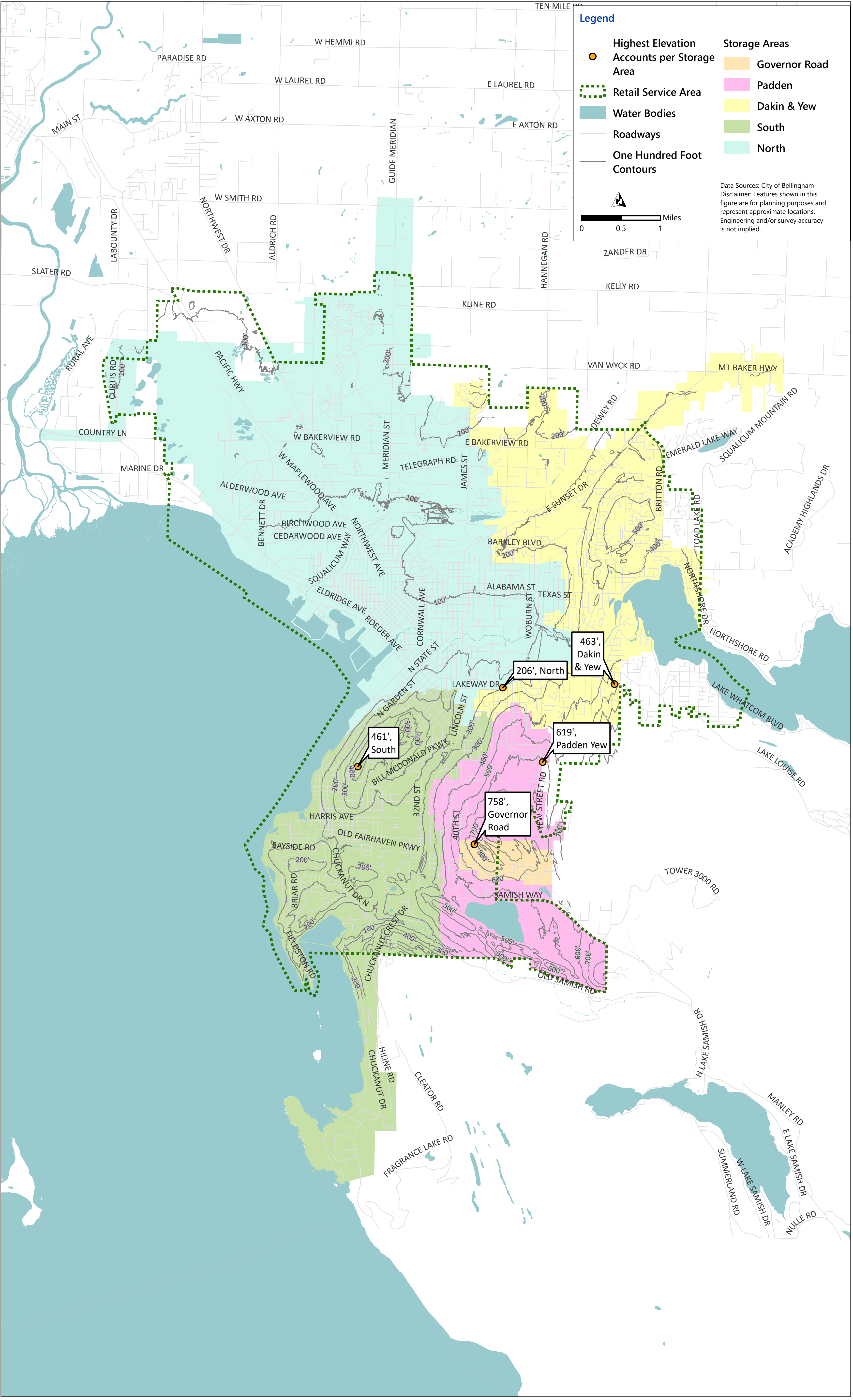

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Figure 7.13 Highest Elevation Customers within Storage Area

7.4.2 Storage Recommendations

A summary of the existing storage and storage needs in 2044 is shown in Table 7.22. This table assumes the recommended projects to address low pressures identified in Section 7.2.1 have been completed. Storage deficits were identified in the following operational areas: North, South, Dakin and Yew, Padden Yew, and Governor Road. The identified storage deficits can be mitigated by constructing additional storage space. While adjustments in operational strategy could mitigate some storage requirements, additional storage construction would still be needed to address deficits in all zones.

All recommended projects are summarized in the sections below.

Table 7.22 2044 Storage Summary

Storage Area	Total Storage Volume (MG)	Available Storage at 20 psi (MG)	Available Storage at 30 psi (MG)	Operational Storage (MG)	Equalizing Storage (MG)	Fire-Suppression Storage (MG)	Standby Storage (MG)	Required Storage (MG)	Storage Volume to Add by 2044 (MG)
Dakin and Yew	1.57	1.57	0.98	0.38	0.20	0.63	4.74	5.31	3.74
North	18.3	18.3	9.91	5.32	0.56	0.63	14.03	19.91	1.61
South	1.09	1.09	0.31	0.21	0.18	0.30	4.62	5.01	3.92
Padden Yew	0.92	0.92	0.40	0.19	0.04	0.30	0.94	1.16	0.24
Governor Road	0.18	0.18	0.18	0.04	0.01	0.30	0.16	0.35	0.17
Total	**22.06**	**22.06**	**11.78**	**6.13**	**0.98**	**2.40**	**24.48**	**31.73**	**9.68**

The City has identified the King Mountain Zone and the Upper Yew Zone as the optimal locations for new storage tanks. Shifting a significant amount of storage to the higher elevation zones in the system, will significantly adjust the City's operational strategy. With such tanks, flow will need to be pumped from the Treatment Plant up to the tanks, then piped and prv'ed back down to customers in lower zones. Due to the complexities in the hydraulics of such a shift, a future study on storage recommendations is included in the CIP. A phased approach to storage recommendations is taken for the next two sections and the CIP, so no all storage needs to be built at once. Table 7.23 outlines the storage deficits for each planning year, 2024, 2034, and 2044.

Table 7.23 Storage Deficits by Planning Year

Storage Area	Total Storage (MG)	2024 Required Storage (MG)	2034 Required Storage (MG)	2044 Required Storage (MG)
Dakin and Yew	1.57	4.07	4.68	5.31
North	18.3	16.55	18.1	19.91
South	1.09	3.95	4.43	5.01
Padden Yew	0.92	0.84	0.99	1.16
Governor Road	0.18	0.35	0.35	0.35
Total	**22.06**	**25.76**	**28.55**	**31.73**
Deficiency (MG)		**3.70**	**6.49**	**9.68**

7.4.2.1 2024 Storage Recommendations

In 2024 there is a 3.7 MG deficit across the distribution system. A general storage study is recommended to understand the operational changes that new storage facilities will cause. To address the 2024 deficits, operational changes to the operating band at Whatcom Falls are recommended. Such changes and sharing storage between the North and South zones and Padden yew and Governor Road zones will save 0.8 MG. The remaining 2.5 MG deficit is recommended to be addressed through a 2.5 MG tank in King Mountain. To fill the new tank a new lower king mountain pump station will also need to be built. To convey flow back down to Dakin and Yew and Cordata, new transmission lines with PRV stations are also recommended. A new lower King Mountain pump station is also needed to fill the new tank. All projects are lumped into project ST-01.

7.4.2.2 2034 Storage Recommendations

By 2034, the storage deficit will grow by 2.8 MG. 0.3 MG can be saved by shifting the operational band at 40th St Reservoir. The remaining 2.5 MG deficit is recommended to be addressed with a second 2.5 MG tank at King Mountain. This is also considered a part of project ST-01.

7.4.2.3 2044 Storage Recommendation

By 2044, there will be an additional deficit of 3.3 MG. Additional changes to the Whatcom Falls operational band can add 0.3 MG of storage. The remaining 3 MG deficit is recommended to be addressed through a 3.0 MG reservoir in the Governor Road Zone. To ensure resilient storage between these zones a new transmission line is required to connect from Governor Road to South and Governor Road to Padden Yew. Each transmission line will be equipped with a PRV. The transmission lines and PRVs will be described in the CIP as a part of ST-02. Reveille and 40th St pump station will be used to fill the new tank. These recommendations build off the analysis performed in the *Yew Street Upper Reservoir Project, 2007* Report.

7.5 Limiting Capacity Analysis

The limiting capacity of the City's physical water system was determined for the 2044 planning year with the assumption that all recommended improvement projects will be online. The limiting capacity analysis uses the methodology described in DOH Water System Design Manual (2009) Worksheet 6-1 and Table 6-1. Table 7.24 describes the method used to calculate capacity for each component.

Table 7.24 Limiting Capacity Calculations

Water System Component	Equation / Notes
Sources (ADD)	$N = \frac{\mathit{Reliable\ Source\ Capacity}}{\mathit{ADD\ ERU\ value}}$ here: Reliable source capacity = capacity of sources with backup power or generators.
Sources (MDD)	$N = \frac{\mathit{Firm\ Source\ Capacity}}{\mathit{MDD\ ERU\ value}}$ where: Firm source capacity = source capacity with largest source (Well 1) offline.

Water System Component	Equation / Notes
Treatment	The City has designed treatment capacity with sufficiency capacity to serve its sources.
Equalizing Storage (ES)	N = $\frac{1}{C}[\left(\frac{1440}{MDD}\right)\left(\frac{ES}{150}+Q_s-18\right)-F]$ where: MDD = MDD, gpd/ERUs. C = Coefficient associated with ranges of ERUs. F - Factor associated with ranges of ERUs. Q_s = Total source pumping capacity, gpm.
Standby Storage (SB)	N = $\frac{SB_t}{(SB_i)(t_d)}$ where: SB_t = total volume of water in standby storage component (gallons). SB_i = Design level of standby storage to meet reliability considerations per ERU (gpd/ERU). t_d = time that storage is to be used (days).
Distribution	Not considered capacity limited because the City has planned projects to address all identified deficiencies and design standards confirm all new development meets City standards.
Transmission	Assumed to be addressed as part of source and pumping capacity.

Notes:
gpd/ERU - gallons per day per equivalent residential unit.

The capacity of many water system components can be expressed as the number of ERUs that can be served. As described in Chapter 4, an ERU for the City's system is one that consumes 154 gpd on an average demand day. On a maximum day, an ERU consumes 231 gpd. These values do not include distribution system leakage.

To determine how many ERUs the City's sources can serve on a maximum demand day, the supply to each operational area was divided by the MDD ERU value of 231 gpd. The MDD ERU value was also used to calculate the capacity of the City's equalizing storage in ERUs. The ERU capacity of standby storage was calculated by subtracting out each tank's equalizing storage and operational storage under 2044 demand conditions from its total available storage capacity.

The capacity of each operational area is either limited by source supply or standby storage. None of the service areas are limited by the amount of equalizing storage available. In total, based on sources, equalizing storage, and standby storage, the City's water system has a limiting capacity of approximately 64,430 ERUs. This is shown in Table 7.25.

As presented in Chapter 3, the City predicts serving approximately 79,120 ERUs in 2044. Considering sources, equalizing storage, and standby storage, the City's water system is anticipated to have insufficient capacity to meet expected growth within the 20-year planning period due to standby storage This confirms the storage recommendations presented in Section 7.4.2.

Fire-suppression storage is not a function of ERUs and therefore is not represented in Table 7.26.

Table 7.25 Calculated Capacity in ERUs for Each Water System Component

Water System Component	System-wide ERUs
2044 ERU	79,120
Sources	104,760
Treatment	104,760
Equalizing Storage	144,630
Standby Storage(1)	64,430
Limiting Capacity	64,430

Notes:

(1) Standby Storage available was calculated by subtracting 2044 required equalizing storage and operational storage from available storage above the 20 psi hydraulic grade line.

7.6 Summary of Recommendations

The system analysis yielded a number of recommended improvements for the pump stations, storage reservoirs, piping, and pressure zones boundaries, which are summarized in Table 7.25 and Figure 7.12. These recommendations are organized into a CIP with associated costs in Chapter 10.

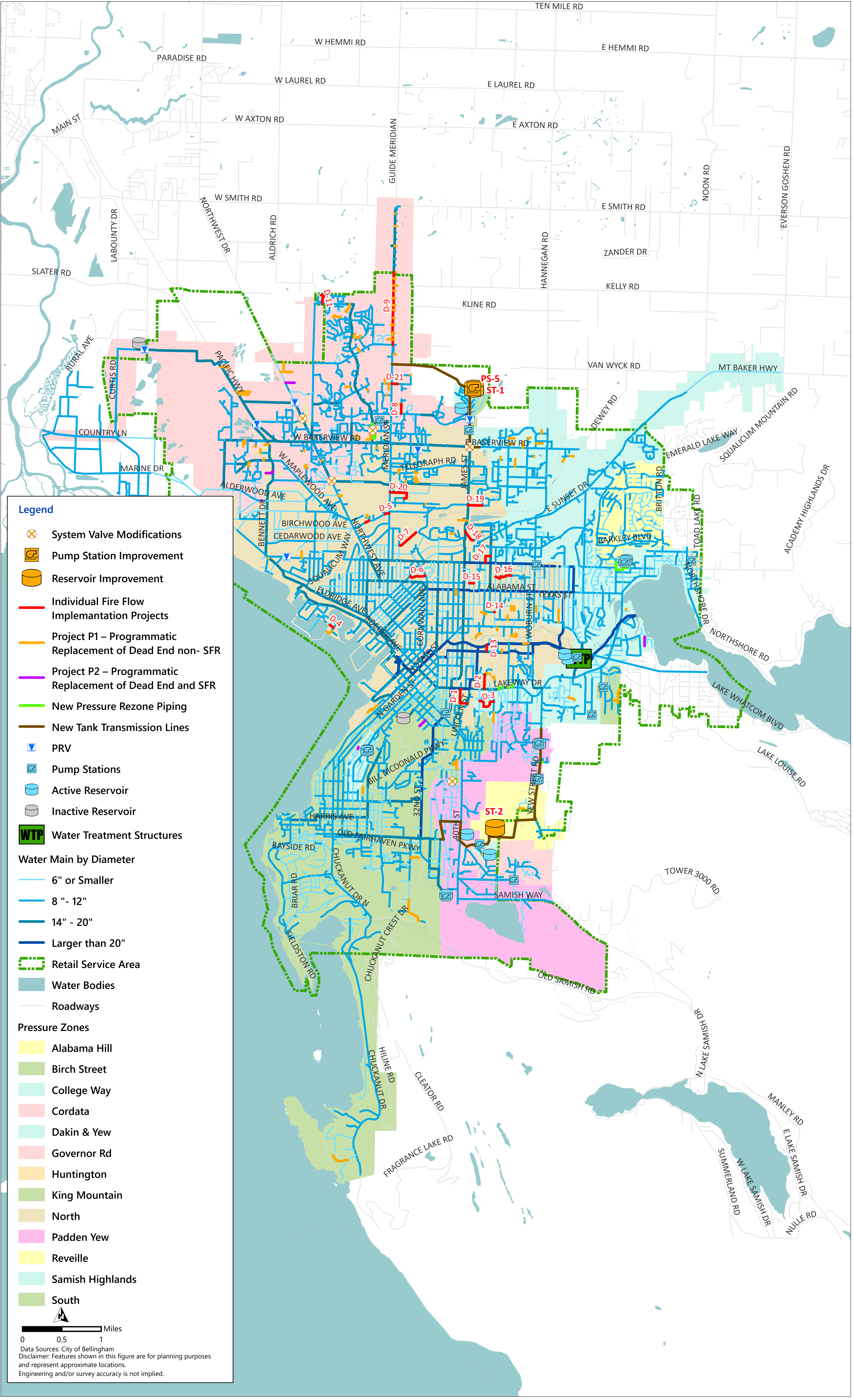


Figure 7.14 Summary of Distribution System Recommendations

Table 7.26 Summary of Recommended Improvement Projects

Project ID	Project Name	Improvement Type	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Description/Purpose
PS-1	Balsam Lane PS Improvement	Pump Station Upsize			Balsam Lane Pump Station	Replace 2 pumps with 1,200 gpm or larger pumps due to fire flow deficiency
PS-2	Reveille PS Improvement	Pump Station Upsize			Reveille Pump Station	2 additional pumps with 1,500 gpm or larger pumps due to fire flow deficiency
PS-3	Huntington PS Improvement	Pump Station Upsize			Huntington Pump Station	2 additional pumps with 700 gpm or larger pumps due to fire flow deficiency
PS-4	Samish Highlands PS Improvement	Pump Station Upsize			Samish Highlands Pump Station	2 additional pumps with 550 gpm or larger pumps due to fire flow deficiency
PS-5	Cordata Parkway Individual Booster Pump Station	Individual Booster Pump Station			Cordata Parkway	This project is an adjustment to serve customers in an area off Cordata PZ and helps address fire flow deficiencies in the area.
PS-6	Academy St Individual Booster Pump Station	Individual Booster Pump Station			Sylvan Street	This project is a booster pump station to supply customers off of South to Alabama Hill PZ near Peters Street Trail.
PS-7	Lakeway Dr Individual Booster Pump Station	Individual Booster Pump Station			Lakeway Drive	This project is a booster pump station to supply customers off of Dakin and Yew PZ along Toledo Street.
PS-8	Bass St Individual Booster Pump Station	Individual Booster Pump Station			Bass Street	This project is a booster pump station to supply customers near the intersection of Bass St and Yew Street Rd.
PZ-1	North to Cordata PZ 1	Rezone			Northwest Drive	This project involves opening an isolation valve and adding a closed isolation valve in order to incorporate an area in North PZ into the Cordata PZ.
PZ-2	North to Cordata PZ 3	Rezone			E Bakerview Road	This project rezones customers from North to Cordata to address low pressure nodes by adding three open valves along E Bakerview Rd and one closed isolation valve.
ST-1	King Mountain Reservoir	Storage				A 5 MG reservoir in the new King Mountain Zone is recommended to address the Storage deficit in the Dakin and Yew Zone and part of the deficit in the North Zone.
ST-2	Sehome/Upper Yew Reservoir	Storage				A 3.0 MG reservoir in the Governor Road Zone is recommended to address the Storage deficit in the remainder of the deficit in the North Zone, South Zone, Padden Yew Zone, and Governor Road Zone.
P-1	General SFR Dead-end Fire Flow Program	Programmatic			Systemwide	Hydrants are unable to supply 750 gpm fire flow requirement in dead end pipes. This program is to move hydrants from dead end pipes to main line pipes. The City's goal is to review 265 LF/year for 20 years.
P-2	General Non-SFR Dead-end Fire Flow Program	Programmatic			Systemwide	Hydrants are on dead ends and experience fire flow deficiencies. These areas should be reviewed when new development takes place and potentially looped or upsized. The City's goal is to review and replace 1,200 LF/year for 20 years.
D-1	Lincoln Street Upsize	Upsize	8	12	Fred Meyer Shopping Center - Lakeway parking lot streets near Lincoln Street	1,450 LF of piping is being upgraded from 8-inch to 12-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 2,500 gpm.
D-2	Orleans Street Upsize	Upsize	6	12	Orleans Street	1,000 LF of piping is being upgraded from 6-inch to 12-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 1,500 gpm.
D-3	Whatcom Street Upsize	Upsize	8	12	Whatcom Street	1,587 LF of piping is being upgraded from 8-inch to 12-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 1,500 gpm.
D-4	Squallicum Harbor Upsize	Upsize	6	8	Squallicum Harbor	322 LF of piping is being upgraded from 6-inch to 8-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 2,500 gpm.
D-5	Birchwood Ave Upsize	Upsize	6, 8	12	Birchwood Ave	590 LF of piping is being upgraded from 6-inch to 12-inch and 277 LF is being upgraded from 8-inch to 10-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 2,500 gpm.
D-6	N Park Drive Upsize	Upsize	4	8	N Park Drive	1,050 LF of piping is being upgraded from 4-inch to 8-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 1,500 gpm.
D-7	W Oregon Street Upsize	Upsize	4	8	W Oregon Street	1,400 LF of piping is being upgraded from 4-inch to 8-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 1,500 gpm.
D-8	Tull Road Upsize	Upsize	4	8	Tull Road	1,173 LF of piping is being upgraded from 4-inch to 8-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 2,500 gpm.

Project ID	Project Name	Improvement Type	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Description/Purpose
D-9	Along Guide Meridian Road Upsize	Upsize	16	20	Along Guide Meridian Road	3,651 LF of piping is being upgraded from 16-inch to 20-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 3,500 gpm.
D-10	Spring Brook Street New Pipeline	New Pipeline		8	Spring Brook Street	400 LF of 8-inch piping is being added in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 2,500 gpm.
D-11	Green Vista Way Upsize	Upsize	8	12	Green Vista Way	791 LF of piping is being upgraded from 8-inch to 12-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 2,500 gpm.
D-12	Meador Ave New Pipeline	New Pipeline		12	Meador Ave	100 LF of 12-inch piping is being added in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 3,500 gpm.
D-13	Moore Street Upsize	Upsize	6	12	Moore Street	413 LF of piping is being upgraded from 6-inch to 12-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 3,500 gpm.
D-14	Virginia Street Upsize	Upsize	4	8	Virginia Street	36 LF of piping is being upgraded from 4-inch to 8-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 3,500 gpm.
D-15	E North Street Upsize	Upsize	8	12	E North Street	309 LF of piping is being upgraded from 8-inch to 12-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 1,500 gpm.
D-16	Valhalla Street Upsize	Upsize	6	12	Valhalla Street	850 LF of piping is being upgraded from 6-inch to 12-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 1,500 gpm.
D-17	E Indiana Street Upsize	Upsize	4	12	E Indiana Street	807 LF of piping is being upgraded from 4-inch to 12-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 2,500 gpm.
D-18	Near E Sunset Drive Upsize	Upsize	8	12	Near E Sunset Drive	1,700 LF of piping is being upgraded from 8-inch to 12-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 2,500 gpm.
D-19	Orchard Drive Upsize	Upsize	8	12	Orchard Drive	959 LF of piping is being upgraded from 8-inch to 12-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 3,500 gpm.
D-20	Beal Street Upsize	Upsize	4,6, 8	12	Beal Street	1,500 LF of piping is being upgraded from 4,6, and 8-inch to 12-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 3,500 gpm.
D-21	Stuart Road Upsize	Upsize	8	12	Stuart Road	399 LF of piping is being upgraded from 8-inch to 12-inch in order to alleviate a fire flow deficiency in this area. The fire flow requirement is 3,500 gpm.

CHAPTER 8 WATER QUALITY AND WATER TREATMENT

8.1 Introduction

The City owns and operates the Whatcom Falls WTP. The Whatcom Falls WTP is located within the City in Whatcom Falls Park.

The Whatcom Falls WTP was originally constructed in the 1968 as a direct filtration plant. Lake Whatcom supplies raw water to the Whatcom Falls WTP through the raw water infrastructure, which includes a raw water pipeline in the lake, a gate house, a 7,600 foot tunnel, and a screen house to remove debris before water is conveyed to the Whatcom Falls WTP. The City can also operate a separate diversion system, originally constructed in 1961, that can divert flows from the Middle Fork of the Nooksack River to Lake Whatcom.

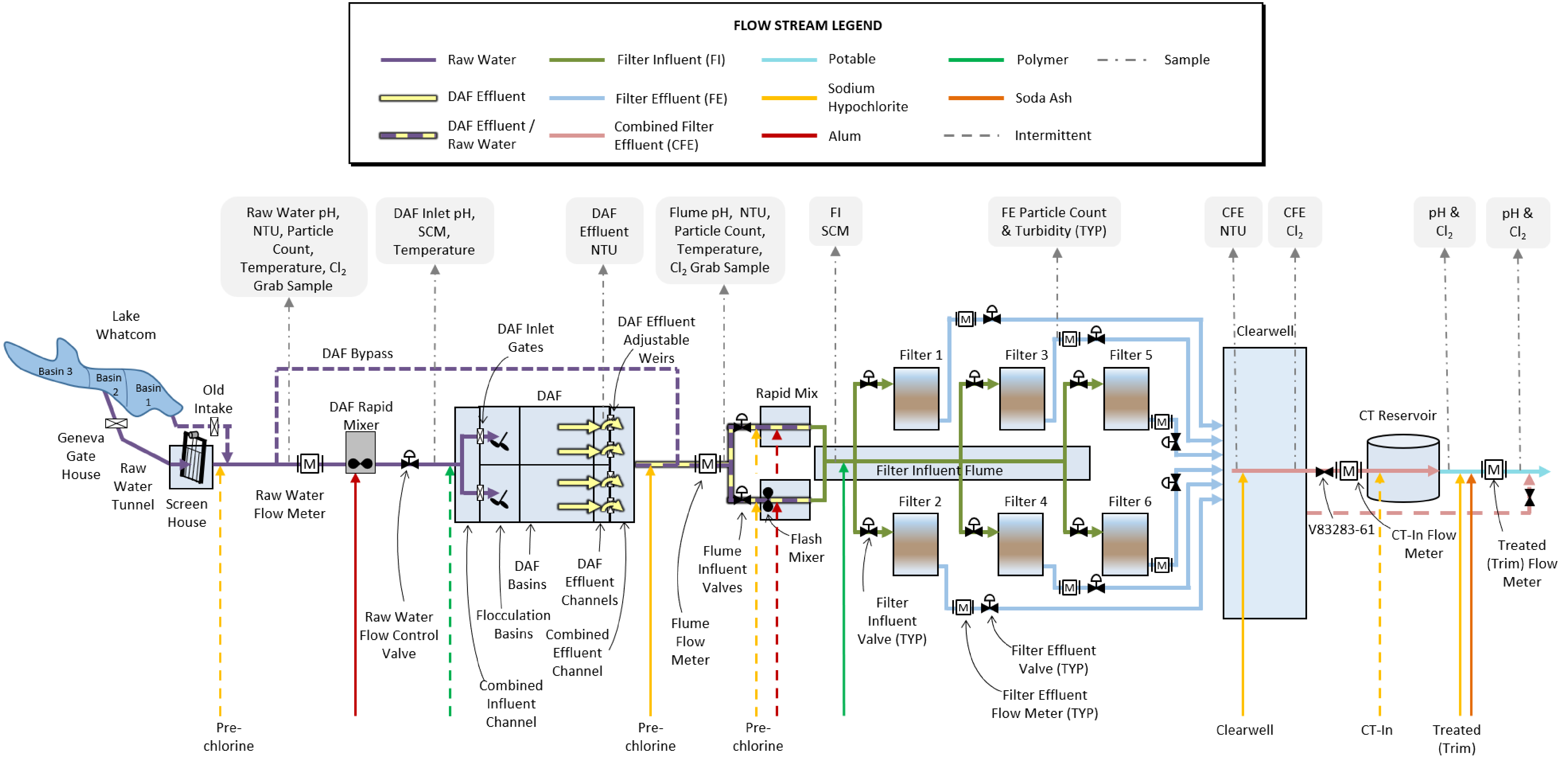
Multiple projects have been completed at the plant since original construction:

- **1981**: Construction of a separate industrial pipeline from the screen house to the waterfront for industrial and irrigation purposes that can be used as a back-up water supply to the raw water main.
- **1994**: Construction of a separate Dakin-Yew pump station on the Whatcom Falls WTP site. Construction of Whatcom Falls Reservoir No. 2 (CT Reservoir), associated pipelines, and new chemical feed piping. Construction of soda ash silos and system.
- **2011**: Construction of filter upgrades to add air scour system for filter backwash.
- **2018**: Construction of DAF to address filter-clogging algae issues. Replacement of chlorine gas disinfection system with on-site hypochlorite generation system.

Major Whatcom Falls WTP plant components/processes are as follows:

- Raw water collected from the intake in Lake Whatcom.
- Raw water conveyed to the Whatcom Falls WTP via the gate house and screen house by gravity.
- Pretreatment provided by DAF.
- Filtration using a dual-media configuration (anthracite and sand).
- CT reservoir for disinfection and distribution system hydraulic grade line control.

Figure 8.1 shows a process diagram for the Whatcom Falls WTP.



Source: Whatcom Falls WTP Electronic Operations and Maintenance Manual

Figure 8.1 Whatcom Falls WTP Process Diagram

8.2 Source Water Protection

The Water Source Protection Plan (WSPP), developed by the City and Whatcom Water District No. 10, outlines strategies to protect the shared water quality of Lake Whatcom:

- The first section, Watershed Description and Characteristics, describes the watershed's geographical boundaries and characteristics.
- In Section 2: Identification of Activities/Land Use Detrimental to Water Quality, the plan identifies specific land uses and activities within the watershed that could pose risks to water quality. These include industrial and urban development, and transportation-related impacts.
- Section 3: Watershed Management and Control Measures provides an outline of various management and control actions intended to protect the watershed. This section discusses preventive measures to limit contamination, remediation efforts for affected areas, and the importance of engaging stakeholders in protection efforts.
- In Section 4: Monitoring Programs, the WSPP describes its framework for ongoing water quality monitoring within the watershed. It includes details on testing protocols and early detection systems to identify potential contamination.
- The final section, System Operations, describes standards and procedures for managing watershed operations to maintain water quality. It includes guidelines for operational standards and emergency response protocols to address any incidents or disruptions affecting water quality.

The overarching effort to protect Lake Whatcom advances from the Lake Whatcom Management Program (LWMP). The LWMP had its beginnings in the 1980s and early 1990s, when the cumulative deterioration of Lake Whatcom's water quality from historic and ongoing land use in the watershed was documented and brought to the attention of agencies and the community. In response, a joint resolution was passed by the City of Bellingham, Whatcom County, and the Lake Whatcom Water and Sewer District in 1992 to organize efforts to address the most serious threats to the watershed. This comprehensive approach to managing the lake became the basis of the LWMP, which was established by Interlocal Agreement in 1998.

These multiple jurisdictions, made up of a variety of staff and elected officials, work together and each play a role in helping protect Lake Whatcom. The legislative bodies of each of the three jurisdictions provide policy guidance and direction for the LWMP. Every five years, LWMP staff create a coordinated Work Plan that provides a broad overview of the upcoming work between the three jurisdictions, which elected officials review and approve. Staff then document the work completed in the watershed each year through annual progress reports that include a summary of reporting metrics.

8.3 Water Quality Regulatory Requirements

This section summarizes the regulatory requirements applicable to the City's Whatcom Falls WTP, and the sampling and monitoring schedules required by the DOH to demonstrate compliance with applicable water quality regulations.

8.3.1 Regulatory Requirements

The Whatcom Falls WTP's finished water must comply with all applicable current federal and state drinking water regulations:

- National Primary Drinking Water Regulations (1975).
- National Secondary Drinking Water Regulations (1979, 1991).
- Phase I, II, and V Regulations for Inorganic Contaminants, Synthetic Organic Contaminants, and Volatile Organic Contaminants (1987, 1991, and 1992, respectively).
- Surface Water Treatment Rule (1989).
- Interim Enhanced Surface Water Treatment Rule (1999).
- Revised Total Coliform Rule (2013).
- Lead and Copper Rule (1991).
- Lead and Copper Rule Revisions (2021).
- Lead and Copper Rule Improvements (2024).
- Consumer Confidence Reports Rule (1998).
- Stage 1 Disinfectants and Disinfection Byproduct Rule (Stage 1 DBPR) (1998).
- Stage 2 Disinfectants and Disinfection Byproduct Rule (Stage 2 DBPR) (2006).
- Unregulated Contaminant Monitoring Rule 1 (1999), 2 (2007), 3 (2012), 4 (2016), and 5 (2021).
- Long-Term Stage 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) (2006).
- Radionuclides Rule (2000).
- Arsenic Rule (2001).
- Filter Backwash Recycle Rule (2001).
- PFAS National Primary Drinking Water Regulation (2024).
- WAC 246-290.

The DOH has adopted the federal drinking water regulations under WAC 246-290, and the DOH's Office of Drinking Water enforces all water quality monitoring and reporting requirements.

8.3.2 Water Quality Sampling

This section summarizes the City's water quality sampling for raw water from Lake Whatcom, for finished water leaving the Whatcom Falls WTP, and for water in the distribution system. Table 8.1 summarizes the current raw water quality sampling schedule, Table 8.2 summarizes the current finished water quality sampling schedule, and Table 8.3 summarizes the current distribution system sampling schedule. For each parameter or contaminant, the current regulatory required sampling frequency is shown alongside the City's current sampling frequency.

As shown below, the City generally conducts sampling and monitoring at greater frequency than required by existing regulations. Table 8.3 also demonstrates that the City proactively monitors distribution system water quality parameters beyond those required for regulatory compliance.

The City's water quality sampling plans and procedures are included in their entirety in Appendix Q.

Table 8.1 Raw Water Quality Sampling Schedule

Parameter / Contaminant	Regulatory Required Sampling Interval/ Frequency(1)	Routine Sampling Interval / Frequency	Notes
TOC	Quarterly	Quarterly	
Alkalinity	Quarterly	Weekly	
Turbidity	-	Continuous	
pH	-	Continuous	
Fecal coliform	Monthly(2)	12 samples per month	

Notes:
(1) Regulatory sampling schedule taken from "Water Quality Monitoring Schedule" from DOH's Sentry Internet Database as of October 2024.
(2) WAC 246-290-664 requires source coliform monitoring at a frequency equal to ten percent of the number of routine coliform samples collected within the distribution system each month, or once per calendar month, with a maximum of one sample per day.
TOC - total organic carbon.

Table 8.2 Finished Water Quality Sampling Schedule

Parameter/ Contaminant	Regulatory Required Sampling Interval/ Frequency(1)	Routine Sampling Interval/ Frequency	Notes
TOC	Quarterly	Quarterly	
Alkalinity	None	Weekly	Minimum alkalinity required at EPDS and tap samples of 18 mg/L as $CaCO_3$(3).
IOCs	Every 9 years.(4)	Annually	
VOCs	Every 6 years.(4)	Annually	
SOCs	Every 9 years.(4)	Annually	
PFAS	Every 3 years.(2)	Every 3 years.(2)	
Radionuclides	Every 6 years.(4)	Every 6 years.	
Turbidity	Every 4 hours (combined filter effluent). Continuous (individual filters).	Continuous monitoring provided at plant.	
pH	Daily	Continuous monitoring provided at plant.	Daily measurement must be taken at end of disinfection sequences. Minimum pH required at EPDS of 7.5(3).
Temperature	Daily	Continuous monitoring provided at plant.	Daily measurement must be taken at end of disinfection sequences.
Chlorine Residual	Continuous	Continuous monitoring provided at plant.	Daily measurement must be taken at end of disinfection sequences.

Notes:
(1) Regulatory sampling schedule taken from "Water Quality Monitoring Schedule" from DOH's Sentry Internet Database as of October 2024.
(2) Anticipated monitoring frequency based on lack of detections to-date in finished water.
(3) Department of Health, Lead and Copper Monitoring and Optimal Parameters, Submittal 99-1225 (12/05/2003).
(4) Sampling interval established by state waiver.
EPDS - entry point to distribution system; IOC - inorganic contaminants; PFAS - per- and polyfluoroalkyl substances; SOC - synthetic organic contaminants; VOC - volatile organic contaminant.

Table 8.3 Distribution System Water Quality Sampling Schedule

Parameter/Contaminant	Regulatory Required Sampling Interval/ Frequency⁽¹⁾	Routine Sampling Interval/ Frequency	Notes
Total Coliform/E. coli	Monthly	Monthly	- 120 routine samples per month. - If positive, follow-up testing required within 24 hours.
Lead and Copper	Every 3 years.	Every 3 years.	- 30 tap samples. - Testing must be between June 1 and September 30.
Asbestos	Every 9 years.	Every 9 years.	- Sampling is only required in areas of distribution system with asbestos concrete pipeline.
TTHMs	Quarterly	Quarterly	- Sampling from eight locations within the distribution system.
HAA5	Quarterly	Quarterly	- Sampling from eight locations within the distribution system.
Free Chlorine Residual	Monthly	Monthly	- Sampling conducted daily at sites including at all total coliform monitoring locations.
Additional Parameters: - Dissolved oxygen - Turbidity - pH - Alkalinity - Iron - Conductivity - Heterotrophic plate count - Temperature	-	Monthly	- Sampled and measured monthly at 24 locations in the distribution system. - Minimum pH in tap samples of 7.0⁽²⁾.

Notes:
(1) Regulatory sampling schedule taken from “Water Quality Monitoring Schedule” from DOH’s Sentry Internet Database as of October 2024.
(2) Department of Health, Lead and Copper Monitoring and Optimal Parameters, Submittal 99-1225 (12/05/2003).
HAA5 - haloacetic acids; TTHMs - total trihalomethanes.

8.4 Water Quality

This section summarizes select water quality monitoring data reviewed as part of this planning effort. Full sampling results for all water quality data analyzed are included in Appendix S.

8.4.1 General Parameters

Table 8.4 summarizes general raw water quality parameters for raw water entering the Whatcom Falls WTP from Lake Whatcom. For each parameter or contaminant, the current finished water maximum contaminant level (MCL) or secondary MCL/standard is included to illustrate where removal or treatment is required. Where secondary MCLs are shown, these are non-enforceable guidelines set for contaminants that may affect the finished water aesthetics. Where secondary standards are shown, exceedance of a secondary standard requires notifying DOH, with follow-up actions to be taken as directed by DOH.

Table 8.4 Summary of General Raw Water Quality Parameters

Parameter	Unit	Finished Water MCL or Regulated Limit(6)	Range (5th - 95th Percentile)(1)	Average/Median(1)
pH		7.5 (EPDS) / 7.0 (tap samples)(7)	7.15 – 7.54	7.33
Turbidity	NTU	≤0.3 for 95% of samples. <1.0 at all times.	0.26 - 0.87	0.4
TOC(2)	mg/L	-	1.7 - 3.7(3)	2.1
DOC(4)	mg/L	-	1.1 - 3.3(3)	1.9
Alkalinity(5)	mg/L as $CaCO_3$	18(7)	19.8 – 22.4(3)	21.0

Notes:
(1) From daily operating data January 2018 to July 2023.
(2) From quarterly testing between January 2013 and May 2023.
(3) Value range is minimum to maximum.
(4) From near monthly sampling conducted between 1999 and 2007.
(5) From weekly testing between January 2018 and July 2023.
(6) Finished water MCL or finished water regulated limit shown to illustrate where removal or treatment may be required.
(7) Department of Health, Lead and Copper Monitoring and Optimal Parameters, Submittal 99-1225 (12/05/2003).
$CaCO_3$ - calcium carbonate; DOC - dissolved organic carbon; mg/L - milligrams per liter; NTU - nephelometric turbidity units.

The average raw water turbidity entering the Whatcom Falls WTP was 0.4 NTU, and below 0.9 NTU 95 percent of the time during the data review period. Figure 8.2 shows the monthly average turbidity with error bars providing the 5th and 95th percentile. Higher turbidity values above 1.0 for the 95th percentile are present in the late fall and winter, November through January. These time periods correspond with the Pacific Northwest's rainy winters and are likely driven by increased precipitation and watershed flushing. Even so, turbidities are consistently very low entering the plant. Lake Whatcom effectively serves as a large pre-sedimentation basin upstream of the Whatcom Falls WTP, lessening the turbidity fluctuations experienced there.

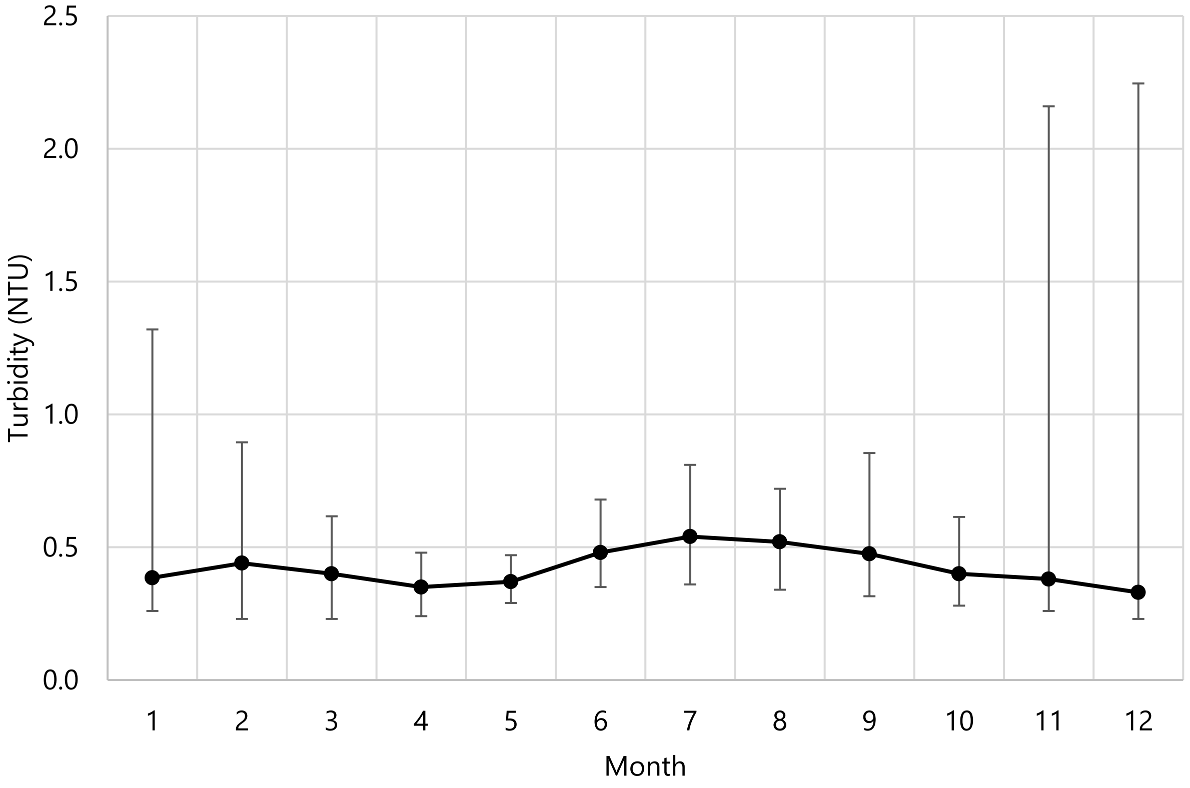


Figure 8.2 Monthly Average Raw Water Turbidity (January 2018 to May 2023)

Raw water alkalinity is consistently around 21 mg/L as $CaCO_3$; Lake Whatcom is considered a low alkalinity water source, consistent with most surface water sources in the Pacific Northwest.

On average, TOC in the raw water is relatively low, with an average of 2.1 mg/L between 2013 and 2023. While overall TOC levels are low, the average of 2.1 mg/L is above the 2 mg/L level, which would trigger TOC removal requirements if the Whatcom Falls WTP were to be recognized as a conventional treatment plant. As the Whatcom Falls WTP is currently rated as a direct filtration plant, with DAF not recognized as pretreatment by DOH, there are no TOC removal requirements. Figure 8.3 shows the trends in quarterly sampling for raw water TOC. TOC levels do not show a clear consistent seasonal trend, although TOC levels are generally lowest in the summer months.

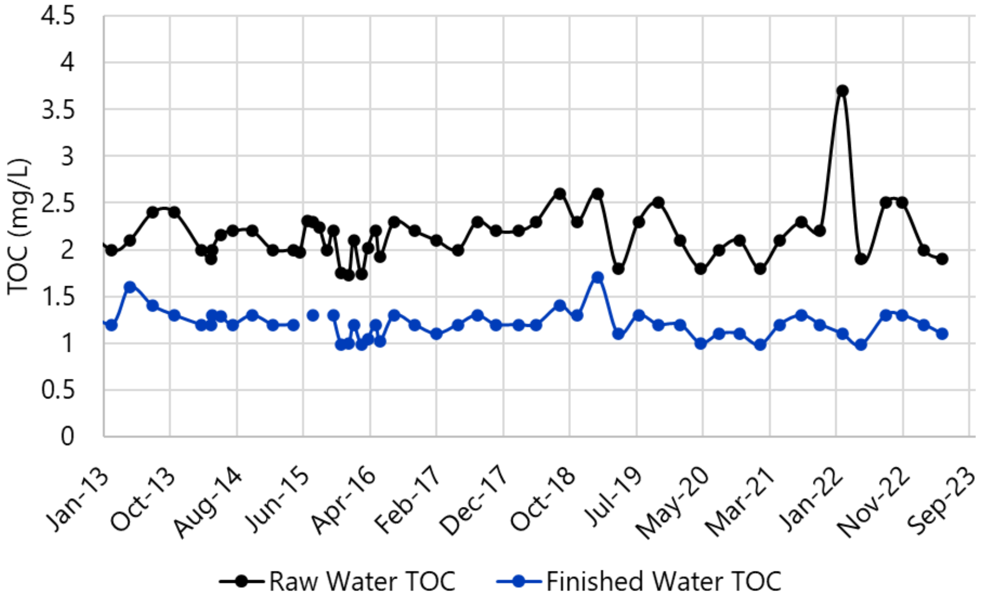


Figure 8.3 Quarterly Raw and Finished Water TOC Monitoring (January 2023 to May 2023)

Before 2007, the City collected data on DOC and TOC, as shown in Figure 8.4. Historically DOC has been 80 to 90 percent of total TOC, indicating the majority of organic carbon entering the plant is in dissolved form.

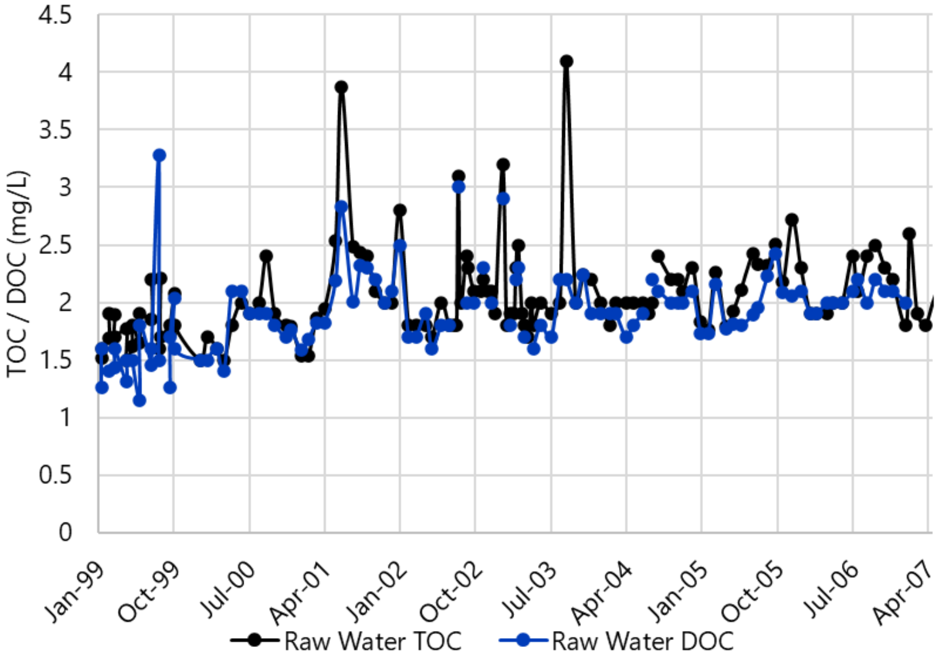


Figure 8.4 Historical Raw Water DOC and TOC Monitoring (January 1999 to November 2005)

Table 8.5 summarizes general finished water quality parameters. For the period examined, the average combined filter effluent (CFE) turbidity was 0.03 NTU, an order of magnitude below the regulatory requirement to be less than 0.3 NTU 95 percent of the time (below 1.0 NTU at all times). The treatment process and filters at the Whatcom Falls WTP provide excellent treatment performance.

Table 8.5 Summary of General Finished Water Quality Parameters

Parameter	Unit	Regulated Value	Range (5th - 95th Percentile)	Average/Median
Turbidity(1)	NTU	≤0.3 NTU for 95% of samples. <1.0 at all times.	0.02 – 0.04	0.03
TOC(2)	mg/L	-	0.98 – 1.7(3)	1.20
DOC(4)	mg/L	-	0.5 – 2.3	1.10
pH(1)	-	7.5 (EPDS) / 7.0 (tap samples)(6) (8.0 - WTP target)	7.97 – 8.02	7.98
Temperature(1)	Degrees C	-	6.6 – 19.5	11.0
Alkalinity(5)	mg/L as CaCO3	18(6)	24.3 – 28.3	26.0

Notes:
(1) Daily operating data from January 2018 to July 2023.
(2) From quarterly testing for TOC and alkalinity between January 2013 and May 2023.
(3) Value range is minimum to maximum.
(4) From near monthly sampling conducted between 1999 and 2007.
(5) From weekly testing between January 2018 and July 2023.
(6) Department of Health, Lead and Copper Monitoring and Optimal Parameters, Submittal 99-1225 (12/05/2003).

While the City is not required to provide TOC removal while rated as a direct filtration plant, they are required to monitor raw and finished water TOC quarterly as part of compliance requirements for the Stage 2 DBPR. As shown in Figure 8.3, finished water TOC is generally between 1.0 and 1.5 mg/L. The plant has historically achieved greater than 40 percent TOC removal, more than the 35 percent removal that would be required if the Whatcom Falls WTP were to be treated as a conventional treatment plant. Low finished water TOC likely contributes to the low disinfection byproduct levels in the distribution system, as discussed further in Section 8.4.6.

Finished water pH is tightly clustered near 8.0, consistent with the Whatcom Falls WTP goal of 8.0. The current dosing practice for soda ash is highly effective at maintaining consistent pH leaving the Whatcom Falls WTP. Finished water alkalinity is slightly higher than raw water, 26 mg/L in the finished water compared to 21 mg/L in the raw water, indicating the alkalinity increase provided by soda ash addition exceeds the alkalinity that is consumed through the treatment process (primarily from aluminum sulfate addition for coagulation). The conversion to on-site hypochlorite generation also likely reduced the amount of soda ash addition required compared to operations with chlorine gas; sodium hypochlorite adds alkalinity, increasing pH, whereas the use of chlorine gas consumes alkalinity and lowers pH.

8.4.2 Secondary Contaminants

Before 2009, the City conducted near-annual sampling at the gatehouse for raw water inorganic contaminants, which includes some regulated secondary contaminants. Table 8.6 summarizes secondary contaminants with detections in the raw water sampling between 1990 and 2009.

Table 8.6 Raw Water Secondary Contaminants

Parameter/ Contaminant	Unit	Finished Water MCL or Regulated Limit[8]	No. of Detects/ No. of Samples	Range[7]	Average/Median
Aluminum[6]	mg/L	0.05 – 0.20[1]	5 / 20	0.008 – 0.098	0.034
Chloride[6]	mg/L	250[2]	7 / 27	2 – 3	2.4
Color[6]	Color units	15[2]	21 / 27	5 – 10	6.6
Copper[6]	mg/L	1(1.3 action level)[3]	1 / 27	0.004	0.004
Iron[5]	mg/L	0.3[2]	42 / 67	0.01 – 0.03	0.01
Manganese[6]	mg/L	0.05[2][4]	7 / 27	0.001 – 0.012	0.005
Sulfate[6]	mg/L	250[2]	11 / 20	3.6 – 10.0	5.3
Zinc[6]	mg/L	5	2 / 27	0.013 – 0.100	0.06

Notes:

(1) United States Environmental Protection Agency (USEPA) established a range with individual states given discretion to establish a specific target. DOH has not established a secondary standard for aluminum. The lower limit of 0.05 mg/L is an optimal value established by the USEPA, with the range providing flexibility to account for variability in water quality and treatment processes. Coagulation with aluminum salts is a common source of aluminum in finished water.
(2) USEPA secondary MCL and DOH secondary standard.
(3) No DOH secondary standard, but copper is required to be included in inorganic chemical monitoring by DOH due to public health significance.
(4) In 2023, DOH issued recommendations to provide manganese treatment if present in the finished water above the 0.05 mg/L secondary MCL.
(5) Iron data from monthly sampling for iron in the raw water, finished water, and distribution system between January 2018 and July 2023.
(6) Data from periodic grab sampling and testing of inorganic compounds between 1990 and 2009.
(7) Range is minimum to maximum of all detections.
(8) Finished water MCL or finished water regulated limit shown to illustrate where removal or treatment may be required.

The sampling data prior to 2009 shows the presence of low levels of trace metals (aluminum, copper, iron, manganese, and zinc) at concentrations well below current secondary MCLs or DOH secondary standards for finished water. Manganese was infrequently detected at levels an order of magnitude below the MCL and DOH secondary standard, and below the 0.02 mg/L level that can cause colored water. Manganese was the source of new recommendations from DOH in 2023 due to an emerging understanding of the public health impacts of exposure (potential manganese regulations discussed further in Section 8.4.7).

Finished water sampling for secondary contaminants has generally been conducted on a nearly annual basis since 2000, with more frequent sampling occurring between 1990 and 2000. Table 8.7 summarizes the results of finished water secondary contaminant sampling going back to 1990.

Table 8.7 Finished Water Secondary Contaminants

Parameter/Contaminant	Unit	MCL or Regulated Limit	No. of Detects/ No. of Samples	Range[6]	Average/Median
Aluminum[5]	mg/L	0.05 – 0.20[1]	17 / 34	0.01 – 0.078	0.019
Chloride[5]	mg/L	250[2]	19 / 42	3.0 – 5.6	4.10
Color[5]	Color units	15[2]	10 / 42	5	5
Iron[4]	mg/L	0.3[2]	10 / 67	0.01 – 0.02	0.01
Manganese[5]	mg/L	0.05[2][3]	5 / 42	0.001 – 0.006	0.0003

Parameter/Contaminant	Unit	MCL or Regulated Limit	No. of Detects/ No. of Samples	Range(6)	Average/Median
Sulfate(5)	mg/L	250(2)	26 / 35	6 – 12	8.5
Total Dissolved Solids	mg/L	250(2)	6 / 6	45 – 72	55.5
Zinc(5)	mg/L	5	2 / 43	0.013 – 0.1	0.06

Notes:
(1) USEPA established a range with individual states given discretion to establish a specific target. DOH has not established a secondary standard for aluminum. The lower limit of 0.05 mg/L is an optimal value established by the USEPA, with the range providing flexibility to account for variability in water quality and treatment processes. Coagulation with aluminum salts is a common source of aluminum in finished water.
(2) USEPA secondary MCL and DOH secondary standard.
(3) In 2023, DOH issued recommendations to provide manganese treatment if present in the finished water above the 0.05 mg/L secondary MCL.
(4) Iron data from monthly sampling for iron in the raw water, finished water, and distribution system between January 2018 and July 2023.
(5) Data from periodic grab sampling and testing of inorganic compounds between 1990 and 2023.
(6) Range is minimum to maximum of all detections.

Finished water sampling shows that low levels of trace metals remain in the finished water but remain at levels well below the MCLs. Iron was detected in 15 percent finished water samples as opposed to 63 percent of raw water samples, indicating some removal of iron is provided at the Whatcom Falls WTP. Manganese was infrequently detected in the finished water, consistent with the raw water, at slightly lower concentrations. The current Whatcom Falls WTP practice of pre-chlorinating may be oxidizing some of the dissolved manganese, when present, facilitating removal in the filters and lowering manganese concentrations leaving the Whatcom Falls WTP.

The chloride-to-sulfate mass ratio (CSMR) can be an indicator of galvanic corrosion; CSMR values greater than 0.6 are associated with high corrosion of lead solder. The City's average CSMR for the sampling period analyzed was less than 0.5, which falls below levels indicative of the increased potential for corrosion. Furthermore, chloride concentrations were low, less than 5 mg/L in both the raw and finished water, further limiting susceptibility to galvanic corrosion.

In general, secondary contaminants in the raw and finished water have been detected infrequently with no apparent long-term trends indicating changes in raw water quality. With low secondary contaminant levels in the raw water, the Whatcom Falls WTP has had no issues producing finished water that meets all secondary contaminant standards.

8.4.3 IOCs, SOCs, and VOCs

Up to 2009 the City collected grab samples to test for IOCs, SOCs, and VOCs in the raw and finished water, generally on an annual basis. Since 2009, the City has collected grab samples for the finished water on an annual basis, exceeding the regulatory required sampling interval identified previously in Table 8.2.

For raw water sampling, IOCs were detected infrequently at levels below their MCLs, except for a single detection of antimony in 1996. Antimony was detected at a concentration of 0.009 mg/L, above the finished water MCL of 0.006 mg/L. For VOCs and SOCs, there were no detections in the raw water, except for a single detection of benzene in 2000 at a level significantly lower than the MCL. A review of City-provided data indicated that this value was a lab test-estimated concentration. The lab-estimated concentration was at very low levels, lower than detection levels for sampling in surrounding years.

Lab-estimated results are likely indicative of very low concentrations or measurement sensitivity associated with the lab test detection limit.

For the finished water sampling, Table 8.8 summarizes sampling results for detected IOCs, all of which are below the MCL.

Table 8.8 Detected Finished Water IOCs

Parameter	Unit	MCL or Regulated Limit	No. of Detects/ No. of Samples(2)	Range(3)	Average/Median
Barium	mg/L	2	16 / 42	0.006 – 0.022	0.008
Beryllium	mg/L	0.004	1 / 40	0.0006	0.0006
Nitrate (as N)	mg/L	10	29 / 43	0.10 – 0.65	0.31
Nitrite (as N)	mg/L	1	1 / 43	0.35	0.35
Sodium	mg/L	None(1)	41 / 42	5.5 – 10.6	8.4

Notes:
(1) DOH has no established MCL. USEPA recommends a level of 20 mg/L as a level of concern for members of the public who have dietary restrictions on daily sodium intake.
(2) From grab sampling of finished water between 1990 and 2023.
(3) Range is minimum to maximum detected concentration.

Table 8.9 summarizes sampling results for detected SOCs in the finished water.

Table 8.9 Detected Finished Water SOCs

Parameter	Unit	MCL or Regulated Limit	No. of Detects/ No. of Samples(1)	Range(2)	Average/Median
Dalapon	mg/L	0.2	2(3)(4)/28	0.00066 – 0.0008	0.0007
Hexachlorocyclopentadiene	mg/L	0.05	8(4)(5)/28	0.00003 – 0.00009	0.00004
Dichloroprop	mg/L	None	1(4)(6)/21	0.0005	0.0005

Notes:
(1) From grab sampling of finished water between 1990 and 2023.
(2) Range is minimum to maximum of all detections.
(3) Both detections were lab-estimated concentrations.
(4) Lab-estimated concentrations were below detection limit in surrounding years, indicative of either very low concentrations near test detection limit or measurement sensitivity associated with the lab test detection limit.
(5) Seven detections were lab-estimated concentrations.
(6) Single detection was lab-estimated concentration.

In sampling of the finished water, the City has detected two regulated SOCs, dalapon and hexachlorocyclopentadiene, at levels well below the MCL. Dalapon was detected in 1997 and 1999; both results were identified as lab-estimated values with concentrations below the detection limit of surrounding test years. Hexachlorocyclopentadiene was detected eight times between 1996 and 2013. Seven of the detections between 1996 and 2004 included a qualifier on the sample result indicating the results were lab-estimated values, with values below the detection limit of surrounding test years. There was an additional detection in 2013 an order of magnitude below the MCL. Lastly, there has been one detection of an unregulated SOC, dichlorprop, in 1997.

Table 8.10 summarizes sampling results for detected VOCs, all of which are currently unregulated. Two detected contaminants, chloromethane and dichlorodifluoromethane, were detected a single time. The remaining detected VOCs are unregulated compounds associated with chlorine disinfection.

Bromodichloromethane, chlorodibromomethane, and chloroform are all halomethanes that are regulated collectively as parts of total trihalomethanes. For select trihalomethanes, USEPA has established maximum contaminant level goals (MCLG). The MCLG is the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals. Bromodichloromethane was detected in all samples, in all cases exceeding the MCLG of 0 mg/L. Collectively, total trihalomethanes have been detected in all samples in the finished water at levels less than 25 percent of the distribution system MCL. Section 8.4.6 discusses DBPs further.

Table 8.10 Detected Finished Water VOCs

Parameter	Unit	MCL or Regulated Limit	No. of Detects/ No. of Samples(3)	Range(4)	Average/Median
Bromodichloromethane	mg/L	None (0)(1)	35/35	0.00088 – 0.005	0.002
Chlorodibromomethane	mg/L	None (0.06)(1)	2/36	0.0002 – 0.0004	0.0003
Chloroform	mg/L	None (0.07)(1)	35/35	0.0056 – 0.04	0.012
Chloromethane	mg/L	None	1/35	0.0006	0.0006
Dichlorodifluoromethane	mg/L	None	1/35	0.0005	0.0005
TTHMs	mg/L	None (0.08)(2)	33/33	0.00648 – 0.045	0.015

Notes:
(1) USEPA has established MCLG. MCLG is the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.
(2) MCL for distribution system monitoring is 0.08 mg/L as part of Stage 2 DBPR. No regulatory MCL on finished water entering the distribution system.
(3) From grab sampling of finished water between 1990 and 2023.
(4) Range is minimum to maximum of all detections.

8.4.4 Microbial Contaminants

Sampling for microbial contaminants, *E. coli*, cryptosporidium, and giardia, was last required to be completed beginning in 2015 for the second round of source monitoring as part of the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). There were no detections of cryptosporidium or giardia in the raw water during the most recent round of sampling. There were nine low-level detections of *E. coli*. The City is in the Bin 1 Classification for LT2ESWTR, where no additional treatment is required for cryptosporidium beyond the removal credit provided for filtration.

In 2018 and 2022, the City conducted Legiolert testing for Legionella pneumophila in the raw water, finished water, and distribution system at the various Total Coliform Rule (TCR) monitoring locations. This testing also included total coliform, *E. coli*, and heterotrophic plate count testing for each sample. At the time of testing, there were no detections of Legionella, total coliforms, or *E. coli* in the finished water. The City's Coliform Monitoring Plan is presented in Appendix R.

8.4.5 PFAS

PFAS have been classified as contaminants of emerging concern (CEC) with increasingly significant public awareness and regulatory investigation. The rising concern over PFAS, particularly over the past decade, is due to their health effects at minute concentrations. PFAS have been used in many consumer products and have been found in drinking water and wastewater, and it is estimated that they are found in the blood of nearly everyone in the United States.

At the federal level, six PFAS were included in Unregulated Contaminant Monitoring Rule (UCMR) 3 (UCMR3) between 2013 and 2015 and with UCMR5 sampling between 2023 and 2025, focusing on 29 PFAS. The USEPA established Health Advisory Limits (HAL) in 2016 for specific PFAS, with additional HALs added in 2022.

The USEPA's rulemaking efforts advanced with the issuance of final regulations pertaining to PFAS in April 2024. The final rulemaking process established new primary MCLs for six PFAS as well as a Hazard Index MCL pertaining to specific mixtures of PFAS compounds. With the finalization of the rule, all utilities must complete initial monitoring by 2027, followed by public notification of the results, and implement solutions to reduce PFAS below the MCL by 2029.

During the UCMR5 monitoring period, the City collected four quarterly samples of treated water. All four quarters of sampling data showed the entry point to the water distribution system to be absent of the 29 low-level PFAS compounds. As a result, follow-up actions will not need to be conducted until 2027 based on how sample detection levels compared against trigger levels established in the new rule, which are set at half the final MCL:

- If all samples are below the trigger levels, utilities are only required to monitor every three years.
- If a sample exceeds the trigger level, one additional year of quarterly monitoring is required. If the additional year of monitoring shows levels are consistently below the MCL, monitoring can be reduced to annually.

At the state level, the DOH established State Advisory Levels (SAL) for five PFAS in 2021. DOH rules established requirements for initial monitoring to be completed by the end of 2025. Because there are no detections, monitoring frequency is set to every three years. If there ever were detections, the follow-up actions are conditional based on the concentrations detected:

- For levels less than 20 percent of the SAL, one follow-up quarterly sample is required.
- For levels between 20 and 80 percent of the SAL, two additional quarterly samples are required, and further actions are dependent on the results of the follow-up samples.
- For levels greater than 80 percent of the SAL but less than the SAL, three additional quarterly samples are required, followed by quarterly monitoring unless directed otherwise by DOH.
- For levels greater than the SAL, public notification and follow-up action as directed by DOH is required.

After the release of the USEPA rule, DOH indicated they will move toward adopting the federal MCLs, which are generally more stringent than the state SAL. The process could take up to two years; in the meantime, the City will have to comply with DOH's established SALs and monitoring requirements.

Table 8.11 summarizes the regulatory limits for PFAS established by USEPA and DOH that the City will have to comply with in the coming years. For three PFAS— perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), and perfluorohexanesulfonic acid (PFHxS), the new primary MCLs are significantly more stringent than the established SAL. Note, for PFOA and PFOS, the MCL of 4 parts per trillion (ppt) is also the practical quantification limit as set by the USEPA, meaning any value recorded under 4 ppt is considered zero in the calculation of running annual averages. DOH has established a SAL for perfluorononanoic acid (PFNA) at a level below the primary MCL and also includes a SAL for perfluorobutane sulfonate (PFBS), which does not have a primary MCL.

Table 8.11 PFAS Federal and State Regulatory Limits

Parameter/Contaminant	USEPA MCL	DOH SAL
PFOA	4 ng/L	10 ng/L
PFOS	4 ng/L	15 ng/L
PFHxS	10 ng/L	65 ng/L
PFNA	10 ng/L	9 ng/L
HFPO-DA	10 ng/L	-
PFBS	-	345
Mixtures	1 (Hazard Index)(1)	-

Notes:

(1) $Hazard\ Index = \left(\frac{HFPO-DA}{10}\right) + \left(\frac{PFBS}{2,000}\right) + \left(\frac{PFNA}{10}\right) + \left(\frac{PHFxS}{10}\right)$

All concentrations for Hazard Index calculation are in ng/L.
HFPO-DA - hexafluoropropylene oxide dimer acid.

To date, the City sampled for six PFAS in UCMR3, with no detections. All rounds of sampling have also been completed in 2024 as part of UCMR5, with no detections for any PFAS. All PFAS with primary MCLs in USEPA's 2024 rule and DOH's SALs were included in the UCMR5 sampling.

Based on the lack of detections to date, the City will only have to sample PFAS every three years.

For many drinking water utilities across the United States, wastewater effluent discharges into surface waters contributed to PFAS presence in drinking water supplies. The City's wastewater is treated at the Post Point Resource Recovery Facility, which discharges treated effluent to Bellingham Bay outside of the Lake Whatcom watershed. Additionally, wastewater solids are incinerated, eliminating another potential PFAS source. No other known major point sources of PFAS loading into the Lake Whatcom watershed are known at this time. As a result, it is not anticipated that there will be detections of PFAS at high levels moving forward. However, as measurement methods continue to detect more minute concentrations, it is possible that the City may detect low levels of PFAS in the future. At this time, it is not anticipated that the City will have issues with ongoing compliance with current PFAS regulations.

8.4.6 Distribution System

This section summarizes the results of distribution system sampling data. As shown in Table 8.3, the City conducts significant additional distribution system sampling in excess of regulatory requirements.

8.4.6.1 Disinfection Byproducts

The City is required to take quarterly samples for two groups of disinfection byproducts (DBP)—TTHMs (bromodichloromethane, dibromochloromethane, bromoform, and chloroform) and HAA5 (monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid)—at eight locations within the distribution system.

Table 8.12 and Table 8.13 summarize TTHM and HAA5 sampling data, respectively, within the distribution system. For both DBPs, the MCLs shown are based on locational running annual averages (LRAA). The LRAA represents the average of four consecutive quarterly samples at a single location in the distribution system and must remain below the MCL. Both tables show summary data for all quarterly samples, the LRAA, and the Operational Evaluation Limit (OEL). The OEL is a weighted average of the three most recent samples, with two times the weight placed on the most recent quarterly sample. This is used to provide an advanced warning of potential DBP increases, allowing for proactive changes to be made prior to an LRAA MCL violation occurring.

Table 8.12 Distribution System TTHMs

Contaminant	Unit	Finished Water MCL	Range(4)	Median(1)
TTHM(1)	µg/L	80	10.3 - 79.9	32
TTHM - LRAA(1) (2)	µg/L	80	14.3 - 54.1	33
TTHM - OEL(1) (3)	µg/L	80	13.3 - 58	33

Notes:
(1) Includes monitoring data from 2012 and beyond.
(2) MCL compliance is based on the location running annual average for each sampling location. Data presented is full dataset across all eight sampling locations.
(3) OELs are calculated for each sampling location. Data presented is full dataset across all eight sampling locations.
(4) Value range is minimum to maximum.
µg/L - micrograms per liter.

Table 8.13 Distribution System HAAs

Contaminant	Unit	Finished Water MCL	Range(4)	Median(1)
HAA(1)	µg/L	60	6.9 - 27.2	15
HAA – LRAA(1) (2)	µg/L	60	9.2 - 22.1	15
HAA – OEL(1) (3)	µg/L	60	8.8 - 23.2	15

Notes:
(1) Includes monitoring data from 2012 and beyond.
(2) MCL compliance is based on the location running annual average for each sampling location. Data presented is full dataset across all eight sampling locations.
(3) OELs are calculated for each sampling location. Data presented is full dataset across all eight sampling locations.
(4) Value range is minimum to maximum.

As shown in Table 8.12 and Table 8.13, DBP levels are generally low within the distribution system. No individual samples have exceeded the LRAA, with only one sample for TTHMs essentially at the 80 µg/L MCL. For TTHMs, the median LRAA has been less than 50 percent of the MCL, while the median LRAA for HAAs has been 25 percent of the MCL. The maximum LRAA for TTHMs has approached 75 percent of the MCL, while the maximum LRAA for HAAs has been approximately one-third of the MCL.

Looking at quarterly TTHM and HAA results since 2012, a slight downward trend was observed for both TTHMs and HAAs across all sampling locations, as shown in Figure 8.5 and Figure 8.6. DBPs are generally highest in late spring and early summer sampling periods (May and August). The general downward trend since 2019 was expected with the organic precursor removal potential of the DAF system.

The low organic content in the raw and finished water appears to limit the potential for DBP formation within the distribution system. The DBP monitoring results demonstrate that the existing Whatcom Falls WTP operations, even with pre-chlorination, present no concern for Stage 2 DBPR compliance.

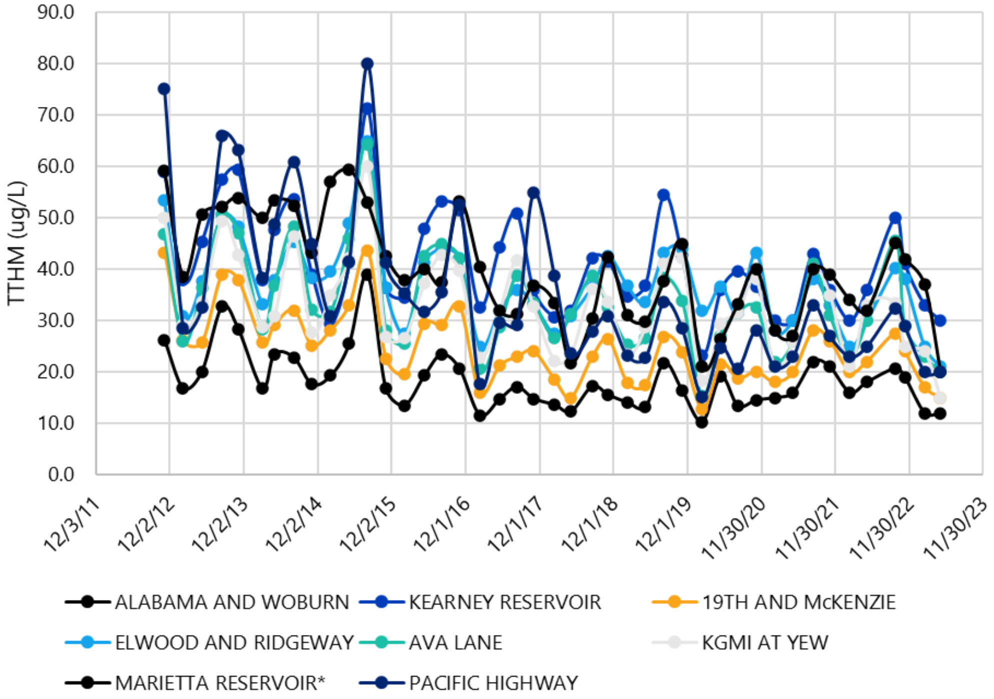


Figure 8.5 Quarterly TTHM Sampling (2012 to 2023)

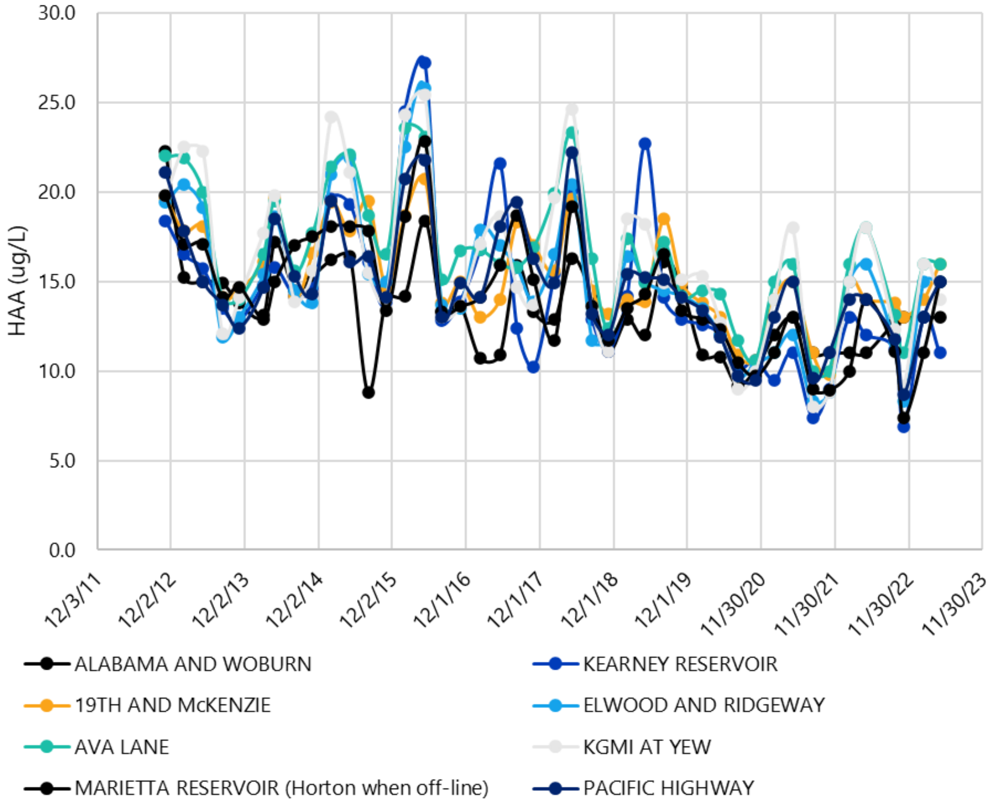


Figure 8.6 Quarterly HAA Sampling (2012 to 2023)

8.4.6.2 Lead and Copper

Regulatory compliance for the Lead and Copper Rule is determined using the 90th percentile concentrations of all lead or copper samples collected during a required sampling period; these concentrations may not exceed their respective established action levels. Utilities are typically required to sample every three years but can be placed under more frequent sampling requirements if the action level is exceeded.

To strengthen public health protections and clarify the Lead and Copper Rule's implementation requirements, the USEPA released proposed Lead and Copper Rule Revisions (LCRR) on October 10, 2019, with a compliance date of October 16, 2024. The LCRR includes the following significant updates for compliance:

- Requirements for utilities to find and fix any tap samples where lead levels exceed the 0.015 mg/L action level.
- A new trigger level for lead at 0.01 mg/L. Utilities exceeding this level will be required to re-optimize their existing treatment for corrosion control.
- Requirements for utilities to begin lead service line replacement programs.

Table 8.14 summarizes the range of detected concentrations and median concentration for all Lead and Copper Rule sampling from 2005 to 2020 and the 90th percentile concentrations from the last three reporting periods (2017, 2020, and 2023). For all monitoring periods, the City's 90th percentile values for lead and copper have been well below the action levels. The City's current corrosion control practices and water quality appear effective at keeping lead and copper concentrations well below the action level. The City had a single tap sample at 0.015 mg/L in 2017, which is at the trigger level for find-and-fix efforts under the new LCRR requirements. In 2020, two individual tap samples exceeded the 0.01 mg/L trigger level. In 2023, no tap samples exceeded the trigger level. In 2024, the USEPA announced final Lead and Copper Rule Improvements (LCRI) rules that will go into effect in 2027. These impacts are discussed further in Section 8.4.7, regarding future regulations.

Table 8.14 Summary of Lead and Copper Rule Monitoring

Contaminant	Unit	Finished Water MCL(1)	Range (2)	Median(2)	90th Percentile for Last Three Reporting Periods(4)
Lead(2)	mg/L	0.015	0.001 - 0.99	0.002	0.003 / 0.006 / 0.003
Copper(2)	mg/L	1.3	0.001 – 0.135	0.036	0.047 / 0.065 / 0.090

Notes:
(1) Regulatory compliance is based on the 90th percentile of sampling data for a monitoring period being below the established action level.
(2) Data from all Lead and Copper Rule compliance sampling between 2005 and 2020. Summary statistics calculated on all detections.
(3) Value range is minimum to maximum.
(4) Last three reporting periods cover 2017, 2020, and 2023. 2023 90th percentile data provided by the City.

8.4.6.3 Microbial Contaminants

The City is required to collect 120 monthly samples in the distribution system and test for total coliforms and chlorine residual. From January 2018 to July 2023, there were seven total coliform detections. All follow-up samples have been negative for fecal coliforms. Three locations in the distribution system have each had two total coliform detections in the period analyzed.

Distribution system free chlorine residual ranged from 0.0 to 1.0 mg/L in the approximately five-year period of data analyzed. The median residual within the distribution system was 0.4 mg/L. Overall, free chlorine residual has been detected in over 99 percent of the samples since 2018, but there have been a total of 14 samples with no detectable free chlorine residual. All of these locations had measurable total chlorine residuals in follow-up testing. Three locations in the distribution system accounted for nearly all of the instances with no free chlorine residual detection. The locations with no free chlorine residual do not coincide with the locations with total coliform detections. Potential future regulations pertaining to minimum distribution system residuals are discussed in Section 8.4.7.

In 2018, the City conducted Legiolert testing for Legionella pneumophila at select City TCR monitoring locations. This testing also included total coliform, *E. coli*, and heterotrophic plate count testing. There were no detections of Legionella, total coliforms, or *E. coli* in the distribution system at the time of testing. Heterotrophic plate count measurements varied across the system.

8.4.6.4 Other Distribution System Monitoring

Table 8.15 summarizes the results of additional distribution system monitoring conducted by the City. The results presented in Table 8.15 reflect the results across all sampling locations; data comes from sampling at 24 locations in the distribution system. Many of the monitored water quality parameters have no regulated MCL in the Whatcom Falls WTP finished water. Where a finished water MCL exists, it is included for context.

Table 8.15 Other Monitored Distribution System Parameters

Contaminant	Unit	Finished Water MCL	Range (minimum – maximum)
Dissolved Oxygen	mg/L	-	8 - 18.7
Turbidity	NTU	Treatment technique. ≤0.3 NTU for 95% of samples. <1.0 at all times.	0.0136 - 2.92
pH	-	-	7.2 - 10.06
Alkalinity	mg $CaCO_3$/L	-	14.8 - 36.2
Iron	mg/L	0.3	0.01 - 0.21
Conductivity	µmhos/cm	-	62 – 142
Heterotrophic Plate Count	colonies/mL	-	1 - 7800
Temperature	°C	-	4.7 - 24
Hardness (EDTA)	mg/L as $CaCO_3$	-	19 - 29.4

Notes:
°C - degrees Celsius; µmhos/cm - micromhos per centimeter; colonies/mL - colony forming units per milliliter.

Distribution system monitoring shows some noticeable water quality changes compared to the Whatcom Falls WTP finished water:

- pH ranged from 7 to 10, compared to the 8.0 leaving the Whatcom Falls WTP.
- Turbidity ranged from 0.01 to 2.9 NTU, compared to the average CFE turbidity of 0.03 NTU.
- Alkalinity ranged from 15 to 26 mg/L as $CaCO_3$, compared to an average of 26 mg/L in the finished water.

Distribution system pipeline material, lining material, scale build-up, unused/stagnant end of system interties, and other factors can all contribute to changes in water chemistry within the distribution system. Localized flushing and even sample collection can stir up particles and create higher turbidity readings. The City proactively monitors and meets all regulatory required parameters within the distribution system. Based on the available data analyzed, there are no concerns pertaining to distribution system water quality.

8.4.7 Contaminants of Emerging Concern and Future Regulations

This section discusses CECs, focusing primarily on the USEPA's Unregulated Contaminant Monitoring Program (UCM), which encompasses contaminants that are most likely to be subject to future regulation.

8.4.7.1 Unregulated Contaminant Monitoring

The USEPA manages and uses the UCMR to collect data on the occurrence and concentrations of contaminants that may be in drinking water but are not currently regulated by the Safe Drinking Water Act (SDWA). Data from the UCMR is used to understand how widespread the occurrence of a particular contaminant is, the approximate population exposed to this contaminant, and the level of that exposure. Results from UCMR monitoring can then form the basis for future regulations.

Every five years, the USEPA issues a list of contaminants for sampling and monitoring under the UCMR, with the majority of selected contaminants taken from the Contaminant Candidate List. The SWDA Amendments of 1996 established the following for the UCMR:

- Monitor no more than 30 contaminants every five years.
- Monitor only a representative sample of public water systems serving fewer than 10,000 people (all public water systems serving more than 10,000 people are required to monitor for the selected contaminants).
- Store analytical results in a National Contaminant Occurrence Database (NCOD).

Thus far, the UCMR has progressed in rounds, the most recent of which, round 5 (UCMR5), will be completed by utilities between 2023 and 2025. The proposal for round 6 (UCMR6) is anticipated to be released in 2025, with a final rule in 2026 and sampling between 2028 and 2030. As of April 2024, the USEPA has identified 68 potential contaminants that may be included in UCMR6 sampling, which include chlorinated acids, pesticides and degradates, volatile/semivolatile organics, flame retardants, phenols, organic compounds, and pharmaceuticals.

The following sections provide an overview of the City's participation in the most recent three UCMR rounds, UCMR3, UCMR4, and UCMR5.

UCMR 3

The City completed UCMR3 sampling in 2013 and 2014. UCMR3 sampling required sampling for finished water entering the distribution system and at the maximum residence time point in the distribution system. Full UCMR3 sampling results are provided in Appendix R.

A total of four contaminants were detected from both monitoring locations: chromium, chromium-6, strontium, and vanadium. All four detected contaminants are naturally occurring metals in the Pacific Northwest and were detected at concentrations well below the reference concentration, health-based values that provide context for the detection of a contaminant.

UCMR 4

The City completed UCMR4 sampling in 2019. UCMR4 sampling required sampling for 27 contaminants in finished water entering the distribution system, including 10 cyanotoxins, and three disinfection byproducts in the distribution system, including the currently regulated HAA5. Full UCMR4 sampling results are provided in Appendix R.

Of the contaminants tested in the finished water entering the distribution system, only manganese was detected. Manganese is currently regulated as a secondary contaminant, and concentrations from UCMR4 testing were an order magnitude below the current secondary MCL. All three disinfection byproducts were detected, with HAA5 levels well below the MCL, consistent with the City's distribution system testing results. Even with the inclusion of additional haloacetic acids, characterized by sampling for HAA9, levels were still less than half of the current MCL for HAA5.

During UCMR4 testing, Whatcom County Water District No. 2, which is supplied by the City, had a detection for an algal toxin, total microcystin. However, during follow-up testing for six specific microcystins, there were no detections. The City believes this detection was a lab error, as this was one of the first samples for UCMR4 using the ELISA testing kits for that laboratory.

UCMR 5

As previously discussed in Section 8.4.5, the City has completed all four rounds of testing for 29 PFAS compounds, and lithium, in 2024 with no detections. Full UCMR5 sampling results are provided in Appendix R.

8.4.7.2 Future Regulations

This section reviews potential future regulations, as well as revisions to existing regulations, which may influence the City.

Disinfection Byproducts

The USEPA is currently reviewing the Microbial and DBP Rules as part of their most recent Six-Year Review, which identifies the potential need for revisions to such rules. A proposal for rule changes is anticipated in Summer 2025. Potential revisions include the following:

- Establish a numeric limit on minimum distribution system residual to reduce Legionella occurrences.

- Change the DBP rules to include additional brominated DBPs that are more toxic than currently regulated TTHMs and HAA5.
- Further review of chlorate and N-Nitrosodimethylamine (NDMA).

The establishment of a numeric limit on distribution system residual has the potential to impact Whatcom Falls WTP operations and distribution system chlorine residual compliance. In November 2023, the National Drinking Water Advisory Council published its "Report of the Microbial and Disinfection Byproducts Rule Revisions Working Group", which includes a recommendation that the minimum distribution system residual be set to 0.5 mg/L as free chlorine or 0.7 mg/L as total chlorine. Based on a review of the City's monthly distribution system sampling for free chlorine residuals from 2018 to mid-2023, free chlorine residuals are below 0.5 mg/L in approximately 50 percent of samples. Note, the City meets the current regulations requiring a detectable chlorine residual concentration 95 percent of the time.

The current target residual entering the distribution system from the Whatcom Falls WTP is 0.9 mg/L (as free chlorine). Meeting a residual target of 0.5 mg/L would likely necessitate increasing chlorine doses and target residuals at the Whatcom Falls WTP or boosting chlorine residuals within the distribution system. Increasing doses at the Whatcom Falls WTP will result in increased sodium hypochlorite usage, and potentially increase DBP concentrations. The City's current DBP levels are well below the MCL, so incremental increases in chlorine dosing at the plant are not anticipated to directly result in DBP compliance challenges, but this will require further monitoring as rule revisions are published.

Other changes to the Microbial and DBP Rules regarding additional DBPs are not anticipated to significantly impact the City. Brominated DBPs were included in UCMR4 sampling, and DBPs have historically been well below current MCLs. Additionally, NDMA is a byproduct of disinfection with chloramines, which are not used at the Whatcom Falls WTP. Finally, chlorate, formed from the degradation of sodium hypochlorite or as a byproduct of disinfection with chlorine dioxide, is discussed further below.

Lead and Copper Rule Improvements

On November 30, 2023, the USEPA announced proposed LCRIs, which were finalized on October 8, 2024. Utilities must comply with LCRI requirements in 2027, three years following rule finalization. The LCRIs includes the following items for utilities to comply with:

- Lowering the action level for lead to 0.01 mg/L.
- Requiring the majority of utilities to replace all lead service lines within 10 years.
- Creating publicly available inventories of lead service lines.
- Modifying tap sampling protocols for sites with lead service lines.

As summarized in Section 8.4.6, lead and copper levels have historically been well below the action levels, even with the lowering of the lead action level to 0.01 mg/L. The City's current corrosion control practices appear to be effective at keeping lead levels low in the distribution system; it is not anticipated that the LCRI changes will have a significant impact on plant operations. The City does not have any lead service lines, so many of the new rule requirements pertaining to lead service lines will not be applicable. There are no anticipated compliance concerns pertaining to the new Lead and Copper Rules based on the City's historical lead and copper results.

Manganese

Manganese is currently regulated by DOH as a secondary standard; any exceedances trigger follow-up actions as directed by DOH. Elsewhere, in 2019, Canada established two new values regulating manganese in drinking water: A health-based maximum allowable concentration (analogous to the US's primary contaminant MCL) of 0.12 mg/L and an aesthetic objective (analogous to the US's secondary contaminant MCL) of 0.02 mg/L. The aesthetic objective for manganese is below the USEPA's current secondary MCL of 0.05 mg/L.

Manganese was included in sampling for UCMR4 to help assess if it should be moved from a secondary MCL to a primary MCL. As of March 10, 2020, the USEPA determined there was not enough information to proceed to the regulatory determination assessment phase. Manganese was included in Contaminant Candidate List 5, finalized in 2022.

However, the USEPA has established HALs for manganese. HALs establish a specific duration and threshold concentration of exposure below which no health effects are anticipated to occur. For all persons, USEPA has a one-day and 10-day HAL of 1 mg/L and a lifetime HAL of 0.3 mg/L. For bottle-fed infants younger than six months, the USEPA also has a 10-day HAL of 0.3 mg/L.

In December 2023, DOH published updated recommendations pertaining to manganese, which included the following:

- Manganese treatment should be installed if levels exceed the 0.05 mg/L secondary MCL.
- Treatment should reduce manganese levels to below 0.02 mg/L.
- Public notification should be provided if manganese levels exceed 0.3 mg/L, consistent with USEPA HALs discussed above.

As shown in Section 8.4.2, manganese concentrations in the finished water are well below current DOH secondary standards. Should manganese be advanced to a primary MCL (likely at the current secondary MCL), it is not anticipated that this will significantly impact Whatcom Falls WTP operations or compliance. The plant's current practice of pre-chlorination and subsequent oxidation of manganese has been effective. If pre-chlorination continues, no additional treatment is anticipated to be required should manganese be converted to a primary MCL.

Chlorate

The USEPA is considering regulating chlorate as part of its Six-Year Review of the Microbial and DBP Rules. Although it was also sampled as part of UCMR3, chlorate has not yet reached the regulatory determination assessment phase. As the Six-Year Review progresses, further steps toward regulation may occur, but potential MCL values or the likelihood of regulation are unclear at this time.

Chlorate was not detected in the City's finished water during UCMR3 because chlorine gas was in use at that time for disinfection. It is likely that chlorate is present in the finished water after the conversion to on-site hypochlorite generation as part of the DAF project. In 2019, after the initiation of sodium hypochlorite disinfection, the City conducted chlorate and perchlorate monitoring at six distribution system locations following treatment. The range of chlorate detections was 24 to 37 µg/L, with an average of 33 µg/L. These values were well below the EPA Health Reference value of 210 µg/L or California's action level of 700 µg/L. No perchlorate was detected in any of the samples.

No common water treatment process effectively removes chlorate. Chlorate levels can be managed by controlling its formation through operational strategies such as managing sodium hypochlorite storage times, establishing purity levels for suppliers, and controlling the dilution levels of sodium hypochlorite. Chlorate levels are not anticipated to be a concern, provided that due diligence is taken regarding the operational strategies listed above.

Cyanotoxins

Currently, the USEPA does not regulate cyanotoxins and no cyanotoxins were detected in the four samples the City collected for UCRM4. However, cyanotoxins are regulated at the state level in Ohio, Rhode Island, and Oregon. The City's existing treatment processes provide limited tools to address a cyanotoxin event. DAF can float out intact algal cells but will not treat toxins in the water outside of the cells. Chlorination can provide some limited treatment but can also lyse algal cells and release algal toxins. Should cyanotoxins be regulated in the future or be of greater concern to the City, additional treatment options may need to be considered. Space for a future powdered activated carbon (PAC) room was reserved in the DAF building construction. No further evaluation of PAC for cyanotoxin has been completed.

8.4.8 Water Quality Goals

Table 8.16 summarizes the City's current water quality goals. The goals pertaining to virus and protozoa control are consistent with regulatory requirements. The remaining goals are either more conservative or stringent than regulatory requirements (CFE turbidity and chlorine residual) or are not directly regulated at the Whatcom Falls WTP. Achieving these additional goals indicates the plant is performing at a high level. Though infringing on these goals does not necessarily indicate an immediate treatment issue, chronic infringement may be a trigger for operational or infrastructure modifications.

Table 8.16 Water Quality Goals

Parameter	Regulatory Requirement	Goal
Giardia Removal/Inactivation	3.0 log removal/inactivation.	2.0 log removal credit through filtration. 1.0 log inactivation through disinfection.
Cryptosporidium Removal	2.0 log removal	2.0 log removal credit through filtration.
Virus Removal/Inactivation	4.0 log removal/inactivation	1.0 log removal credit through filtration. 3.0 log inactivation through disinfection.
Chlorine Residual	0.2 mg/L	0.9 mg/L
Clarified Water Turbidity	None	< 1 NTU when raw water turbidity less than 10 NTU. <2 NTU when raw water turbidity more than 10 NTU.
Combined Filter Effluent Turbidity	≤0.3 NTU for 95% of samples. <1.0 at all times.	< 0.1 NTU 95% of the time.
Finished Water pH (after soda ash addition)	6.5 – 8.5	8.0

Operational performance is discussed in further detail in Section 8.5, but the City currently meets all its water quality goals. No additional water quality goals will be established as part of this planning effort.

8.4.9 Water Treatment Process Capabilities

The City's existing water treatment processes were reviewed against all current regulations, water quality goals, and potential contaminants of concern/future regulations to determine whether additional treatment technologies should be considered in this planning effort. Taste and odor events and cyanotoxins were the only potential contaminants of concern identified by City staff during this planning effort. At this time, neither were determined to be of significant enough concern to warrant exploring additional treatment options in this planning effort.

8.5 Historical Operational Performance

This section summarizes the plant's historical operational performance to identify any major process performance concerns that should be considered for Whatcom Falls WTP improvement projects.

8.5.1 Plant-Wide Performance

Figure 8.7 summarizes monthly average flows and production efficiencies between 2018 and 2023. Average production varies between approximately 8 and 12 mgd, with demands highest during the summer months.

The plant's average production efficiency (finished water produced divided by raw water taken in) was greater than 96 percent year-round. Production efficiencies higher than 95 percent are representative of a well-performing, efficient water treatment process. Average production efficiency is consistent year-round, likely due to the minimal seasonal variability in raw water turbidity and consistent water quality delivered to the filters. The installation of DAF to address past filter-clogging algae issues has likely greatly improved plant production efficiency. The impact of DAF on filter performance is discussed in the following section.

Note that the raw water flow for this analysis is equal to the sum of the filter effluent flow meters, which slightly underestimates the total raw water flow due to sludge removal cycles from DAF. Finished water flow was taken as the gravity flow measurement from City-provided data. As noted in Chapter 4, the gravity flow measurement has been found to be inaccurate, with consumption values exceeding production values measured at the Whatcom Falls WTP. If gravity flow measurements are higher than those used for this analysis, overall plant production efficiencies may be even higher than what is calculated here.

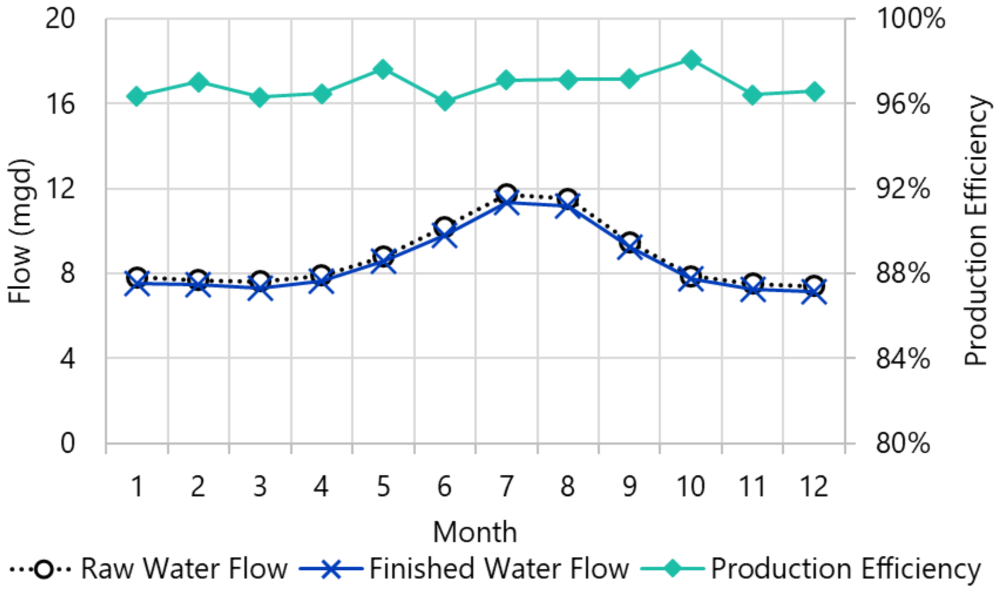


Figure 8.7 Plant Production Efficiency

Average daily energy use has been approximately 1,500 kilowatt hours (kWh) per month based on power utility data from 2020 to 2023. Note that the Dakin Yew pump station pumps are included in the power utility measurements, which are used to supply a portion of the distribution system and are not part of the energy used to produce water at the Whatcom Falls WTP.

Historical average energy intensity, the total energy used to produce a unit volume of water, is characterized in Figure 8.8. Average energy intensity varies between 500 and 700 kWh per million gallons, peaking in the winter months. Apart from the Dakin Yew pump station, the Whatcom Falls WTP has very few large electrical loads, with the entire process being gravity-driven. The only major electrical power consumption for water production is the backwash pumps and air scour blowers. High energy intensity during the wintertime may be indicative of higher energy use for heating and other loads not directly related to water production.

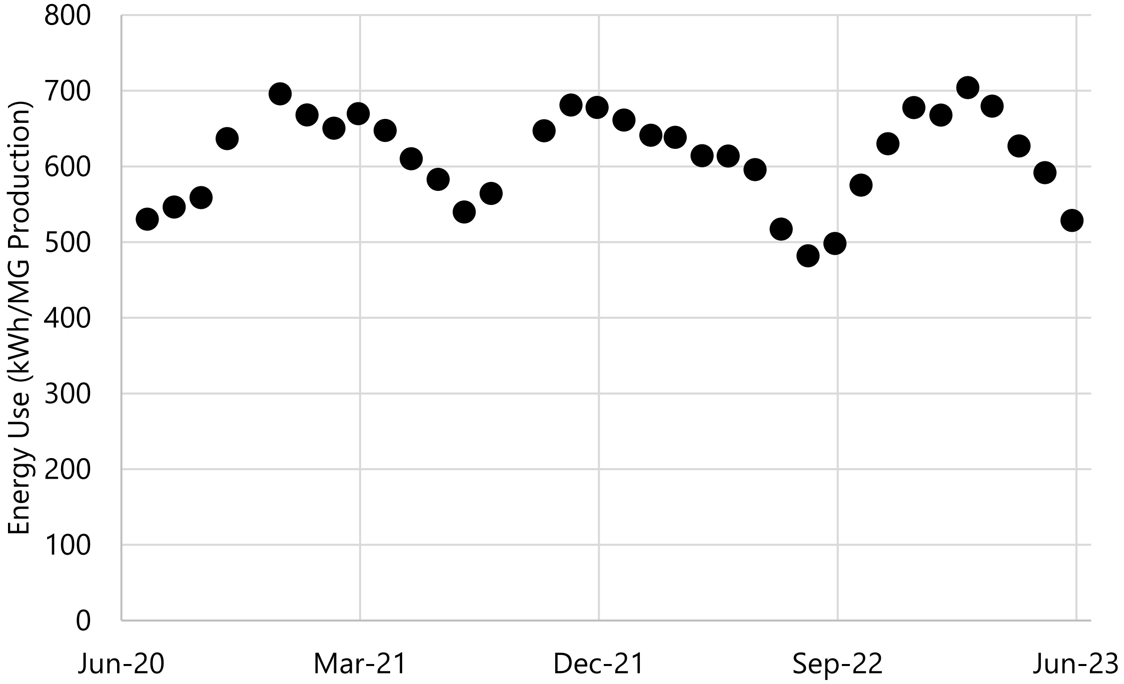


Figure 8.8 Whatcom Falls WTP Monthly Energy Intensity

8.5.2 DAF

No operational data pertaining to DAF performance was evaluated. City staff have indicated the DAF system has performed well, and the benefits of DAF installation on filter performance are discussed in the following section.

8.5.3 Filtration

The Whatcom Falls WTP has six dual-bay filters that can be operated at filtration rates of 5 gallons per minute per square foot (gpm/ft^2), or a maximum of 2,800 gpm per filter. The filters are typically operated close to 2,000 gpm and are backwashed when head loss reaches approximately 8 feet.

Filtration performance was evaluated by looking at unit filter run volume (UFRV), which provides the volume of water filtered per square foot of media area during a filter run. This normalizes filter production and allows for filter performance to be evaluated across a spectrum of flows and water quality conditions. The City records the UFRV for each filter at the time of backwash for each filter.

Overall filtration performance was improved significantly with the addition of DAF in 2018, as shown in Figure 8.9. Prior to DAF going online in 2018, UFRVs were around 5,000 – 6,000 gal/ft^2 in the later winter and spring in early 2018. With the onset of the summer months, the time period when filter-clogging algae have the greatest impact on filter performance, UFRVs consistently declined to 3,000 gal/ft^2 or lower. Low UFRVs are indicative of frequent backwashing and overall poor filtration efficiency. In the fall of 2018, DAF went online, and filter UFRVs increased to 6,000 gal/ft^2 and higher for the entire year of 2019. Average UFRVs doubled after DAF installation, due to filter run times doubling. Typical filtration rates and backwash triggers (head loss of 8 feet) were unchanged.

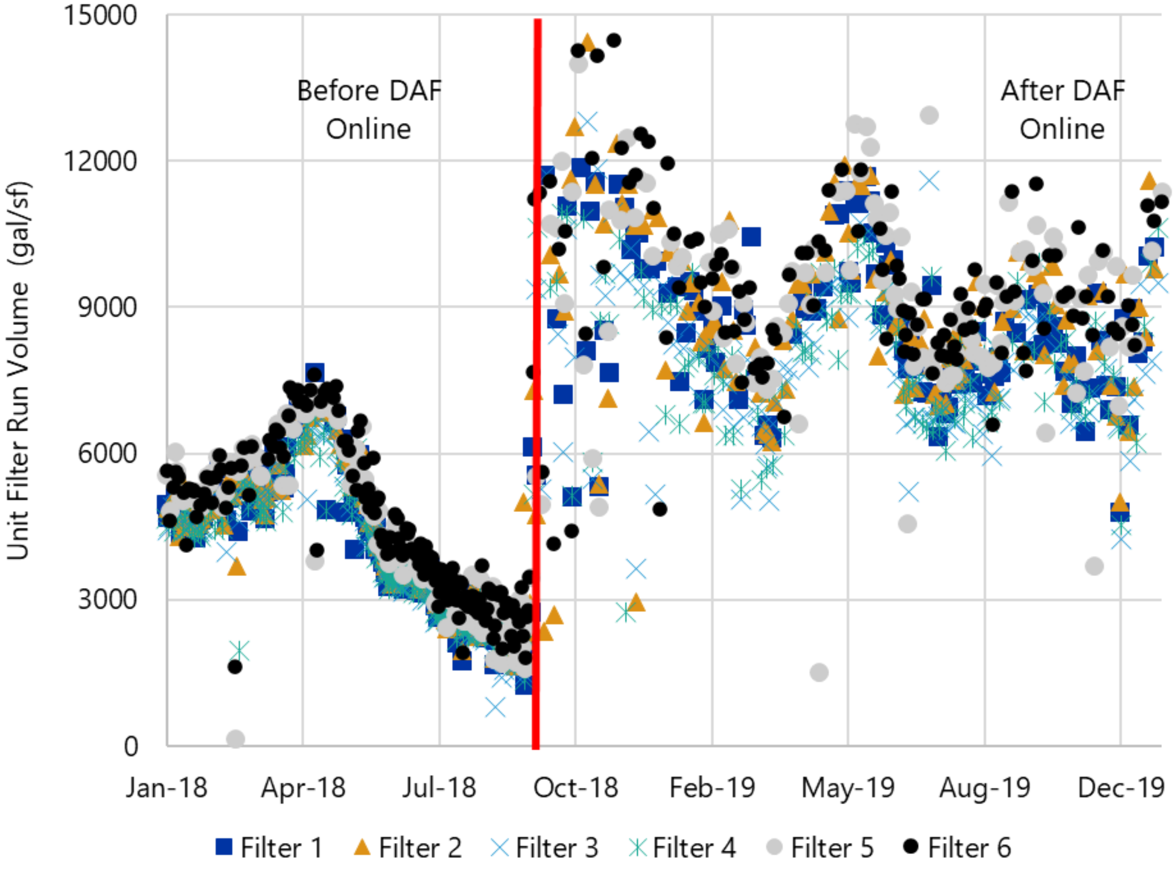


Figure 8.9 Unit Filter Run Volumes Before and After DAF Operation

Figure 8.10 summarizes average monthly filter UFRVs for each of the six filters for operating periods exclusively after DAF went online. Filters 5 and 6 have the longest average UFRVs, followed by Filters 1 and 2, with Filters 3 and 4 having the lowest UFRVs. Filters 1, 2, 5, and 6 typically have run times of 48 to 50 hours, while Filters 3 and 4 typically have run times of 40 to 42 hours.

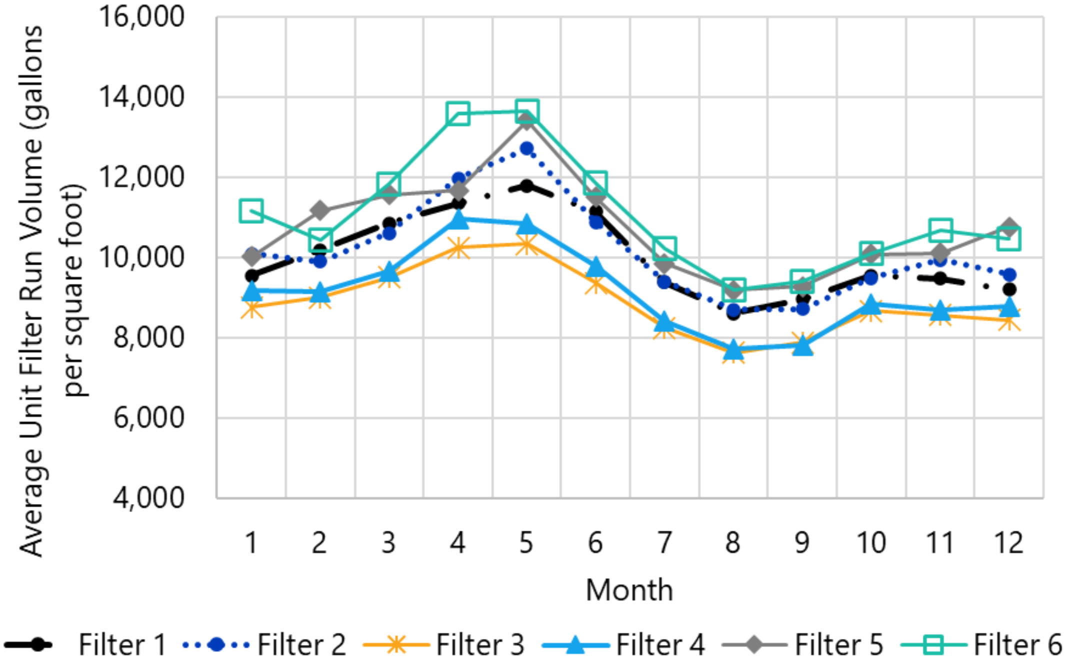


Figure 8.10 Unit Filter Run Volumes by Filter

During discussions with the City, it was noted that there were issues identified with the flow rate measurements for Filters 3 and 4 during the DAF installation process. Actual filter flow rates are closer to 2,400 gpm, not the approximately 1,900 gpm reported in City data. Filters 3 and 4 operate at higher filtration rates than Filters 1, 2, 5, and 6, which accounts for the shorter filter run times. Data presented in Figure 8.10 includes the flow rates reported in City data. If a flow rate of 2,400 gpm is used in conjunction with the recorded run times of 40 to 42 hours for Filters 3 and 4, the UFRVs for Filters 3 and 4 are approximately 10,000 to 11,000 gal/ft^2, consistent with average UFRVs observed for the remaining filters.

Overall filtration performance is excellent, UFRVs greater than 10,000 gal/ft^2 indicate highly efficient and effective filtration performance. As shown in the water quality evaluation, CFE turbidities are excellent, on average 0.03 NTU. Apart from the flow metering discrepancies, there were no noted performance issues with the filters.

8.5.4 Disinfection

Disinfection at the Whatcom Falls WTP is provided through the injection of chlorine (sodium hypochlorite) with the Whatcom Falls WTP utilizing hydraulic residence time in the CT Reservoir (Whatcom 2) to achieve the necessary CT. For CT purposes, chlorine is normally dosed to the clearwell influent. Residual chlorine is measured at the clearwell effluent for dose control before entering the CT Reservoir. Residual chlorine is also measured exiting the CT Reservoir.

Disinfection performance was evaluated using the inactivation ratio achieved through the CT Reservoir, the ratio of CT achieved to CT required to meet 1.0 log of giardia inactivation (calculated based on operating flow rate, pH, temperature, and chlorine residual). Figure 8.11 shows inactivation ratios by month, along with the average temperature and flow rate used for disinfection calculations.

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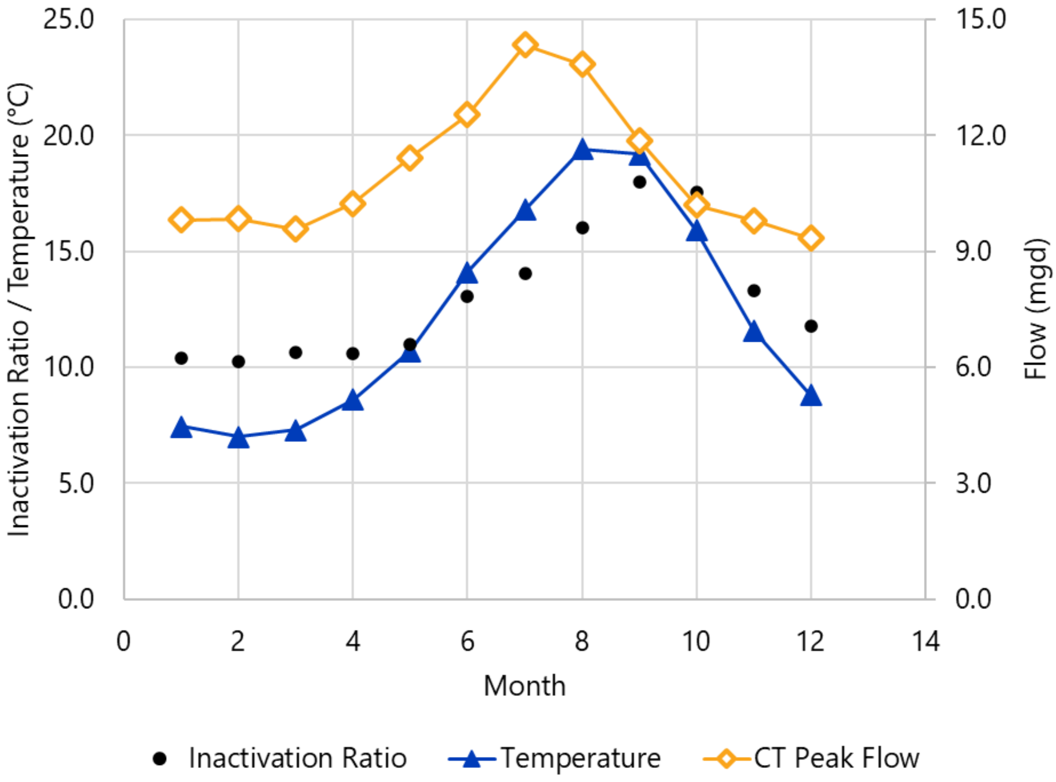


Figure 8.11 Inactivation Ratio by Month

Average inactivation ratios exceed 10 for all months of the year, with the 5th percentile inactivation ratios still greater than seven year-round. Inactivation ratios are typically lowest during the winter when water temperatures are low, but the Whatcom Falls WTP has no issues meeting disinfection requirements year-round. The normal operating volumes in the CT Reservoir are more than sufficient to meet all disinfection requirements.

8.5.5 Chemical Use

The Whatcom Falls WTP has four chemicals that are used throughout the treatment process:

- Aluminum sulfate (alum) for coagulation.
- Filter aid polymer for improved filter performance.
- Sodium hypochlorite (chlorine) for oxidation and disinfection.
- Soda ash for pH and alkalinity adjustment.

Figure 8.12 summarizes the monthly average chemical doses for all four chemicals. Overall, chemical dosing is very consistent throughout the year. With little variability in the raw water turbidity, alum doses are generally between 10 and 12 mg/L year-round. The alum dose is increased in the summer, likely related to algal growth and other lake-influenced summer water quality changes. The soda ash dose generally follows the trend in alum dosing; higher alum doses consume more alkalinity, lowering pH. The total chlorine dose (inclusive of pre-chlorination, disinfection, and distribution system residual trim dose) also generally peaks in the summer but is relatively consistent year-round.

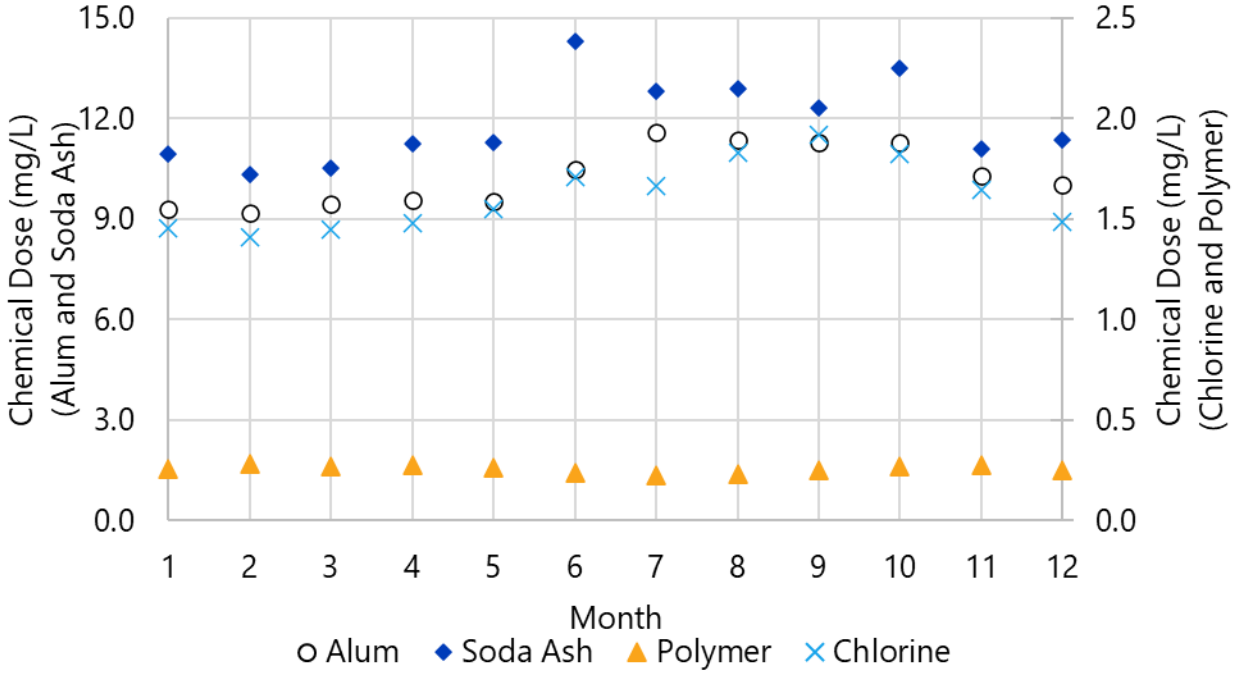


Figure 8.12 Average Chemical Dose by Month

8.6 Risk Analysis

High-level risks to the Whatcom Falls WTP site and infrastructure were reviewed using the City's previous efforts to develop its Emergency Response Plan and Risk and Resilience Assessment. Seismic activity was the primary risk identified for the Whatcom Falls WTP and surrounding area. To better understand the detailed seismic risks, and required mitigations, the City should conduct a WTP seismic resilience and life safety evaluation. This evaluation should include the following items:

- Evaluate structural performance of Whatcom Falls WTP facilities during seismic hazard event.
- Conduct geotechnical hazard evaluation to develop seismic hazard maps encompassing full extent of Whatcom Falls WTP infrastructure.
- Identify structural deficiencies and life-safety deficiencies in existing structures, structural connections, equipment anchors, mechanical/electrical systems, and other ancillary components at the Whatcom Falls WTP. Evaluation should include assessment of existing, wooden clearwell baffles.
- Identify areas of pipeline subject to geohazards for raw and finished water pipelines.

8.7 Major Equipment and Future Planning

Major Whatcom Falls WTP equipment and processes were evaluated to help identify the need for near-term replacement or improvement projects to be included in capital improvement planning. This evaluation focused predominantly on major process equipment, not piping and overall concrete structures/facilities. The evaluation consisted of a site visit to the Whatcom Falls WTP for discussions with the operations staff and a comparison of major equipment age against typical replacement frequencies (useful life evaluation). A site visit to the Whatcom Falls WTP was conducted in October 2023 to physically observe the overall condition and discuss current treatment performance, capacity, and condition with operations staff. City staff also provided additional information on previously identified Whatcom Falls WTP projects to include in future Whatcom Falls WTP improvement planning.

In addition to any condition issues noted by City staff during the Whatcom Falls WTP walkthrough, the age of major equipment was also used to identify potential replacement projects within the planning period. City staff provided equipment age data, and the remaining useful life was calculated for each piece of equipment. For the purposes of this assessment, useful life is defined as the period of time (or total amount of activity) for which the asset will be economically feasible for use in water treatment and water production. Although the useful life of an asset can be extended indefinitely, it will typically reach a point of diminishing returns, where the cost to maintain the existing equipment (both materials and labor) exceeds the cost of replacement. The useful life of a piece of equipment is highly variable – depending on constructed quality, materials, service conditions, and many other factors.

For this evaluation, information published by the USEPA and the AWWA was used as a baseline for determining the equipment's useful life. Typical useful life values published by the USEPA are shown in Table 8.17.

Table 8.17 USEPA Typical Useful Life for Water Treatment Infrastructure

Asset Type	Typical Useful Life(1)
Reservoirs and Dams	50 - 80
Treatment Plants - Concrete Structures	60 - 70
Treatment Plants - Mechanical and Electrical	15 - 25
Trunk Mains	65 - 95
Pumping Stations - Concrete Structures	60 - 70
Pumping Stations - Mechanical and Electrical	25
Distribution Infrastructure	65 - 95

Notes:
(1) Source: USEPA. Clean Water and Drinking Water Infrastructure Gap Analysis. USEPA-816-R-02-020, September 2002.

AWWA's Asset Management Committee publishes a spreadsheet-based Effective Useful Life Tool that can be used to help facilities determine renewal and replacement needs. The tool was developed from surveys of operating facilities and includes low, average, and high useful life values for a wide range of equipment and infrastructure. Table 8.18 includes select data taken from the tool that were used for analysis of Whatcom Falls WTP infrastructure in this plan.

Table 8.18 AWWA Water Treatment Equipment Useful Life

Equipment Category	Equipment Type	Useful Life Range (years)
Electrical	Switchgear	15 - 35
Electrical	Generators	10 - 30
Electrical	Control Panel/Switchgear	10 - 30
Electrical	AC Motors	10 - 30
Electrical	Variable Frequency Drives	7 - 15
Instrumentation	Flow Meters	10 - 25
Instrumentation	Analyzers	5 - 30

Equipment Category	Equipment Type	Useful Life Range (years)
Instrumentation	SCADA Hardware/PLC	7 - 25
Instrumentation	PLC	10 - 20
Mechanical	Chemical Feed System	7 - 20
Mechanical	Screens	15 - 30
Pumps	Diaphragm	5 - 25
Pumps	Vertical Turbine	10 - 30
Valves and Gates	Actuator	10 - 30
Valves and Gates	Unspecified	10 - 25
Valves and Gates	Metal Valves	20 - 50
Valves and Gates	Check Valves	10 - 50

Notes:
(1) Information adapted from AWWA's spreadsheet-based Effective Useful Life Tool.
PLC - programmable logic controller.

For each major piece of equipment, the City provided an estimated installation date to calculate the remaining useful life. AWWA useful life low and high ranges were both included to account for the variability in effective useful life of equipment. Note, manufacturing quality, increased maintenance intervals, decreased run time, rebuild/refurbishment, service environment, and other factors can contribute to useful life differing from the ranges indicated. However, these general metrics provide a helpful indicator for planning equipment replacement needs within the planning horizon.

Full data for the useful life evaluation presented in tables below can be found in Appendix T.

8.7.1 Raw Water Infrastructure

The Whatcom Falls WTP raw water infrastructure includes all of the water system components upstream of the Whatcom Falls WTP. This evaluation focuses on the Lake Whatcom raw water infrastructure and does not include the City's separate diversion system infrastructure:

- Wood stave intake pipeline in Lake Whatcom.
- Geneva gate house.
- Screen house.
- Raw water tunnel from the gate house to the screen house.
- Screen house piping and raw water pipeline from the screen house to the Whatcom Falls WTP.

Table 8.19 summarizes the useful life analysis for the raw water infrastructure mechanical equipment. As discussed later, the City is actively working on multiple projects pertaining to the raw water infrastructure. No separate project will be included to address gaining raw water infrastructure.

Table 8.19 Raw Water Infrastructure Useful Life

Equipment	Age	Useful Life	Exceeds Useful Life in 10 Years?	Exceeds Useful Life in 20 Years?
Screens	23	15-30	**X**	**X**

Key:
X = Exceeds useful life for full range of useful life.
O = Exceeds useful life for low end of useful life range only.
– = Does not exceed useful life range.

During discussions with the City, development of redundant raw water infrastructure was identified as a priority project for the 20-year planning period. Whatcom Falls WTP improvement projects will be included for a redundant raw water intake feasibility study and subsequent redundant raw water intake capital project. At this stage of planning, the scope and extent of these raw water improvements are undefined and are to be refined further during the feasibility study.

8.7.2 DAF

The DAF building and equipment were brought into service in 2018. There are two DAF trains, each with a treatment capacity of 10 mgd and a hydraulic capacity of 12 mgd. The DAF treatment train consists of the following:

- An in-line rapid mixer; alum is added at the rapid mixer for coagulation prior to entering the DAF trains.
- Two single-stage flocculation basins, each with a single vertical shaft flocculator.
- Two DAF basins with effluent laterals, sludge troughs, and effluent weirs.
- Recirculation/saturation system with recycle pumps and saturators to form pressurized air to inject into the DAF basin.

Table 8.20 summarizes the estimated useful life of the major DAF equipment. All the equipment is less than 10 years old and will only exceed the low-end range of AWWA's useful life within the 20-year planning period. Operations staff did not identify any issues with the existing equipment. No projects are recommended for inclusion to improve or replace DAF infrastructure.

Table 8.20 DAF Infrastructure Useful Life

Equipment	Age	Useful Life	Exceeds Useful Life in 10 Years?	Exceeds Useful Life in 20 Years?
Flash Mixer	6	10 – 30	**O**	**O**
Recirculation Pumps/Motors	6	10 – 30	**O**	**O**
Flocculators	6	15 – 25	**O**	**O**
DAF Valves	6	20 – 50	**–**	**O**
Gates	6	20 – 40	**–**	**O**
Flow Meters	6	10 – 25	**O**	**O**

Key:
X = Exceeds useful life for full range of useful life.
O = Exceeds useful life for low end of useful life range only.
– = Does not exceed useful life range.

8.7.3 Rapid Mix/Flume

Water flows either from the raw water pipeline or from DAF through two rapid mix basins, each of which is equipped with modulating flume valves for level control across the Whatcom Falls WTP process. No data was available on the age of the flume valves, but there have been no known issues with their condition or operation. No projects specific to the rapid mix/flume equipment are recommended currently.

8.7.4 Filtration

The Whatcom Falls WTP has six equal-sized dual bay filters, each with 560 ft^2 of surface area and a maximum 5 gpm/ft^2 allowable filtration rate. Water flows into the filter influent flume and is directed to the online filters. Filter aid polymer is dosed at the entrance to the filter influent flume. Backwash water is supplied by the three backwash pumps. Filters are backwashed with a combination of air and water. The original surface wash system is only occasionally used instead of air scour.

City staff currently skim the top layer of media annually, but there are no major operational or condition concerns related to the filters. City staff have already identified a project to replace media, backwash troughs, and other items. The only concerns of note pertaining to the filtration system are the issues with metering flow on Filters 3 and 4 and capacity limitations on the backwash pumps. Two backwash pumps must operate at a time to achieve backwash flow rates.

Table 8.21 summarizes the remaining useful life for major equipment associated with each filter. For this analysis, major equipment was defined as the filter control valves and actuators. Each filter has the following butterfly valves and actuators:

- Two 3-inch surface wash valves with open/close electric actuators.
- Two 6-inch air scour valves with open/close electric actuators.
- One 8-inch filter to waste valve with open/close electric actuators.
- Two 14-inch bay valves with open/close electric actuators.
- One 14-inch backwash valve with modulating electric actuator.
- One 14-inch filter effluent valve with modulating electric actuator.
- One 16-inch waste valve with open/close electric actuator.
- One 24-inch filter influent valve with open/close electric actuator.

Table 8.21 Filtration Valves and Actuators System Useful Life

Equipment	Useful Life	Exceeds Useful Life in 10 Years?	Exceeds Useful Life in 20 Years?
Filter 1 Valves	20 – 50	**X** (except for waste) **–** (waste only)	**X** (except for waste and filter to waste) **O** (waste and filter to waste only)
Filter 1 Actuators	10 – 30	**X** (except for waste and backwash) **O** (waste and backwash)	**X**
Filter 2 Valves	20 – 50	**O**	**X** (except for filter to waste) **O** (filter to waste)
Filter 2 Actuators	10 – 30	**X** (except for influent and backwash) **O** (influent and backwash)	**X**
Filter 3 Valves	20 – 50	**O**	**X** (except for waste and filter to waste) **O** (waste and filter to waste only)
Filter 3 Actuators	10 – 30	**O** (except for bay and filter to waste) **X** (bay and filter to waste)	**X** (except for effluent) **O** (effluent)
Filter 4 Valves	20 – 50	**O** (except for left bay) **X** (left bay only)	**X** (except for filter to waste) **O** (filter to waste only)
Filter 4 Actuators	10 – 30	**X** (except for waste) **O** (waste)	**X**

Equipment	Useful Life	Exceeds Useful Life in 10 Years?	Exceeds Useful Life in 20 Years?
Filter 5 Valves	20 – 50	**O**	**X**
Filter 5 Actuators	10 – 30	**X** (except for waste and backwash) **O** (waste and backwash)	**X**
Filter 6 Valves	20 – 50	**O**	**X** (except for filter to waste) **O** (filter to waste)
Filter 6 Actuators	10 – 30	**X** (except for waste and backwash) **O** (waste and backwash)	**X**

Key:
X = Exceeds useful life for full range of useful life.
O = Exceeds useful life for low end of useful life range only.
– = Does not exceed useful life range.

Table 8.22 summarizes the age and remaining useful life for the backwash pumps.

Table 8.22 Backwash Pumps Useful Life

Equipment	Age	Useful Life	Exceeds Useful Life in 10 Years?	Exceeds Useful Life in 20 Years?
Backwash Pump 1	56	10 - 30	**X**	**X**
Backwash Pump 2	56	10 – 30	**X**	**X**
Backwash Pump 3	14	10 – 30	**O**	**X**

Key:
X = Exceeds useful life for full range of useful life.
O = Exceeds useful life for low end of useful life range only.
– = Does not exceed useful life range.

The filter rehabilitation project previously identified by the City did not include assessment or replacement of mechanical equipment associated with the filters. A separate filter mechanical equipment replacement project is recommended to replace the aging backwash pumps and all filter valves and actuators.

8.7.5 Chemical Systems

8.7.5.1 Aluminum Sulfate

Alum is normally dosed to the rapid mixer upstream of DAF for coagulation, but can also be added to the flume inlet upstream of the flume influent vales if DAF is not in service. The alum system consists of a storage tank, day tank, and three metering pumps.

Table 8.23 summarizes the remaining useful life of alum system equipment. All equipment has exceeded its useful life or will exceed its useful life within the 10 and 20-year planning period. A condition assessment of the alum tank 10 years ago did not identify any concerns. Additionally, no condition or performance concerns were identified with the alum system. Even so, with the overall age of the system, replacement and/or improvement of the alum system will be included as a future Whatcom Falls WTP improvement project.

Table 8.23 Aluminum Sulfate Useful Life

Equipment	Age	Useful Life	Exceeds Useful Life in 10 Years?	Exceeds Useful Life in 20 Years?
Storage Tank	56	10 – 30 (chemical tanks)	**X**	**X**
Pump 1	15	5 – 25	**X**	**X**
Pump 2	42	5 – 25	**X**	**X**
Pump 3	19	5 – 25	**O**	**X**

Key:
X = Exceeds useful life for full range of useful life.
O = Exceeds useful life for low end of useful life range only.
– = Does not exceed useful life range.

8.7.5.2 Soda Ash

Soda ash (sodium carbonate) is added to the treated effluent to raise the pH and alkalinity prior to entering the distribution system. The soda ash feed system consists of the following components:

- Soda ash storage silos and associated ventilation system.
- Weigh belt feeders.
- Solution tanks with mixers.
- Soda ash solution centrifugal pumps.
- Dust control and ventilation system.

Additional redundancy is recommended for the soda ash system. Currently, each silo, feeder, and solution tank are completely independent. The ability to feed each solution tank from either silo would provide greater overall system redundancy in the event one silo or feed system is out of service for maintenance.

Table 8.24 summarizes the useful life evaluation of the soda ash system equipment. Much of the soda ash system equipment will exceed its useful life in the 20-year planning period. In 2023, the City completed an alternatives evaluation for improvements to the soda ash system that will be included in an already planned Whatcom Falls WTP improvement project. These improvements will address the identified operational and age concerns with the soda ash system, and no additional improvement project is needed.

Table 8.24 Soda Ash Useful Life

Equipment	Age	Useful Life	Exceeds Useful Life in 10 Years?	Exceeds Useful Life in 20 Years?
Silos	1994			
Dust Collection	16	7 – 30	**O**	**X**
Belt Feeders	16	7 – 20	**X**	**X**
Solution Pumps	0			
Tank Mixers	No data			

Key:
X = Exceeds useful life for full range of useful life.
O = Exceeds useful life for low end of useful life range only.
– = Does not exceed useful life range.

8.7.5.3 Polymer

Cationic polymer is used as either a coagulant aid when dosed prior to the DAF system or as a filter aid when dosed just before the filters. The polymer system consists of:

- Liquid emulsion polymer drums.
- Liquid polymer pump.
- Aging tank and mixer.
- Solution tank.
- Polymer transfer pump.
- Two polymer metering pumps.
- Polymer drum scale.

The polymer system is designed to create a batch of diluted polymer solution that is metered at an adjustable rate. Neat, emulsion polymer is pumped into the aging tank and mixed with plant water to create a diluted polymer solution. The polymer solution is aged in the aging tank and then pumped to the solution tank, where it is dosed by the metering pumps.

The overall functionality of the polymer system is good, even though the blending/aging system was originally installed in the 1980s and is well past its useful life, as shown in Table 8.25. The primary challenge with the existing polymer system is managing the age of batched polymer. Because of the low doses of polymer used, batches of polymer sit in the aging and solution tank longer than recommended or required.

A Whatcom Falls WTP improvement project is recommended to replace the existing polymer feed system with a more modern blend and feed system that is sized appropriately for plant chemical usage requirements. As part of this project, the design of the new system should consider alternatives to the existing drum-based system to better manage challenges with polymer age and procurements. Options to evaluate may include tote-based feed systems and neat polymer feed systems.

Table 8.25 Polymer System Useful Life

Equipment	Age	Useful Life	Exceeds Useful Life in 10 Years?	Exceeds Useful Life in 20 Years?
Metering Pumps	No Data	7 – 25		
Blending/Aging System	41	7 – 20	**X**	**X**

Key:
X = Exceeds useful life for full range of useful life.
O = Exceeds useful life for low end of useful life range only.
– = Does not exceed useful life range.

8.7.5.4 Sodium Hypochlorite

The on-site sodium hypochlorite generation system was installed in 2018 as part of the DAF project. There are no major operation or condition concerns with this system. No projects pertaining to it are currently recommended.

8.7.6 Electrical and Controls Infrastructure

Table 8.26 summarizes the remaining useful life of major electrical equipment at Whatcom Falls WTP. A project to replace Motor Control Center (MCC) 2 and MCC 3 with modern electrical equipment is recommended.

No major issues or concerns were identified with the electrical and controls infrastructure. The City identified that the SCADA system software is 12 years old. Currently, there are no known issues with software support, but a SCADA evaluation project is recommended to help evaluate the software age and determine if upgrades are needed.

Table 8.26 Electrical and Controls Infrastructure Useful Life

Equipment	Age	Useful Life	Exceeds Useful Life in 10 Years?	Exceeds Useful Life in 20 Years?
Switchboard	6	15 - 35	**O**	**O**
MCC 1	13	10 - 30	**O**	**X**
MCC 2	31	10 - 30	**X**	**X**
MCC 3	31	10 - 30	**X**	**X**
Generator	14	10 - 30	**O**	**X**
WTP PLC	12	10 - 20	**X**	**X**
SCADA Software	12	-		

Key:
X = Exceeds useful life for full range of useful life.
O = Exceeds useful life for low end of useful life range only.
– = Does not exceed useful life range.

8.7.7 Recommended Whatcom Falls WTP Improvement Projects

Table 8.27 summarizes all Whatcom Falls WTP recommended improvement projects from this master plan, along with a brief project description.

Table 8.27 Recommended Whatcom Falls WTP Improvements Projects

Project	Source
Redundant Raw Water Intake Feasibility Study	▪ Conduct a feasibility study to identify options to provide a redundant source of raw water to the Whatcom Falls WTP, including intake and raw water piping. ▪ Intake evaluation will include assessment of multi-level intake tower, fish screening requirements, water rights considerations, and other permitting implications.
Redundant Raw Water Intake	▪ Construct redundant raw water supply to the Whatcom Falls WTP site, including intake and piping. ▪ Project scope to be refined based on the results of the feasibility study.
Alum System Replacement	▪ Replace alum storage tank and metering pumps that have exceeded their useful life. ▪ Metering pump replacement will include replacement of all mechanical equipment and instrumentation on individual pump discharge piping up to combined discharge piping from all three pumps.
SCADA System Evaluation	▪ Complete evaluation of plant SCADA system. ▪ Determine if improvements and software upgrades are needed.

Project	Source
Polymer System Replacement	▪ Replace existing polymer feed system (mixing/batch tanks, mixers, feeds pumps) with modern polymer blend and feed system. ▪ Current system is over-sized for normal usage; new polymer system design will be optimized to match plant requirements. ▪ Design will evaluate alternatives to current drum-based system to address challenges with polymer age and procurement. Evaluation will consider tote-based feed and batch system and neat polymer feed system.
Filter Mechanical Equipment Replacement	▪ Two backwash pumps are original to the plant and have far exceeded their useful life. Replace three existing backwash pumps and motors. ▪ Replace all filter valves and actuators.
MCC Replacement	▪ Replace existing MCCs 2 and 3 that are reaching the end of useful life.
Whatcom Falls WTP Seismic Resilience and Life Safety Evaluation	▪ Conduct geotechnical hazard evaluation to develop seismic hazard maps encompassing the full extent of Whatcom Falls WTP infrastructure, including Whatcom Falls WTP site yard piping. ▪ Evaluate structural performance of Whatcom Falls WTP facilities during seismic hazard event. ▪ Identify structural deficiencies and life-safety deficiencies in existing structures, structural connections, equipment anchors, mechanical/electrical systems, and other ancillary components. Evaluation to include assessment of clearwell baffles. ▪ Identify any raw water pipeline areas subject to geohazards. ▪ Develop a seismic risk mitigation plan to identify seismic retrofits or improvements.

8.7.8 Previously Identified Improvement Projects

Table 8.28 summarizes Whatcom Falls WTP projects previously identified by the City or identified during discussions with the City beyond the process-specific improvement projects identified in this Chapter.

Table 8.28 Previously Identified Whatcom Falls WTP Improvements Projects

Project	Description	Project Source Document
Raw Water Intake Rehabilitation Improvement	▪ Complete rehabilitation projects on existing raw water intake pipeline identified in Intake Pipelines Condition Assessment Report (Jacobs 2024). ▪ Includes replacement of pipeline components critical to pipeline integrity and securing ballast weights. Further inspection of metal fasteners and pipeline bands on the buried portion of the intake pipeline.	▪ Intake Pipelines Condition Assessment (Jacobs 2024)

Project	Description	Project Source Document
Screenhouse Rehabilitation	▪ Reline/recoat three pipelines in screenhouse. ▪ New gates/valves. ▪ New screen mechanism. ▪ Design/planning for the project to include evaluation of alternative delivery options to get contractor input on methods to keep Whatcom Falls WTP operational while portions of the raw water supply are out of service during project construction. ▪ Repairs to spalled concrete and corroded rebar at the pilaster on the second floor. ▪ Wet well protective coating system, stop log channel cleaning, slide gate replacement. ▪ Non-destructive investigation of structural defects and develop alternative water intake strategy.	▪ Gatehouse Condition Assessment Report (Jacobs 2024) ▪ Screenhouse Condition Assessment Report (Jacobs 2024) ▪ Tunnel Condition Assessment Report (Jacobs 2024)
Filter Rehabilitation Project	▪ Replace filter media/backwash troughs. ▪ Underdrain inspection. ▪ Handrail replacement and access improvements.	▪ Technical Memorandum WTP Filter Improvements (RH2 2023)
Soda Ash Feed System Replacement	▪ Replace mechanical equipment and infrastructure between silos and solution piping (feeders, solution mixers, etc.). ▪ Provide ability to feed soda ash from either silo. ▪ Clean soda ash silos.	▪ Technical Memorandum Soda Ash Improvements (RH2 2023)
Whatcom Falls WTP Flow Metering Improvements Study	▪ Address issues with production data recorded by the gravity flow meter leaving the Whatcom Falls WTP site. ▪ Provide evaluation of flow meter performance and options for replacement or improvements. ▪ Assess the accuracy of the existing meter and determine options for replacement if meter proves to be inaccurate. ▪ If meter replacement is recommended, evaluation will determine if existing meter can be replaced in the current location or if an alternative metering location or strategy is required.	▪ Chapter 2 ▪ Memorandum, City of Bellingham Gravity Flow Meter Assessment (Jacobs 2020)
Whatcom Falls WTP Flow Metering Improvements Study	▪ Construct recommended Whatcom Falls WTP flow metering improvements identified in prior study.	▪ Chapter 2 ▪ Memorandum, City of Bellingham Gravity Flow Meter Assessment (Jacobs 2020)
Powerhouse Demolition	▪ Demolish existing Powerhouse structure and restore diversion pipeline running through the Powerhouse site. ▪ Project execution to be coordinated with PSE.	▪ Discussions with City.
Whatcom Falls WTP HVAC System Improvements	▪ During previous maintenance efforts, contractors recommended full replacement of the Whatcom Falls WTP HVAC system. ▪ Conduct assessment of existing HVAC system, identify improvements required, and develop design for improvements. ▪ Construct recommended improvements to HVAC system.	▪ Discussion with City.

8.8 Improvement Projects Summary

Table 8.29 summarizes all recommended Whatcom Falls WTP improvement projects identified from previous work by the City as well as the evaluations completed in this plan for inclusion in capital improvement planning, presented in Chapter 10.

Table 8.29 Whatcom Falls WTP Improvements Projects

Project	Source
Raw Water Intake Rehabilitation Improvements	▪ Intake Pipelines Condition Assessment (Jacbos 2024)
Redundant Raw Water Intake Feasibility Study	▪ Section 8.7.1 and Section 8.7.7
Redundant Raw Water Intake	▪ Section 8.7.1 and Section 8.7.7
Screenhouse Rehabilitation	▪ Gatehouse Condition Assessment Report (Jacobs 2024) ▪ Screenhouse Condition Assessment Report (Jacobs 2024) ▪ Tunnel Condition Assessment Report (Jacobs 2024)
Filter Rehabilitation	▪ Technical Memorandum WTP Filter Improvements (RH2 2023)
Soda Ash Feed System Replacement	▪ Technical Memorandum Soda Ash Improvements (RH2 2023)
Whatcom Falls WTP Flow Metering Improvements Study	▪ Chapter 2 ▪ Memorandum, City of Bellingham Gravity Flow Meter Assessment (Jacobs 2020)
Whatcom Falls WTP Flow Metering Improvements	▪ Chapter 2 ▪ Memorandum, City of Bellingham Gravity Flow Meter Assessment (Jacobs 2020)
Alum System Replacement	▪ Section 8.7.7
Powerhouse Demolition	▪ Section 8.7.8
SCADA System Evaluation	▪ Section 8.7.7
Polymer System Replacement	▪ Section 8.7.7
Filter Mechanical Equipment Replacement	▪ Section 8.7.7
MCC Replacement	▪ Section 8.7.7
Whatcom Falls WTP Seismic Resilience and Life Safety Evaluation	▪ Section 8.6
Whatcom Falls WTP HVAC System Improvements	▪ Section 8.7.8

CHAPTER 9 OPERATIONS AND MAINTENANCE

The City proactively operates and maintains its water system as an effective means of system management. The City began developing an Operations and Maintenance (O&M) Manual in the mid-1990s and has since continued to update it periodically and add new material. Appendix V is the table of contents for this document. This section is formatted consistent with the format presented in Chapter 6 of the Washington State DOH Planning Handbook.

9.1 Water System Management and Personnel

Bellingham manages its water and wastewater systems cooperatively within the same management unit, the Public Works Department. Daily maintenance and operations are conducted by the Operations Division, which is primarily comprised of operators, maintenance staff, field crews, and laboratory staff. Water system planning, design, and other non-routine management of the water system are addressed by engineering staff within the Engineering Division. The Operations Division organizational structure is presented in Figure 9.1 to Figure 9.8. The structure reflects the utility's internal organization and how the different branches of the Operations Division are structured. This section includes a brief discussion of the responsibilities of positions in the Operations Division.

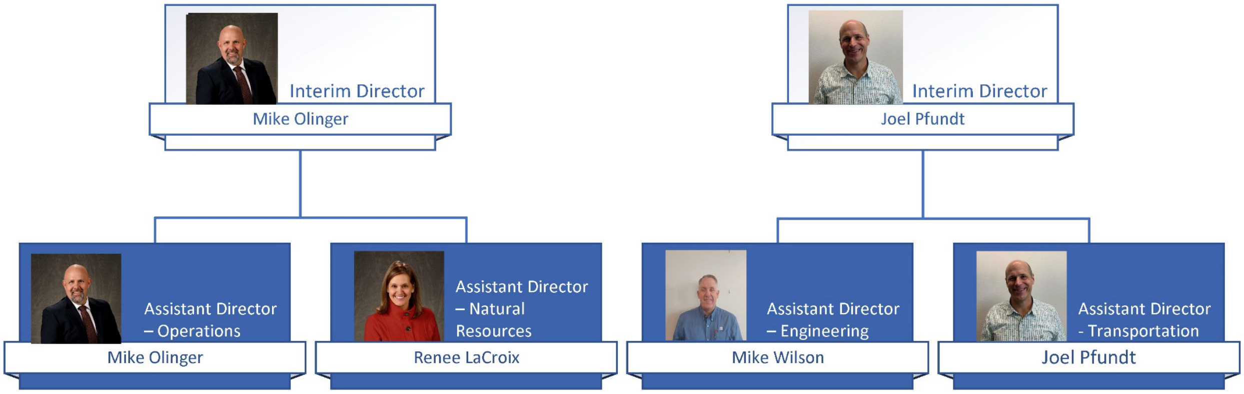


Figure 9.1 Operations Division Organizational Structure

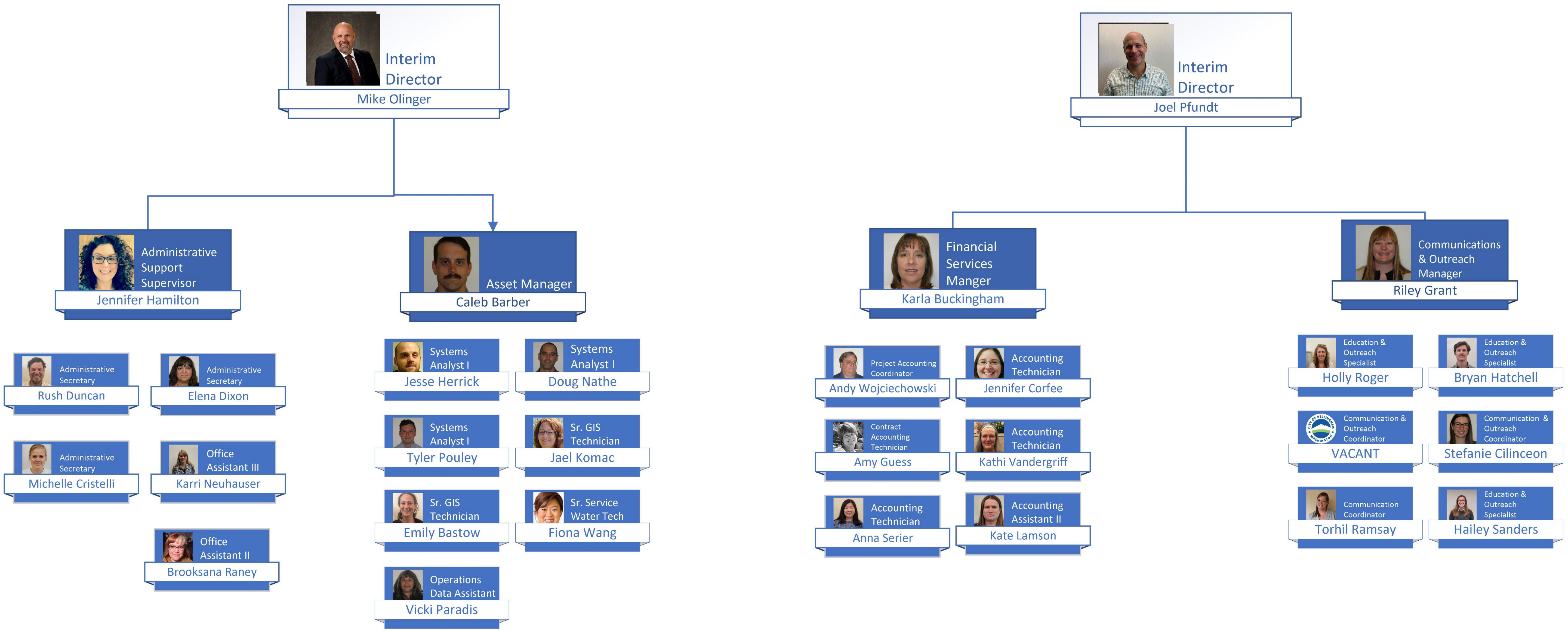


Figure 9.2 Operations Division Organizational Structure - Public Works

Natural Resources

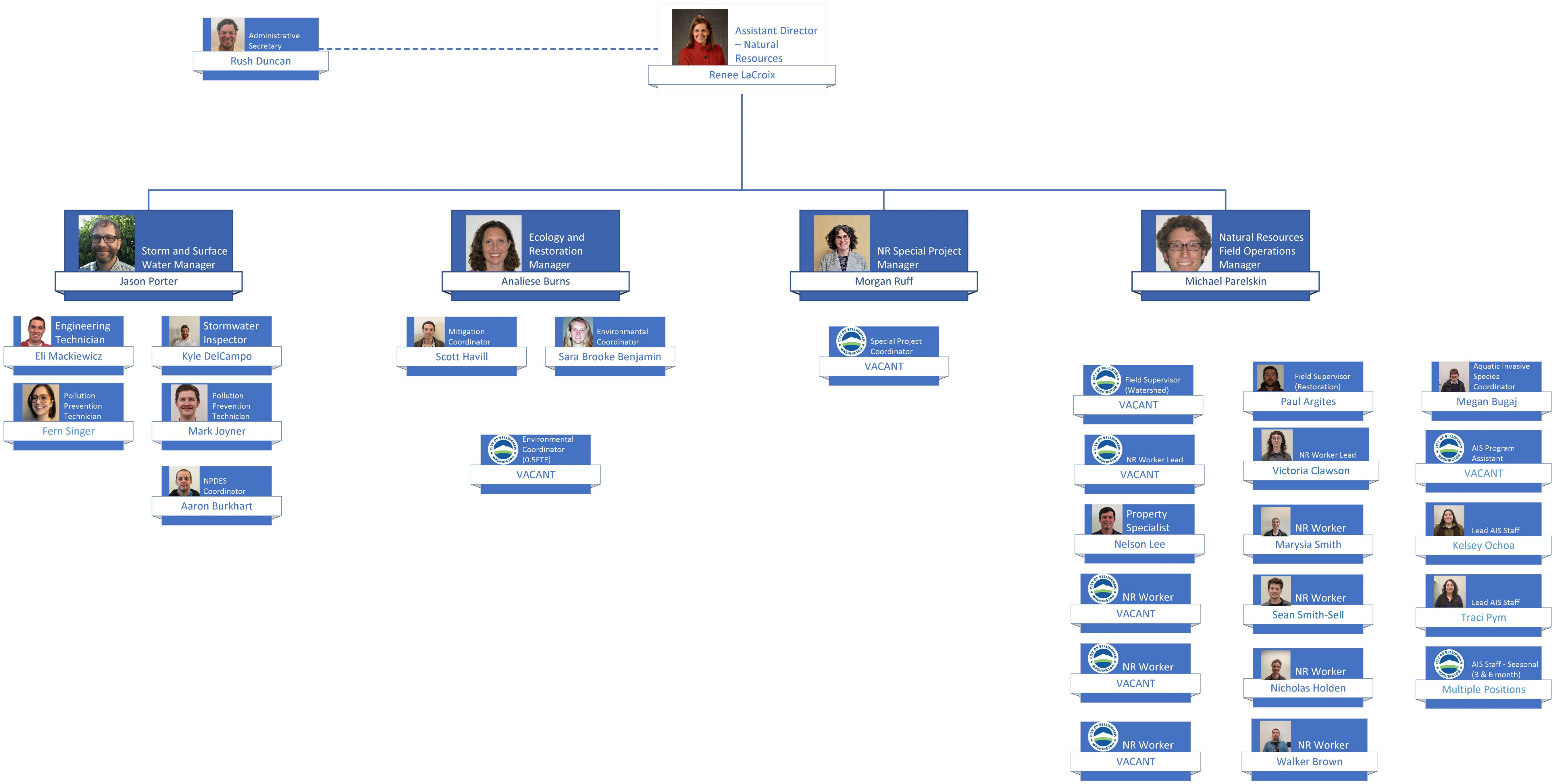


Figure 9.3 Operations Division Organizational Structure - Natural Resources

Engineering

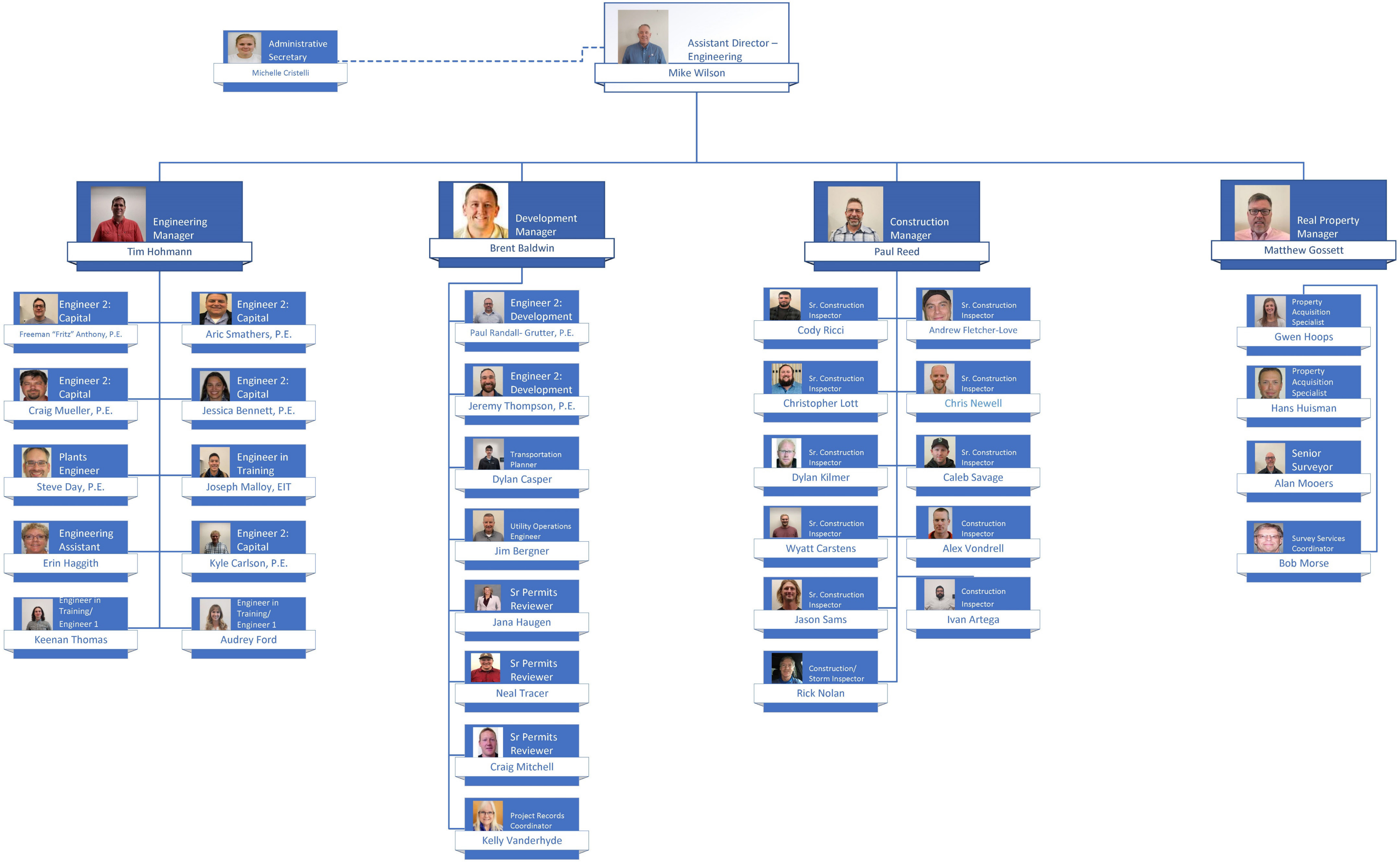


Figure 9.4 Operations Division Organizational Structure - Engineering

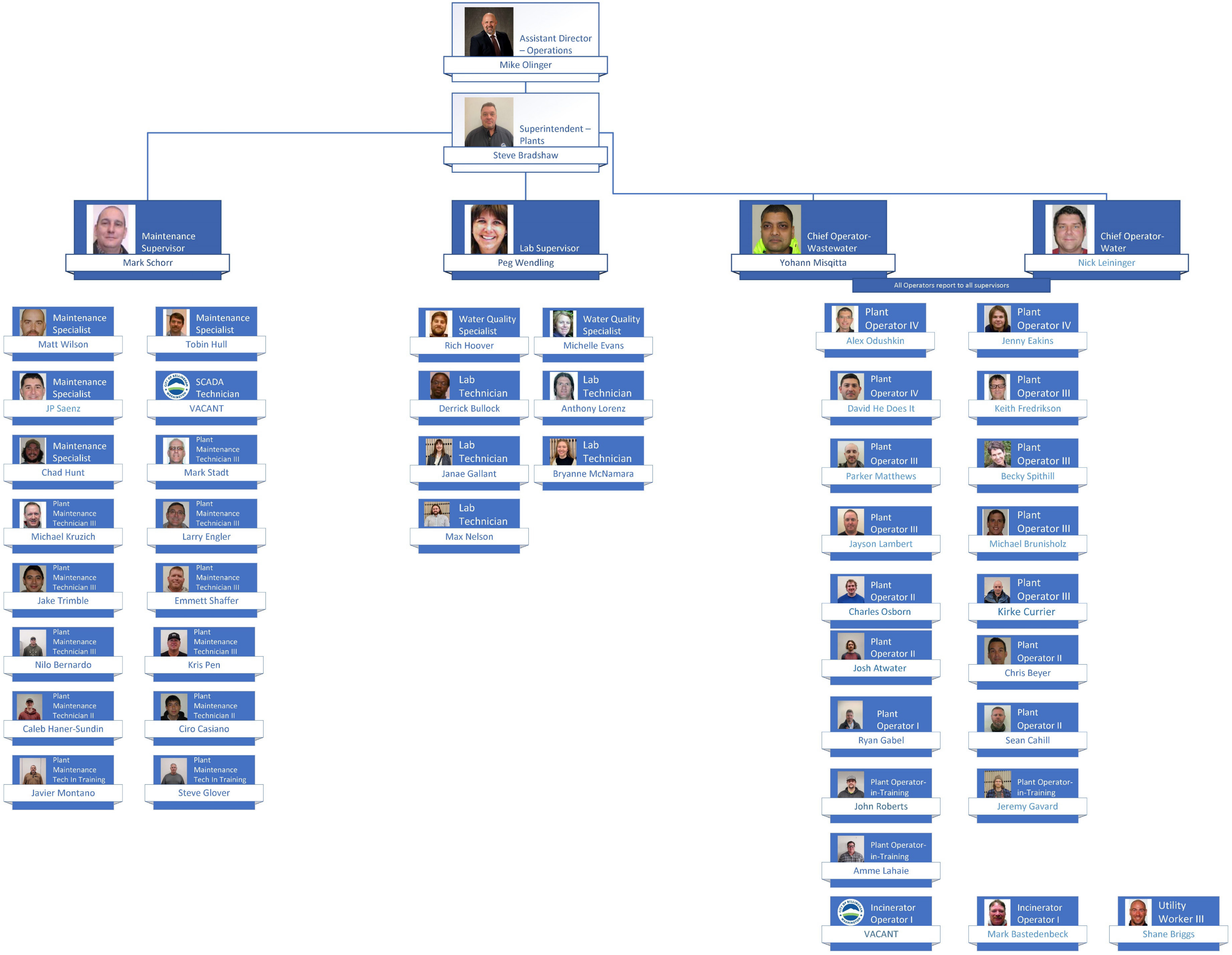


Figure 9.5 Operations Division Organizational Structure - Operations

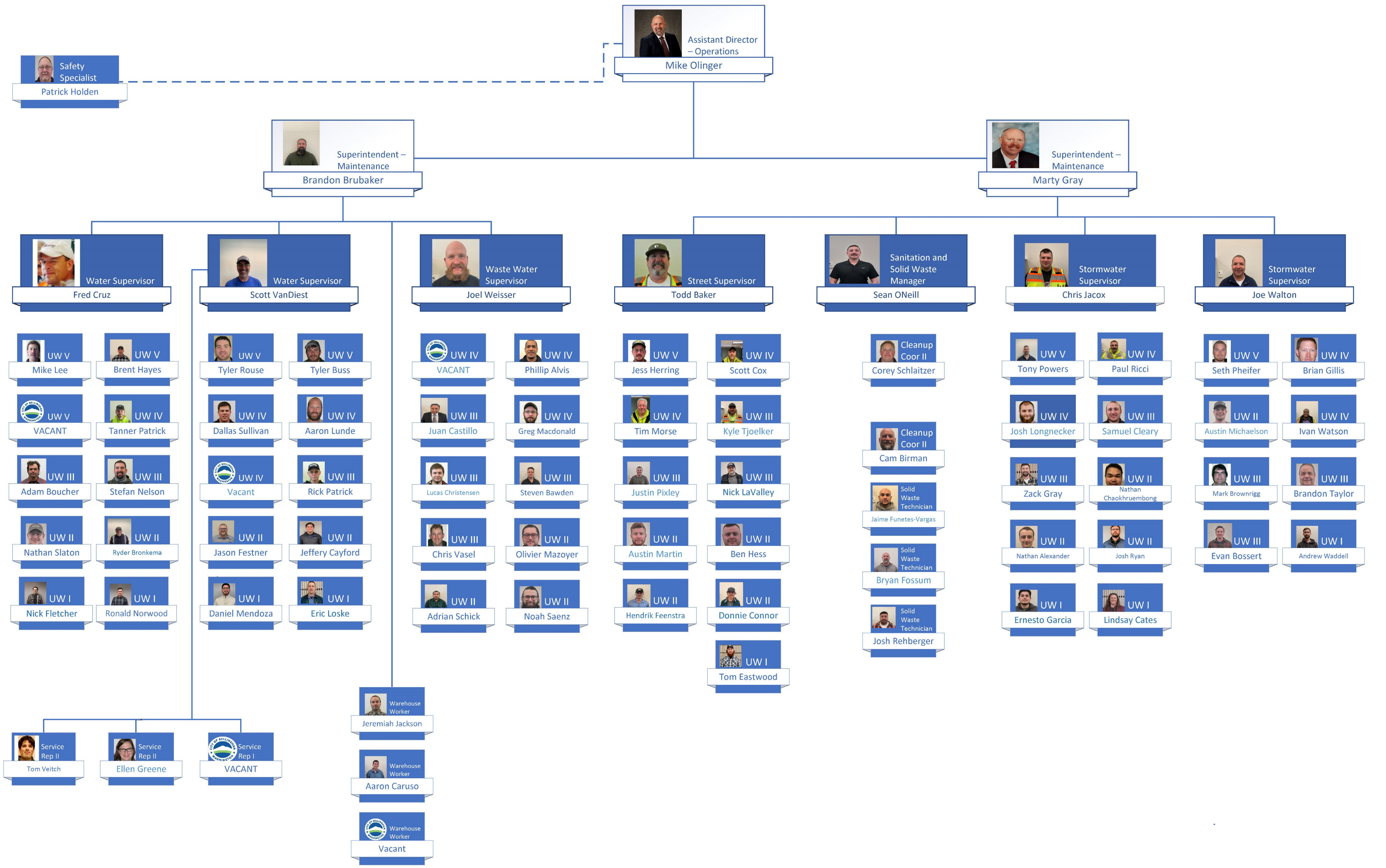


Figure 9.6 Operations Division Organizational Structure - Maintenance

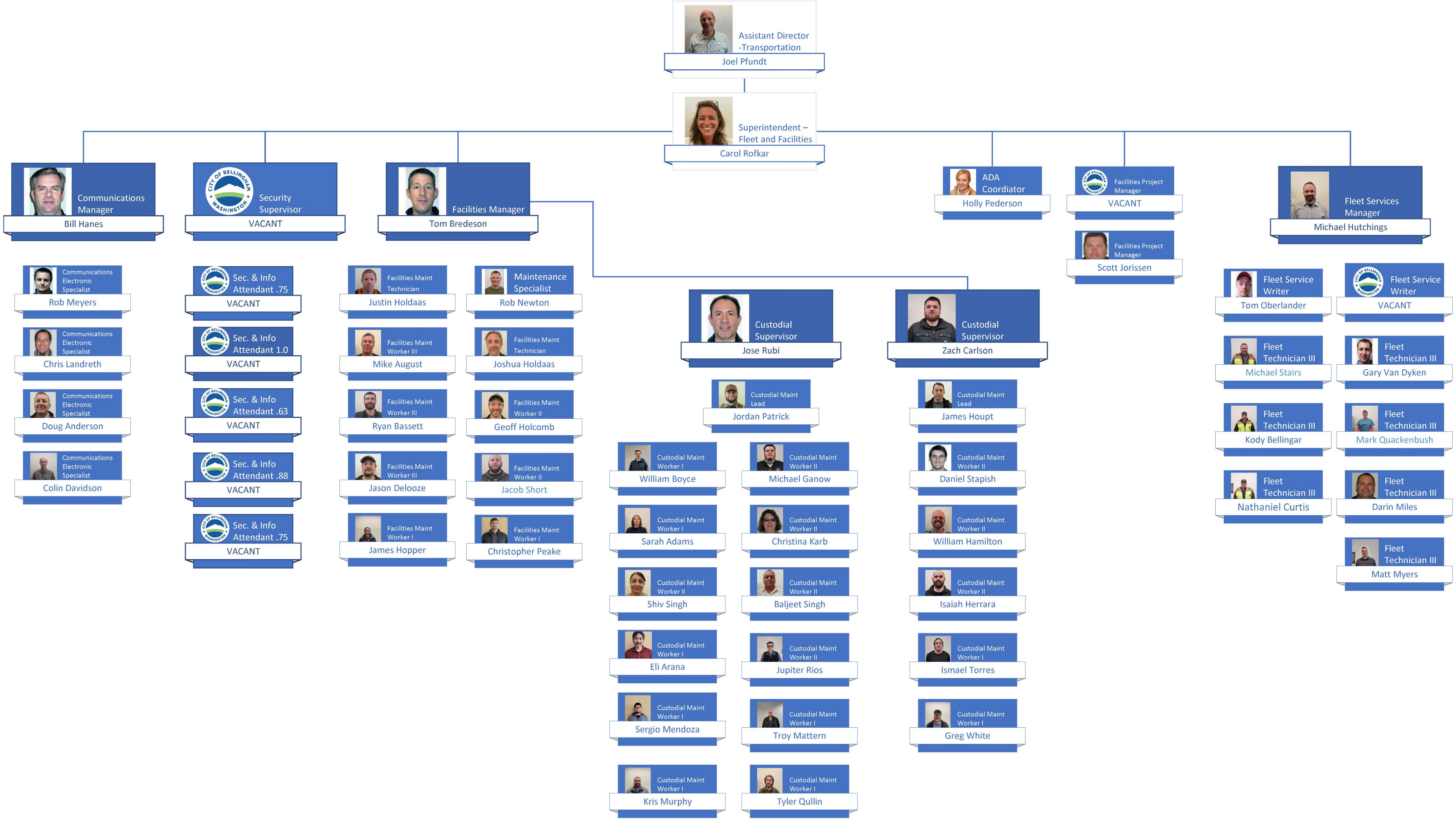


Figure 9.7 Operations Division Organizational Structure – Fleet and Facilities

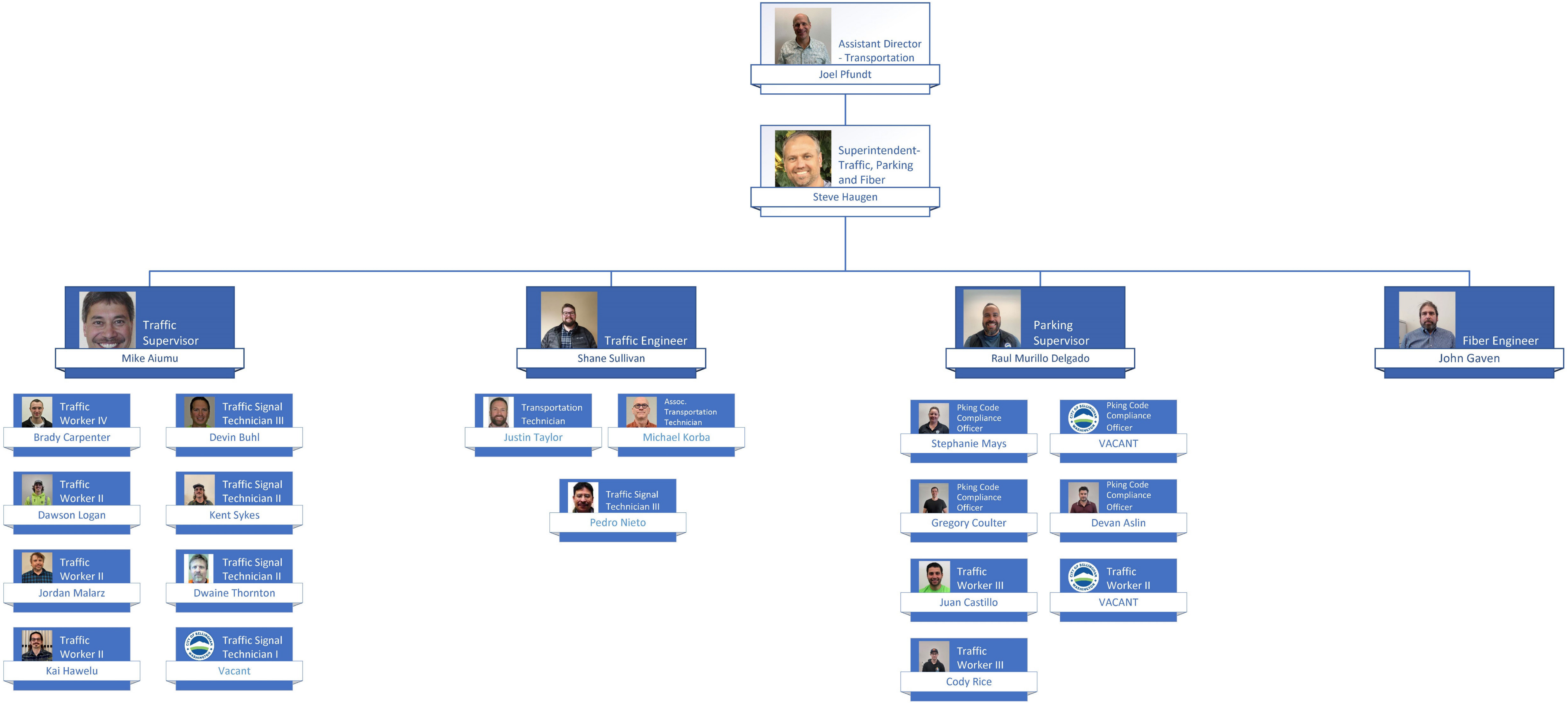


Figure 9.8 Operations Division Organizational Structure – Traffic, Parking, and Fiber

9.1.1 Superintendent of Plants

The Public Works Superintendent of Plants is responsible for management of the operation and maintenance of Bellingham’s watershed, water supply, water treatment, pumping, and wastewater treatment systems. This includes responsibility for water and wastewater treatment management, budgets, process control systems, quality standards, laboratory services, and responsibility for overall supervision of supervisors and personnel in both the plants and pumping groups. The Superintendent ensures that all federal, state, and local regulations are met, and that departmental policies and procedures are followed to provide a safe, dependable, and cost-effective operation of the municipal water and wastewater facilities. The Superintendent is responsible for the City’s water and sewer utility, which includes establishing business practices, rates, and long-range plans.

9.1.2 Superintendent of Maintenance

The Public Works Superintendent of Maintenance is responsible for management of the operation and maintenance of Bellingham’s water distribution and wastewater collection systems. This includes responsibility for budgets, process control systems, quality standards, distribution activities and responsibility for overall supervision of supervisors and personnel in both the distribution and collection groups. The Superintendent ensures that all federal, state, and local regulations are met, and that departmental policies and procedures are followed to provide a safe, dependable, and cost-effective operation of the municipal water and wastewater facilities. The Superintendent is responsible for the City’s water and sewer utility, which includes establishing business practices, rates, and long-range plans.

9.1.3 Utility Operations Engineer

The Utility Operations Engineer performs a variety of civil engineering duties for Bellingham’s water and sewer systems. They identify, analyze, and resolve system needs. They also provide guidance and technical information to the Department of Public Works and to the public about water and sewer system management.

9.1.4 Water Conservation Specialist

The City’s Water Conservation Specialist performs a variety of work and field duties associated with Bellingham’s water conservation program in accordance with the State Municipal Water Supply-Efficiency Requirements. Examples of the Specialist’s responsibilities include the following:

- Coordinating and developing methods, standards, and practices for water management planning.
- Performing a variety of tasks associated with conservation education.
- Researching, evaluating, and designing innovative technologies for water use.
- Providing technical assistance with the implementation of conservation measures.
- Assisting with the City’s water shortage contingency plan.
- Facilitating partnerships with fellow water purveyors through participation in coalition and committee workshops.

- Coordinating financial assistance for joint projects and partnerships with other agencies, water conservation projects, or awareness campaigns.
- Reporting on water conservation performance.

9.1.5 Technical Supervisor - Water Quality

The Water Quality Technical Supervisor is responsible for the supervision and management of the monitoring and testing programs for Bellingham's potable water, drainage, and wastewater systems and oversight of the City's state accredited laboratories. The also oversee the City's Industrial Pretreatment Program. Additional duties include preparing reports according to local, state, and federal requirements.

Additionally, the Water Quality Technical Supervisor conducts personnel functions and handles citizen inquiries and complaints regarding water issues.

9.1.6 Water Quality Specialist

The Water Quality Specialist evaluates water quality and plant process data, develops and implements laboratory and field projects, evaluates laboratory methodology and recommends changes, coordinates the lab's quality assurance programs, and prepares scientific and technical reports (including reports for local, state, and federal compliance). They also utilize computer software to perform research and data management and respond to citizen inquiries and complaints regarding water and wastewater issues. Their work requires a high degree of accuracy since error or negligence may compromise Bellingham's water and wastewater treatment systems, as well as have an impact on its water, wastewater, and stormwater capital improvement programs.

9.1.7 Laboratory Technicians

Laboratory Technicians have the primary responsibility of collecting and testing surface water, drinking water, and wastewater samples for regulatory compliance, plant process control, and the monitoring of environmental programs as they apply to water and wastewater compliance. The Laboratory Technicians are responsible for quality control procedures in the laboratory including analyzing performance evaluation samples to ensure state certification of both laboratories. Additional duties include assisting with information gathering and the initial preparation of compliance reports, implementation of new laboratory procedures, and special project assignments. Further duties include working with laboratory and treatment plant process control instrumentation. The Laboratory Technicians are responsible for monitoring, calibrating, maintaining, troubleshooting, and repairing process instruments and laboratory-related instruments. They maintain an inventory of supplies and procure equipment and supplies, as needed.

Figure 9.9 Laboratory Technician

9.1.8 Maintenance Supervisor - Water Distribution

The Water Distribution Maintenance Supervisor combines supervisory and customer service responsibilities in the installation, maintenance, improvement, operation, monitoring, testing, inspection, and repair of water distribution system facilities and equipment. Error or negligence in the performance of the maintenance unit could have serious consequences for the viability of the City's water supply, public safety, the successful operation of the water distribution system, and/or potential legal liability or financial impacts due to non-compliance with federal and state requirements.

9.1.9 Water Distribution Specialists

Below is a list of the various Water Distribution Specialists in order of decreasing responsibility.

9.1.9.1 Water Distribution Specialist V - Cross-Connection Control Specialist

The Cross-Connection Control Specialist performs inspections of construction projects and existing facilities to ensure compliance with specification and standards for cross-connection control. They perform recordkeeping to ensure that state regulations are met, and results are compiled to meet the appropriate department's standards. As a secondary focus, time permitting, the Specialist performs construction, maintenance, and repair of Bellingham's water distribution system, applying special expertise and in-depth knowledge to a variety of more complex, difficult, or specialized assignments. The Specialist functions as a lead to crews of other City staff and works independently on specialized assignments requiring well-developed skills, abilities, and knowledge. They are also capable of performing the work of the other water distribution specialists.

9.1.9.2 Water Distribution Specialist IV

The Water Distribution Specialist IV is the highest level of skilled manual labor and equipment operation in the self-advancing Water Distribution Series. The Specialist IV performs all phases of construction, maintenance, and repair of the City’s water distribution system. They regularly apply special expertise and in-depth knowledge to a variety of more complex, difficult, or specialized assignments. The Specialist IV functions as lead worker to crews of other Bellingham staff and works independently on specialized assignments requiring well-developed skills. They are also capable of performing the work of water distribution specialists below this class.

9.1.9.3 Water Distribution Specialist III

The Water Distribution Specialist III combines manual labor and the operation of various types of specialized mechanical equipment to install, maintain, and service Bellingham’s water distribution system; they primarily work as part of an assigned crew, assisting higher-classified staff with more complex and skilled tasks. The Specialist III occasionally works independently and may organize the work of a particular assignment involving others; they may also receive assignments focused on one or two areas of a particular skill, ability, or work need. They receive training in all functions of water distribution system maintenance and operation and have a well-rounded working knowledge of the City’s water distribution system, policies, and procedures, in addition to the purpose of assigned maintenance tasks. The Specialist III assists in the development of knowledge and skills in less experienced co-workers through on-the-job training, maintaining attention to safety and protection of personnel and equipment is integral to the work. They are also capable of performing the work of all other water distribution specialists below this class.

9.1.9.4 Water Distribution Specialist II

The Water Distribution Specialist II combines manual labor and the operation of various types of specialized mechanical equipment in order to install, maintain, and service Bellingham’s water distribution system. They primarily work as part of an assigned crew, assisting higher classified workers and receive training in all functions of water distribution system maintenance and operation. The Specialist II in the process of developing a working knowledge of the City’s water distribution system, policies, and procedures, and the purpose of assigned maintenance tasks. They maintain safety and protection of personnel and equipment as an integral part of their work. They are capable of performing the work of Utility Workers.

Figure 9.10 Water Distribution Specialist Testing Hydrant

9.1.9.5 Utility Workers 1 and 2

Utility Workers 1 and 2 provide various manual labor services in the construction, maintenance, and service work of all public works facilities. They operate hand and power tools and motorized equipment and usually operate as part of an assigned crew. Utility Workers labor in an assigned section but may have an individual or specialized assignment. They work indoors and outdoors in all weather conditions and sometimes under hazardous conditions; they may also be called out for emergency work.

9.1.10 Maintenance Supervisor - Plants

The position of Maintenance Supervisor of the Plants combines supervisory responsibilities, the application of technical knowledge, and occasional skilled labor to maintain the equipment and facilities for the water and wastewater treatment plants, water distribution and wastewater collection systems, and associated facilities. The Maintenance Supervisor of the Plants ensures 24-hour operation of equipment and facilities. Error or negligence in maintenance unit performance could have serious consequences for Bellingham’s water supply or public safety, the water and wastewater systems and treatment plant operation, or could result in legal liability or financial impacts due to non-compliance with federal and state requirements.

9.1.11 Maintenance Specialists

Maintenance Specialists include Maintenance Planning staff, Electrical and Electronic staff, and Mechanical staff.

9.1.11.1 Maintenance Planning

Maintenance Planning staff implement and maintain the computerized maintenance management system for corrective and preventative maintenance of the treatment plants, pumping stations, water distribution, and wastewater collection systems. They prepare and distribute work assignments for their assigned section. Maintenance Planning staff also perform complex technical and troubleshooting tasks on mechanical, electrical, and electronic equipment associated with the systems. Error or negligence in performance could have serious consequences for Bellingham's water and wastewater systems.

9.1.11.2 Electrical and Electronic

Electrical and Electronic staff coordinate, direct, assist, and perform preventative and corrective maintenance on all electrical, electronic, and instrumentation equipment associated with the water and wastewater systems. Error or negligence in performance could have serious consequences for Bellingham's water and wastewater systems.

9.1.11.3 Mechanical

Mechanical staff coordinate, direct, assist, and perform preventative and corrective maintenance on all mechanical, pneumatic, and hydraulic equipment associated with the water and wastewater systems. Error or negligence in performance could have serious consequences for Bellingham's water and wastewater systems.

9.1.12 Maintenance Technician

The Maintenance Technician performs multi-discipline preventative, corrective, rebuild, upgrade, and special project maintenance for complex plant process systems, equipment, and facilities at the water and wastewater treatment plants, pumping stations, lift stations, reservoirs, and other facilities. Examples of duties include performing troubleshooting, preventative, corrective, and special project maintenance on industrial electric, electronic, electrical generating, and distribution, electronic process control instrumentation, distributed control systems, PLC, remote telemetry units, heating, ventilation, and air conditioning (HVAC) systems, mechanical pumping equipment, high horsepower motors, compressors, heavy industrial process machinery, piping, and pneumatic and hydraulic systems.

9.1.13 Skilled Worker

The Skilled Worker represents experienced employees who perform manual and semi-skilled labor of all kinds, indoors and outdoors, in all types of weather and under sometimes hazardous conditions. Employees in this classification may be assigned to streets, stormwater, plants maintenance or operations, traffic, clean green, or wastewater collection. They operate a variety of hand and power tools, motorized mobile equipment, and electronic test equipment, depending on assigned unit. The Skilled Worker usually works as part of an assigned crew but may be given an individual or special assignment; they perform all duties of Utility Workers. Attention to safety and protection of personnel and equipment is integral to their work.

9.1.14 Chief Operator - Water Treatment

The Chief Operator of Water Treatment is responsible for supervision and direction of watershed, water supply, water treatment, and water distribution operations; serves as the system administration for water and wastewater computerized automated control and data acquisition systems; and recommends budgets, standards, and operations. Error or negligence in supervision or performance could jeopardize municipal water supplies, facilities, and water and wastewater computerized process controls; put public health at risk; result in loss of life, property, financial resources, and equipment; and violate water quality, air, and other standards. The Chief Operator works under Washington State regulations and procedures for water supply, and water treatment in addition to Bellingham and departmental policies and procedures.

9.1.15 Plant Operators

Plant Operators-In-Training and Plant Operators I, II, III, and IV together promote proper operation of the water treatment, water distribution, wastewater collection, primary wastewater treatment, and advanced secondary wastewater treatment plant systems.

9.1.15.1 Plant Operator IV

The Plant Operator IV acts as a lead worker and performs water and wastewater treatment operations, work scheduling, plant computer functions, training, and technical resource services to assist in supervisory activities and ensure proper operation of direct filtration water treatment, water distribution, wastewater collection, primary wastewater treatment, and advanced secondary wastewater treatment.

9.1.15.2 Plant Operator III

The Plant Operator III acts as shift operator-in-charge performs water and wastewater treatment operations, work scheduling, plant computer functions, training, and technical resource services to assist in supervisory activities and ensure proper operation of direct filtration water treatment, water distribution, wastewater collection, primary wastewater treatment, and advanced secondary wastewater treatment plant systems. Error or negligence in performance could have serious consequences for the City’s water supply and wastewater treatment system.

9.1.15.3 Plant Operator II

The Plant Operator II performs water and wastewater treatment operations, work scheduling, plant computer functions, training, and technical resource services to assist in supervisory activities and ensure proper operation of direct filtration water treatment, water distribution, wastewater collection, primary wastewater treatment, and advanced secondary wastewater treatment plant systems. The Plant Operator II may perform relief duties for the Plant Operator I. Error or negligence in performance could have serious consequences for the City’s water supply and wastewater treatment system.

9.1.15.4 Plant Operator I

The Plant Operator I performs water and wastewater computer console operations, process control, and troubleshooting functions to ensure proper operation of direct filtration water treatment, water distribution, wastewater collection, primary wastewater treatment, and advanced secondary wastewater treatment plant systems. Duties are performed on a rotating shift basis and include swing shift, graveyard, weekend, and after hours public works dispatch and responsibilities. Error or negligence in performance could have serious consequences for the City's water supply and/or wastewater treatment system.

9.1.15.5 Plant Operator-In-Training

The Plant Operator-In-Training completes and performs progressively responsible water and wastewater duties, computer console operations, process control, and troubleshooting functions to ensure proper operation of direct filtration water treatment, water distribution, wastewater collection, primary wastewater treatment, and advanced secondary wastewater treatment plant systems. Duties are performed on a rotating shift basis and include swing shift, graveyard, weekend, and after hours public works dispatch and responsibilities. Error or negligence in performance could have serious consequences for the Bellingham's water supply, wastewater treatment system, or both.

9.1.16 Billing and Meter Reading

Water system customers are billed monthly consistent with the City's adopted rate schedule. Customer rates vary by type (single-family, industrial, and so forth); by purpose (consumption, irrigation); and by location (inside the City limits or outside the City limits).

Metered connections are read on a monthly schedule to accommodate the applicable billing cycle. All water bills include a Lake Whatcom Watershed Land Acquisition and Preservation Charge that varies depending on the service type and purpose. Base rates are charged to single family, non-single family, and irrigation services based on meter size. The consumption rates for metered single family connections are currently $2.59 per hundred cubic feet (ccf) inside the City and $3.88 per ccf if outside the City limits. Non-single family services pay $2.63 per ccf within the City and $3.94 per ccf outside of the City. Irrigation consumers pay $3.48 per ccf (inside City) and $5.22 ccf (outside City).

Current and adopted future water rates are presented in Chapter 11, Financial Analysis.

9.2 Operator Certification

Water utility personnel have a variety of certifications indicating experience and competency levels for operation of the water system. Members of the water utility staff are mandated by job classification and duties to retain a designated certification level.

Bellingham pays for renewal fees, the employee's time spent during training, and training cost for the utility. Current certifications held by Water Operations staff are summarized in Appendix W.

9.3 System Operation and Control

The City is served by a water system distribution network that includes storage reservoirs, control valves, and pump stations. The distribution system is divided into thirteen pressure zones. Each of the pressure zones is operated at different hydraulic elevations, or HGLs, to maintain relatively consistent water system pressures throughout the service area. The pressure zones are presented in Chapter 2 in Figure 2.1 and schematically in Figure 2.2.

9.4 Major System Components and Normal Operation

The major components of Bellingham's water system, including pump stations, reservoirs, interties, and major transmission pipelines are shown in Figure 2.1. A description of the components of the City's water system and a discussion on how each normally operates within the system is presented in Chapter 2, Existing System.

9.5 Preventative Maintenance Program

The WTP has its own Procedure Manual, which includes Standard Operating Procedures (SOP) for all online and lab equipment that are maintained, calibrated, and undergo preventive maintenance. This includes online instruments such as turbidimeters, pH sensors, and chlorine analyzers. A summary of the preventive maintenance activities regularly scheduled by Plants Operations Division staff is provided in Table 9.1. O&M Manuals are stored on the City's secure computer network and are accessible to the appropriate water staff. Hard copies of the O&M Manual are also maintained at the WTP.

9.6 List of Equipment and Service Representatives

The Operations Division maintains and updates lists of equipment, supplies and chemicals needed to operate and maintain the water system. Information on suppliers, service representatives, technical specifications, and materials safety data sheets (MSDS) are also maintained and regularly updated by Bellingham Operation Division staff. A stock of supplies, chemicals, pipe, parts, and fittings are kept at the treatment plant and at the Corp Yard.

Table 9.1 City of Bellingham Water Department Preventative Maintenance Plan Summary

Location	Preventative Maintenance Activity
Pump Stations	▪ Bi-weekly water pump run. ▪ Monthly pump station check. ▪ Annual fire extinguisher inspection.
Reservoirs	▪ Monthly reservoir check. ▪ Semi-annual reservoir valve exercise. ▪ Annual reservoir check. ▪ Annual fire extinguisher inspection. ▪ Monthly level check.
Gate House	▪ Monthly gate house check.
Pipeline	▪ Monthly line cathodic protection check.
Lake Whatcom Control Dam	▪ Quarterly lube and inspection. ▪ Annual oil change and lube and inspection.
Screenhouse	▪ Annual fire extinguisher inspection. ▪ Annual screenhouse check. ▪ Semi-annual screen inspection. ▪ Semi-annual screenhouse inspection.

Location	Preventative Maintenance Activity
Water Treatment Plant	▪ Daily checks for accuracy on chlorine analyzers. ▪ Weekly preventative maintenance on chlorine analyzers. ▪ Daily checks for accuracy of pH sensors. ▪ Quarterly pH sensor calibration. ▪ Weekly calibration verification of turbidimeters. ▪ Quarterly primary calibration of turbidimeters. ▪ Quarterly backwash pump greasing. ▪ Annual backwash pump inspection. ▪ Annual backwash level calibration. ▪ Annual filter flow loop calibration (all six filters). ▪ Annual filter headloss loop calibration Annual filter valve oil check. ▪ Annual Dakin and Yew pump oil change. ▪ Annual Dakin and Yew flow meter check Annual alum pressure transmitter calibrate. ▪ Annual low vacuum switch industrial chlorinator calibration. ▪ Two-year industrial chlorinator rebuild. ▪ Annual low vacuum switch trim chlorinator calibration. ▪ Two-year No. 1 chlorinator rebuild. ▪ Annual low vacuum switch No. 2 trim chlorinator calibration. ▪ Two-year No. 2 chlorinator rebuild. ▪ Annual low vacuum switch calibration, screenhouse. ▪ Two-year screenhouse chlorinator rebuild. ▪ Annual low vacuum switch trim chlorinator calibration. ▪ Two-year vacuum regulator rebuild bank No. 1. ▪ Two-year vacuum regulator rebuild bank No. 2. ▪ Annual vacuum switch/inspection/report. ▪ Bi-weekly water pump run. ▪ Monthly emergency generator run. ▪ Annual raw water flow loop calibration. ▪ Annual Dakin and Yew flow calibration. ▪ Annual clear well level calibration.

9.7 Comprehensive Monitoring Plan

The Bellingham's Comprehensive Monitoring Plan follows the monitoring requirements summarized in Chapter 8 - Water Quality and Water Treatment. Water Quality personnel use the Plan to ensure that all testing is completed in the required time frame. Monitoring locations, sampling schedules, and frequency are summarized in Tables 8.1, 8.2, and 8.3.

DOH-certified laboratories are used to provide analytical services. Laboratories utilized by the City are summarized in Table 9.2.

9.8 Emergency Response Plan

The City has an Emergency Response Plan, known as the City of Bellingham Water System Emergency Response Plan for Public Works Operations. A copy of the table of contents for this Plan can be found in Appendix X.

Table 9.2 List of Certified Laboratories Used by the City of Bellingham

DOH ID	Name and Address	Analyte(s)
023	Anatek Labs 504 E Sprague Avenue #D Spokane, WA 99202	Radionuclides.
046	Edge Analytical Incorporated 1620 S Walnut Street Burlington, WA 98233	Inorganic compounds, volatile organic compounds, synthetic organic compounds, trihalomethanes, haloacetic acids, Unregulated Contaminants Rule analytes, lead, and copper.
060	City of Bellingham Water Filtration Plant Laboratory 2221 Pacific Street Bellingham, WA 98229	All microbiologic work and conventional chemistry.
064	Eurofins 941 Corporate Center Drive Pomona, CA 91768	Trihalomethanes, haloacetic acids, and total organic carbon.
119	Lab/Cor 7619 6th Avenue NW Seattle, WA 98117	Asbestos.
N/A	Analytical Services Inc 130 Allen Brook Lane Williston, VT 05495	*Giardia* and *Cryptosporidium* analyses.

9.9 Safety Procedures

The Water and Engineering Divisions maintain and continually update a set of both (1) the Washington State General Occupational Health Standards, Chapter 296-62 WAC, and (2) the Safety Standards for Construction Work, Chapter 296-155 WAC. These Standards are referenced on a regular basis. In addition, the Water Division consults with a Washington State Department of Labor and Industries Safety Consultant in preparation for work that it is not typically familiar with or does not consider routine operation and maintenance.

9.10 Cross-Connection Control Program

Bellingham has an ongoing cross-connection control program as incorporated into the BMC. A copy of the program is included in Appendix Y. The purpose of the cross-connection control and backflow prevention program is to protect water quality and thereby public health through:

- The Water Utility's program conforms to WAC 246-290-490 and generally follows the guidance as outlined in Accepted Procedure and Practice in Cross-Connection Control published by the Pacific Northwest Section of the AWWA.
- The Water Utility is currently the responsible organization for implementation of the program, though customers are responsible for installation, testing, inspection, repair, maintenance, and operation of backflow preventers.

9.11 Record Keeping and Reporting

Bellingham maintains a variety of water system performance records. Such record keeping covers the issues of water quality, flow, reservoir level, and chemical use. These records provide historical reference for future operation of the water system, provide information to plan for future maintenance and replacement, and ensure that the system provides high quality water for its customers. Each water utility keeps the following records:

- Date.
- Influent volume.
- Effluent volume.
- Backwash water volume.
- Plant usage volume.
- Dakin and Yew pump station volume.
- Raw water turbidity.
- Raw water pH.
- Raw water alkalinity (twice a month).
- Raw water temperature.
- Treated water turbidity reduction (percent).
- Treated water pH.
- Treated water alkalinity (twice a month).
- Treated water chlorine residual concentration.
- Treated water minimum chlorine residual concentration.
- DAF Raw pH.
- DAF Raw Turbidity.
- Filter run times.
- Ultimate filter run volumes.
- Filter turbidities.
- Filter headloss.
- Filter rates.
- Chemicals used.
- Watershed data.
- Total Plant Production.
- Distribution System Water Quality Parameters (WQP).
- Peak hourly flow to system.
- CT.
- CT calculated.
- CT required.
- CT ratio.

Treatment plant staff prepare a monthly flow and water quality report, which is sent to DOH as documentation of the treatment plant operation. The DOH monthly report includes various items such as source water fecal levels, the number of water quality complaints, calibration dates for turbidimeters, instances where turbidity exceeded the limit, free chlorine levels leaving the plant and within the distribution system, testing of critical alarms, and other relevant data.

These reports are archived in the City's record system. In addition, Bellingham's SCADA system creates daily reports showing reservoir levels and flow rates, as well as hourly pump station flows. These reports are archived in the City's record system.

9.12 Customer Complaint Response Program

There are three ways a customer can register a complaint. One way is by simply calling the front office and the customer’s complaint will be dispatched by the administrative staff to appropriate personnel. Another way of filing a complaint is by sending an email to AskPW@cob.org. This is a shared email inbox that is monitored by several staff in the Communications and Outreach workgroup within the Public Works Department. Staff regularly read and respond to these emails. Finally, customers can submit a complaint using SeeClickFix.

SeeClickFix is a web-based and mobile application designed for the public to report non-emergency issues directly to the City. Users can submit reports complete with descriptions, photos, and specific locations. These reports are then routed to the appropriate department for action, keeping residents informed throughout the resolution process. Since its launch, the City's SeeClickFix program has received a considerable volume of requests across various departments, including nearly 6,000 internal Public Works requests and over 12,000 external Public Works requests.

Water quality complaint information and utility response are entered into the Cityworks database program which has ArcGIS spatial capability. Complaints specific to water quality are reported to the DOH monthly on the water quality report.

9.13 Operations and Maintenance Improvements

This section outlines the identified deficiencies and proposed improvements to address operational challenges and maintain system efficiency.

9.13.1 40th Street Reservoir Drain

The 40th Street Reservoir Drain presents notable issues. Currently, it drains into a ditch on the property, leading to overflow across the access road and onto 40th Street. This overflow washes out the city driveway and poses safety hazards to traffic on 40th Street. Such recurring problems necessitate an effective rehabilitation strategy.

Rehabilitation efforts for the 40th Street Reservoir Drain should aim to prevent overflow and ensure compliance with stormwater management regulations. Two primary actions are proposed: rehabilitating the drain to connect to the storm drainage system or providing adequate on-site detention to manage overflow effectively.

9.13.2 Consolidation Reservoir Drain

The Consolidation Reservoir Drain drains into a private neighboring farm and barn raising potential legal disputes and environmental concerns. This issue highlights the need for redesigning the drainage system to reduce its impact on surrounding properties.

Redesigning the drainage system to connect directly to a storm drain across Yew Street is a potential solution. This solution is expected to reduce the impact on neighboring properties and enhance stormwater management in the area.

9.14 Pipe Risk Assessment

The deterioration of water distribution pipes is an inevitable issue due to factors like corrosion, soil conditions, and manufacturing defects. Accurately assessing the condition of these pipes requires on-site inspection, which limits maintenance efforts and thus increases the risk of costly failures. Pipe failures can lead to significant economic losses, disruption to essential services, and risks to public health and safety.

A risk assessment model is designed to be simple, cost-effective, and informative, with a focus on predicting pipe failures and prioritizing high-risk pipes for maintenance.

The model operates in three stages:

1. Calculate the remaining useful life (RUL) of each pipe. Factors like installation year, material, and past failures are analyzed and pipes are then scored based on their Probability of Failure.
2. Assess the geospatial location, material properties, and flow values of each pipe, along with economic factors like repair costs and impact on traffic. This stage assigns a Consequence of Failure score to each pipe.
3. Combine the Probability of Failure and Consequence of Failure scores into a Risk of Failure score, which indicates the likelihood of a pipe's failure and its priority for rehabilitation or replacement.

9.14.1 Probability of Failure

The primary goal of this stage in the risk assessment model is to calculate the RUL of water mains. This is done by assessing the pipe's current age and comparing it to the anticipated service life of its material type. The analysis considers the pipe's installation year (Figure 9.11 summarizes by decade), material type (Figure 9.12), and the anticipated service life provided by the manufacturer (Table 9.4).

Once the RUL is determined, the pipe is assigned a Probability of Failure score based on its RUL using Table 9.3. This score helps in evaluating the likelihood of a pipe's failure, aiding in prioritizing maintenance and replacement activities.

Figure 9.11 represents a system wide look at RUL. It is important to note that there is a large difference between the 100 year average annual replacement (23,325 feet per year) and the 20 year average annual replacement (12,199 feet per year). This difference is due to the ductal iron installed between 1970 and 1990, and the cast iron installed between 1950 and 1970, reaching their end of anticipated life between 2050 and 2070.

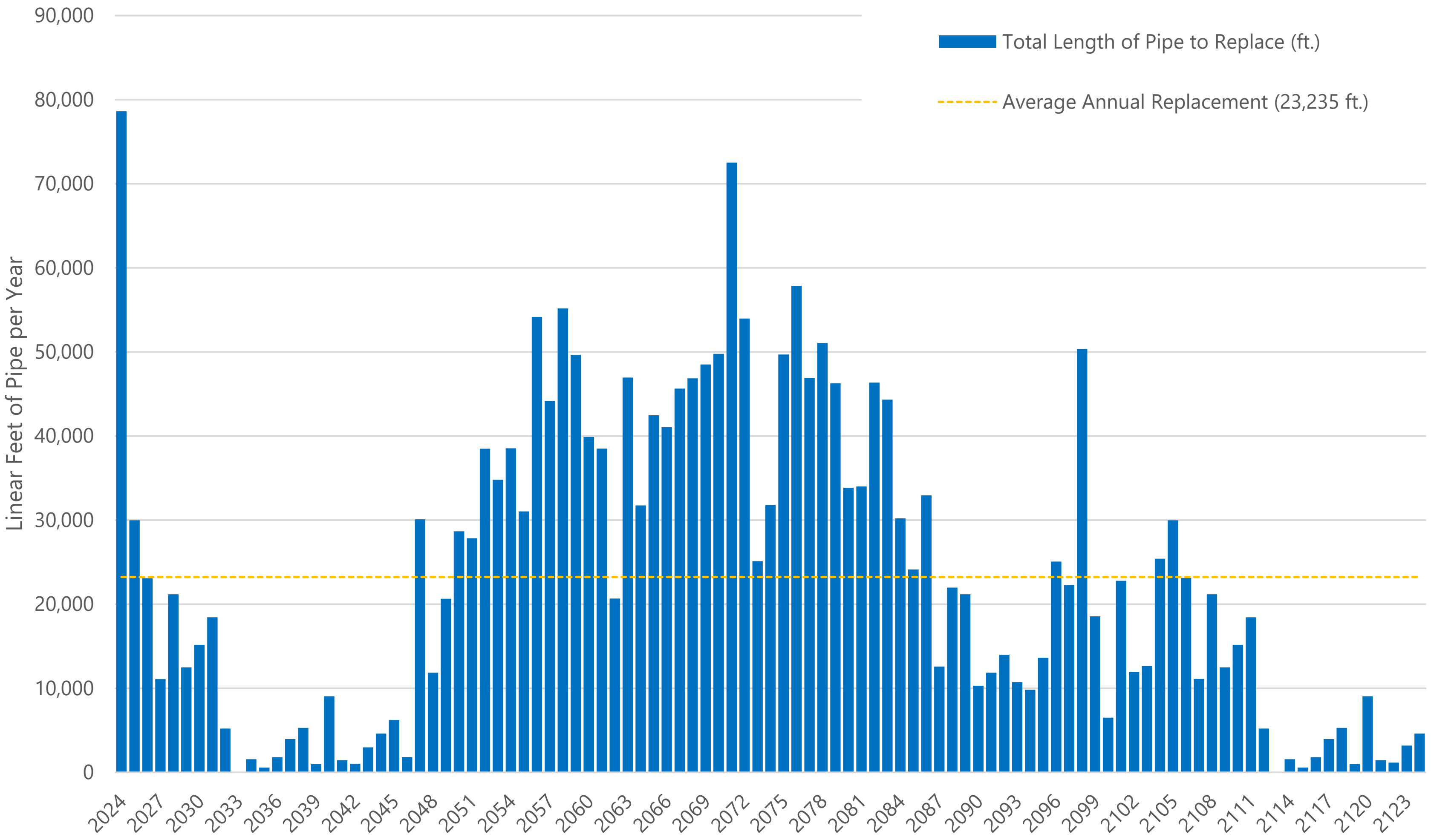


Figure 9.11 100-year End of Anticipate Service Life

Note: Only pipes owned by the City were included in this analysis.

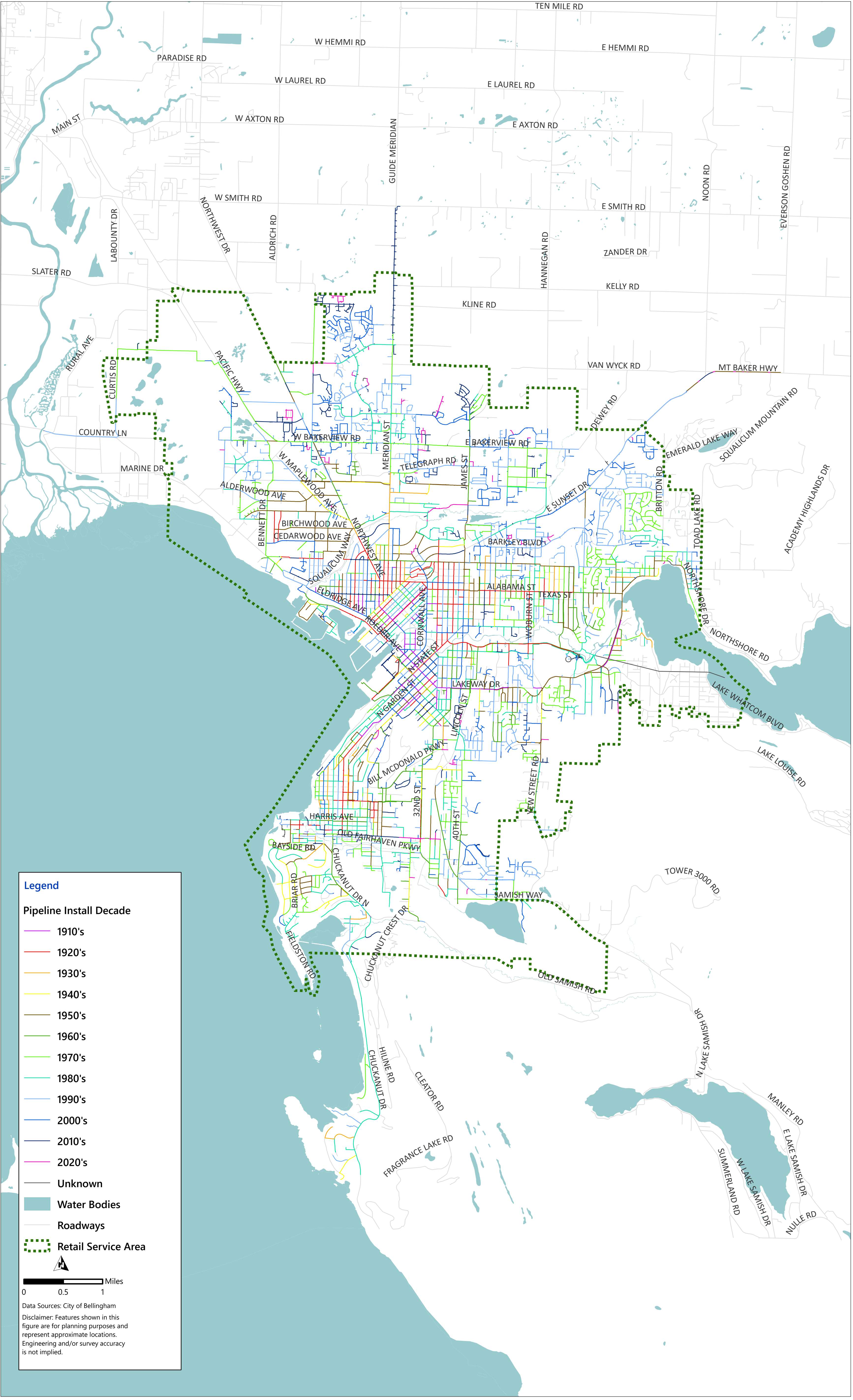
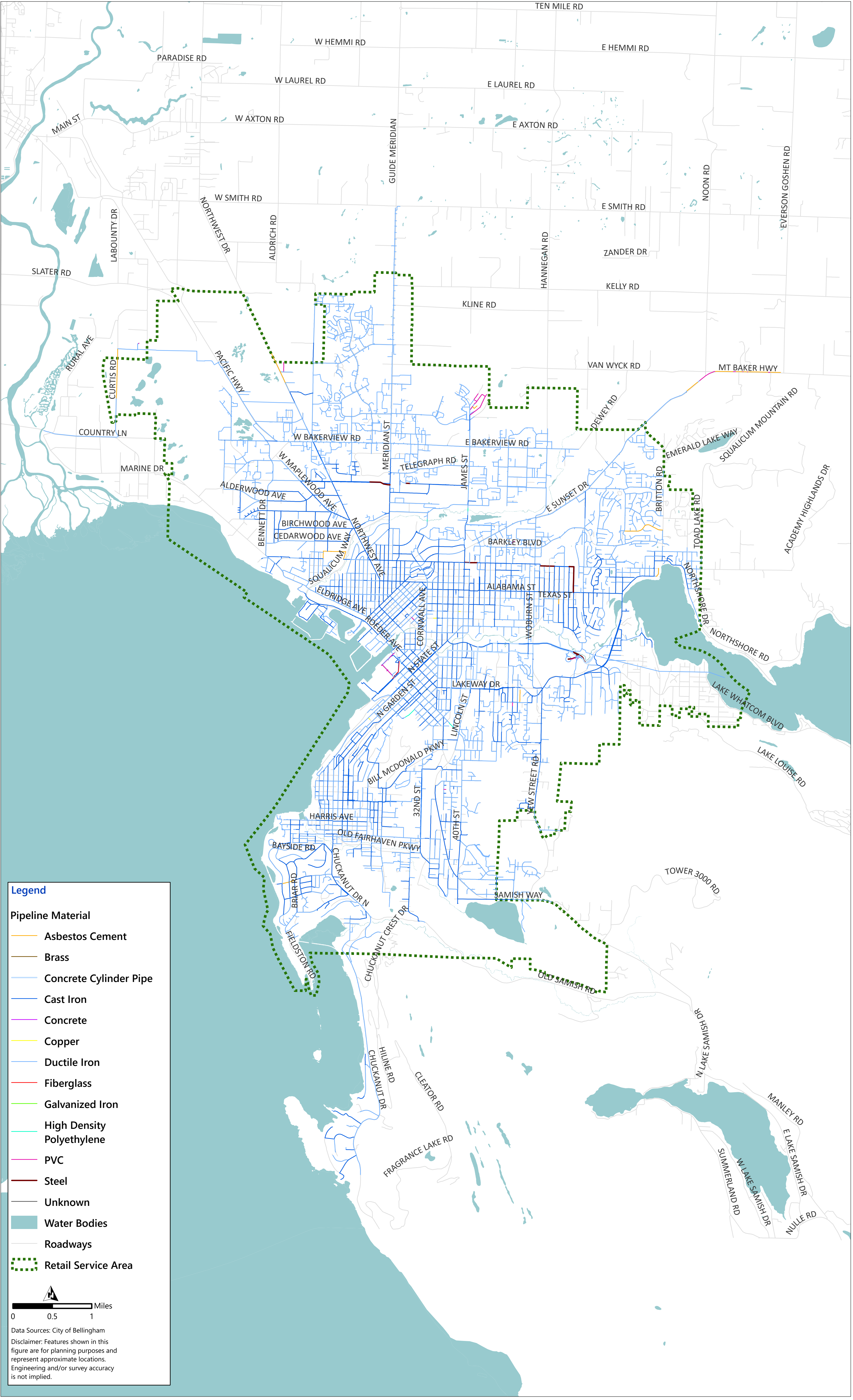


Figure 9.12 Pipeline by Install Decade



Data Sources: City of Bellingham

Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

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Figure 9.13 Pipeline Material

Table 9.3 Probability of Failure

Remaining Useful Life (years)	Probability of Failure Score	Risk Level
<2	10	High ↕ Low
2 - 4	9	
4 - 6	8	
6 - 8	7	
8 - 10	6	
10 - 12	5	
12 - 14	4	
14 - 17	3	
17 - 19	2	
>20	1	

9.14.1.1 Pipe Age

A pipe's age is calculated as the number of years since its installation. This period assumes continuous service without accounting for interruptions due to repairs or replacements.

9.14.1.2 Pipe Material

Different pipe materials have different anticipated service lives (ASL) as recommended by manufacturers (see Table 9.4). The model uses these recommendations to estimate the ASL, assuming the pipe is made of a single, untreated material. The ASL values used in the study are conservative estimates derived from the mean of the manufacturer's recommended service life.

Table 9.4 Anticipated Service Lives

Pipe Material Type	Useful Life (years)
Cast Iron (CI)	100
Ductile Iron (DI)	80
Asbestos-Cement (AC).	50
Copper (COP)	50
High Density Polyethylene (HDPE)	50
Polyvinyl Chloride (PVC)	50
Stainless/Steel (STEEL)	50
Brass (BRASS)	50
Concrete (CCL)	50
Galvanized Iron (GAI)	50
Unknown (UNK)	50

9.14.2 Consequence of Failure

The second stage of the risk assessment model evaluates various criteria that could affect the rehabilitation or replacement of water mains, focusing on economic impact and operational consequences. This stage considers seven criteria:

1. **Customer Criticality**: The importance of the water main in serving critical customers as defined in Section 1.2.1 of this document.
2. **Pipe Material Phasing**: The need to phase out outdated or less durable pipe materials.
3. **Land Use**: The influence of surrounding land use on the impact of pipe replacement.
4. **Service Demand**: The demand for water services in the area served by the pipe.
5. **Service Size**: The diameter of the water main.
6. **Traffic Impact**: The potential disruption to traffic during pipe rehabilitation or emergency replacement.
7. **Estimated Replacement Cost**: The estimated material cost for replacing or rehabilitating the pipe.

Each of these criteria is assigned a numerical score based on its impact, and these scores are added together to produce a cumulative Consequence of Failure score for each pipe segment (see Equation 9-1).

The Consequence of Failure score reflects the relative importance of each water main within the distribution network, accounting both for economic costs and the impact on municipal operations and customer demand. By combining this with the Probability of Failure score from the first stage, the model enhances the prioritization of water mains for maintenance or replacement, ensuring that resources are efficiently allocated to the most critical areas.

$$Total\ CF = CF_{Demand} + CF_{Size} + CF_{Criticality} + CF_{Land} + CF_{Traffic} + CF_{Material} + CF_{Cost} \qquad \text{Equation 9-1}$$

Where:

- $Total\ CF$ = Cumulative Consequence of Failure Score.
- CF_{Demand} = Service demand consequence score.
- CF_{Size} = Service size consequence score.
- $CF_{Criticality}$ = Customer criticality consequence score.
- CF_{Land} = Land use consequence score.
- $CF_{Traffic}$ = Traffic impact consequence score.
- $CF_{Material}$ = Material phasing consequence score.
- CF_{Cost} = Estimated Replacement Cost consequence score.

Table 9.5 Consequence of Failure Rubric

Criteria Score	1	2	3	4	5
Service Demand (gpm)	<10	10 - 100	100 - 500	500 - 2000	>2000
Service Size (inches)	<6	8 - 10	12 - 14	16 - 30	>30
Customer Criticality	0	1 -2	3-5	6-8	9-10
Land Use	Recreation Open Space Water	Residential Single-Family Urban Residential	Residential Multi-Family	Urban Village Urban Residential Mixed Use	Airport Operations Commercial Industrial Institutional Public Hospital
Traffic Impact	Private	Alley Residential Other	Secondary Route	Collector Route	Principal Route
Material Phasing	DI	CI HDPE PVC	STEEL COP	BRASS CCP GAI	AC UNK
Replace Cost	<$20,000	$20,000 - $80,000	$80,000 - $175,000	$175,000 - $300,000	> $300,000
Risk Level	Low		⟷		High

Notes:
CCP - Concrete; COP - Copper.

9.14.2.1 Service Demand

This part of the assessment model focuses on the average daily flow of each pipe segment, using modeled flow values to determine the relative importance of pipes. By ranking these flow values, the model identifies critical pipes that require priority maintenance and repair, ensuring that resources are effectively allocated to support the City's water needs.

9.14.2.2 Service Size

Similar to service demand, service size focuses on the diameter of each pipe segment to determine its relative importance. By ranking pipes based on their diameter, the model identifies which pipes are most critical and should be prioritized for maintenance and repair.

9.14.2.3 Customer Criticality

The model aims to protect these essential services from disruptions caused by pipe failures or repairs. Pipes within a 0.25-mile radius of critical customers are given higher priority. Critical customers were defined as:

- Dialysis centers.
- Hospitals.
- Nursing homes.
- Public schools.
- Private schools.
- Business centers.
- Police stations.
- Fire stations.
- Water treatment plant.
- City Operations Center.

Critical customers were split into three tiers of importance. Factors of importance per tier were developed in collaboration with the City.

The first tier included dialysis centers, hospitals, and nursing homes, and the City Operations Center. The first tier’s customers have an importance factor of four. The second tier covered public schools, private schools, business centers, police stations, and fire stations which were multiplied by a factor of two. The third tier only included the WTP, which was multiplied by one.

In many instances pipe segments fall under multiple radii. When this occurs, the customer criticality score is the sum of the critical customers.

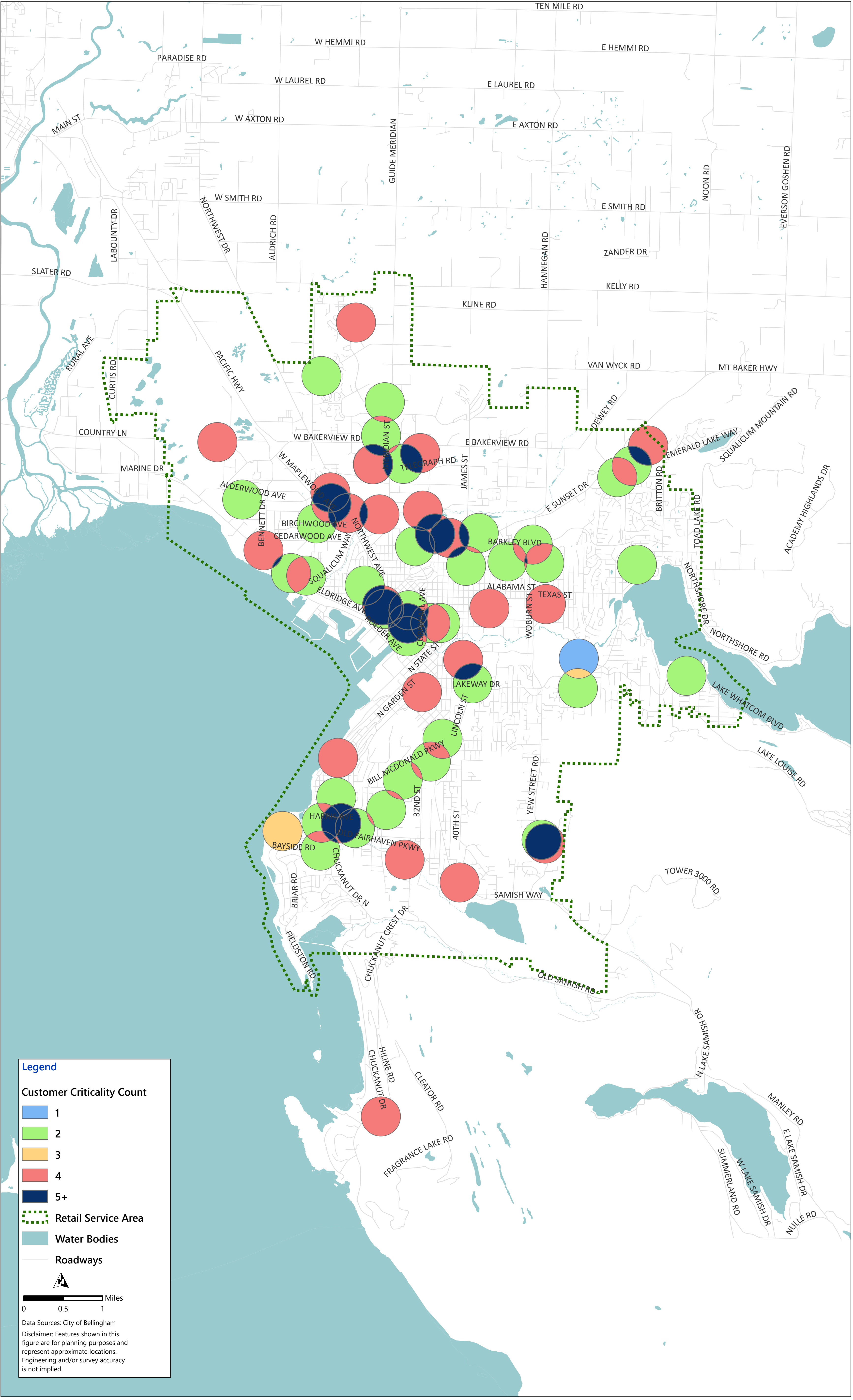

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Figure 9.14 Customer Criticality Count
CITY OF BELLINGHAM
WATER SYSTEM PLAN

9.14.2.4 Land Use

Relative land use is a critical factor in water distribution system maintenance, especially since water mains are mostly located underground. Different land uses can greatly influence the impact of pipe improvement projects. Failure to account for these land uses can result in significant financial losses, project delays, and operational disruptions for municipalities. The model assigns a relative importance score to each land use. Land uses with higher importance will more significantly influence the priority of nearby pipe rehabilitation. For example, because hospitals are considered crucial, water conveyance to hospitals needs to be a high priority. To emphasize this level of importance a 0.25 buffer was created around hospitals and included as a new land use type. If pipes intersected this buffer, their land use score was set to five.

9.14.2.5 Traffic Impact

The model incorporates the impact of pipe improvement projects on a city's traffic patterns, recognizing that such projects can disrupt daily commercial, transit, and public transportation operations. The risk assessment model evaluates potential effects by classifying transit routes based on their importance and proximity to the water main in need of repair. Roads are categorized into classifications such as Residential/Other, Alley, Collector Route, Private, Secondary Route, and Principal Route. Assumed traffic density was used to rank impact from low to high (Table 9.6). By considering these classifications, the model aims to minimize disruptions and delays in traffic flow, ensuring that pipe repair projects have a minimal impact on daily transit activities and business operations.

To increase the importance of pipes crossing railroads, pipes that intersect railroad tracks were flagged, and their traffic impact score was set to five.

Table 9.6 Traffic Impact

Road Classifications	Assumed Traffic Density
▪ Residential/Other ▪ Alley ▪ Collector Route ▪ Private ▪ Secondary Route ▪ Principal Route	Low ↕ High

9.14.2.6 Pipe Material Phasing

As technology advances and new, stronger pipe materials become available, cities face a practical need to replace outdated components in their water distribution systems to ensure public health and safety. This risk assessment model incorporates pipe phasing emphasizing the importance of replacing old pipes to prevent catastrophic failures and water contamination.

The model evaluates the need for upgrades based on the pipe's age relative to its anticipated service life, using the mean value of the manufacturer's life expectancy for different materials. By ranking pipe materials based on their anticipated service life and overall quality, the model provides a structured approach to upgrading infrastructure, reducing the risk of failures, and maintaining efficient water distribution.

9.14.2.7 Estimated Repair and Replacement Cost

Accounting for all the costs associated with a pipe improvement project is a complex yet crucial aspect of municipal planning. Estimating the total expense involves considering various factors such as pipe materials, excavation, traffic control, construction labor, and installation components.

The risk assessment model uses cost per linear foot, including contingencies. Because the city anticipates replacing pipes with ductile iron pipe, in most cases, Table 9.7 was used to calculate the cost of replacing the pipe. These costs include contingencies presented in Chapter 10 - Capital Improvement Plan and are used to calculate total CIP for each pipe segment evaluated.

Table 9.7 Ductile Iron Pipe Cost per Linear Foot, Including Contingencies

Diameter (inches)	Cost ($/lf)
60	$9,679.12
48	$7,378.35
36	$5,073.73
30	$3,915.54
24	$2,769.52
20	$2,002.26
16	$1,121.10
14	$930.81
12	$740.51
10	$650.94
<=8	$561.56

Notes:
$/lf - cost per linear foot.

Pipes with a diameter of fewer than 8-inches are assumed to be replaced with 8-inch pipe, therefore the estimated cost ($/lf) is that of an 8-inch pipe.

9.14.3 Risk of Failure

The final phase of this risk assessment model focuses on determining the overall risk of failure for each pipe and water main within the city's distribution system. This involves combining the Consequence of Failure score and the Probability of Failure score to get the Risk of Failure.

$$RFS = Total\ CF * PF \qquad \text{Equation 9-2}$$

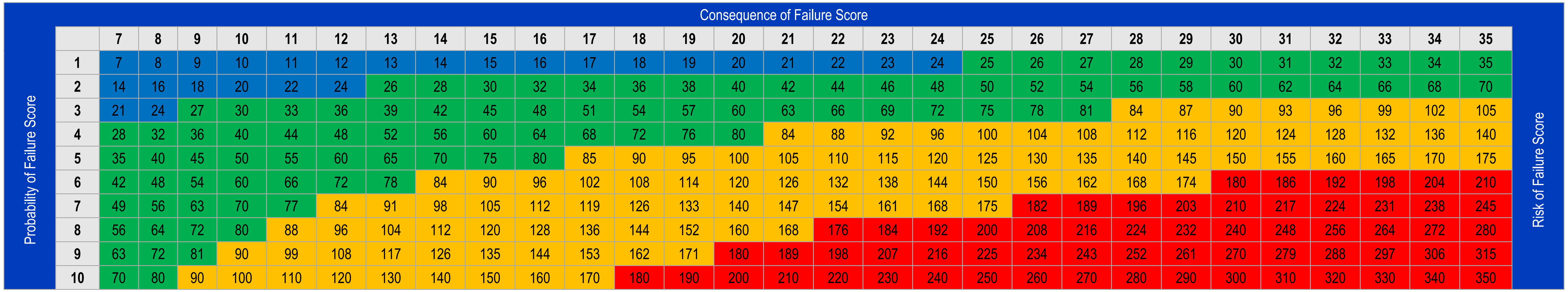
Where:

- RFS = Pipe risk of Failure Score.
- $Total\ CF$ = Cumulative Consequence of Failure Score (Equation 9-1).
- PF = Probability of Failure Score (Table 9.3).

The Risk of Failure quantifies the likelihood of a pipe failing during its service life, with values ranging from 3 to 300. These scores are categorized into risk levels: very low risk (<24), low risk (25-82), medium risk (83-175), and high risk (>176) see Table 9.8.

The scoring system helps municipalities prioritize pipe rehabilitation or replacement projects by identifying which pipes pose the greatest risk of failure and thus require the most urgent attention. By using this model, cities can allocate resources effectively, plan future projects, and ensure the reliability of their water distribution systems, ultimately safeguarding public health and safety, particularly for critical services such as fire stations, hospitals, care centers, and police stations.

Table 9.8 Possible Risk of Failure Scores



		Consequence of Failure Score																												
		7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Probability of Failure Score	1	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
	2	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70
	3	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81	84	87	90	93	96	99	102	105
	4	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120	124	128	132	136	140
	5	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175
	6	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210
	7	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147	154	161	168	175	182	189	196	203	210	217	224	231	238	245
	8	56	64	72	80	88	96	104	112	120	128	136	144	152	160	168	176	184	192	200	208	216	224	232	240	248	256	264	272	280
	9	63	72	81	90	99	108	117	126	135	144	153	162	171	180	189	198	207	216	225	234	243	252	261	270	279	288	297	306	315
	10	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350

Risk of Failure Score

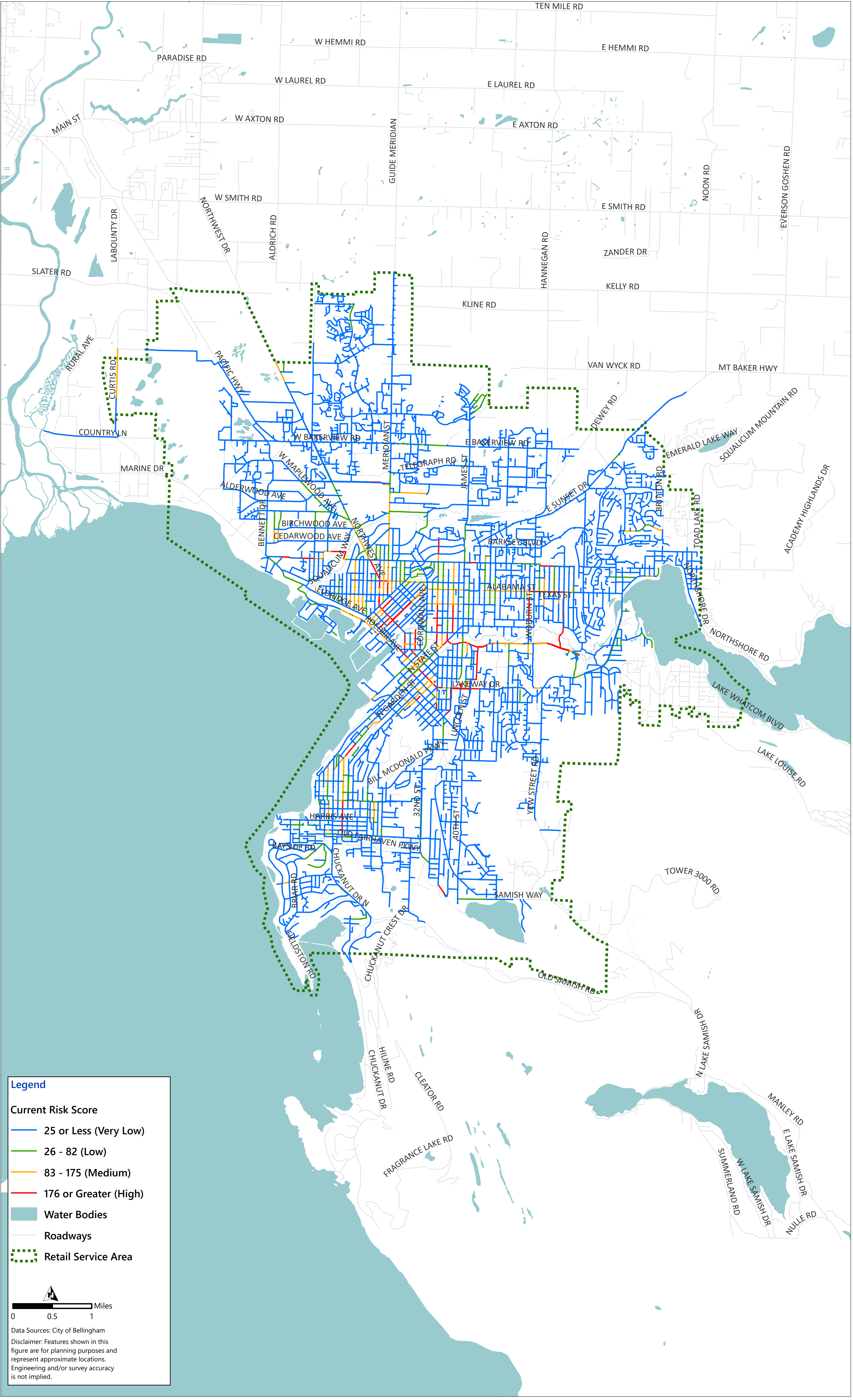
Risk of Failure Value	Risk Level
≤ 24	**Very Low**
25 to 82	**Low**
83 to 175	**Medium**
≥ 176	**High**

9.14.4 Risk Assessment Results

The risk assessment analyzed 7,406 pipe segments totaling 2,098,161 linear feet. The current Risk of Failure projections (Figure 9.15) for those pipe segments are summarized in Table 9.9. A complete analysis containing the components of the Consequence of Failure score, Probability of Failure score, and Risk of Failure of each pipe segment is available in Appendix Z.

Table 9.9 Risk of Failure Summary

Risk Level	Count			Length of Pipe		
	Current	10 Year	20 Year	Current	10 Year	20 Year
Very Low	86.9%	81.2%	63.8%	83.7%	76.4%	57.4%
Low	3.7%	7.4%	18.1%	5.1%	10.4%	20.8%
Medium	5.6%	6.4%	11.7%	6.1%	6.6%	13.6%
High	3.8%	5.0%	6.3%	5.1%	6.6%	8.2%



Data Sources: City of Bellingham

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Figure 9.15 Pipeline Current Risk Score

CITY OF BELLINGHAM
WATER SYSTEM PLAN

CHAPTER 10 CAPITAL IMPROVEMENT PLAN

10.1 Introduction

This chapter combines the various projects recommended in the Plan for the City's water system and presents them as a comprehensive CIP. With this CIP, the City will have guidelines to plan and budget for the water system over the next 20 years, along with the recommended timing and cost estimates for each identified project. Project phasing is described as either short-term (0 to 10 years, which corresponds to 2025-2034) or long-term (10 to 20 years, which corresponds to 2035-2044).

As part of the CIP's planning and development, the water utility will continue considering programs and projects to support the City's business plan, vision, and mission for economic growth, social equity, and environmental sustainability goals. The water utility will continue to implement capital improvement projects transparently, informed by system and community needs and the financial, environmental, and social costs and benefits, to provide long-term community value.

Appendix Z details each project with cost estimates and detailed implementation timing and prioritization.

10.1.1 Capital Project Categories

The Plan's CIP projects are categorized by the following:

- Pump Station (PS).
- Pressure Zone (PZ).
- Storage Facilities (ST).
- Programmatic (P).
- Distribution pipeline (D).
- Water Treatment Plant (WTP).
- General (G).

The abbreviations presented above were used during project identification to delineate each project category. An overview of the City's recommended CIP is presented in Section 10.2.

10.1.2 Capital Project Types

To support the City's financial evaluation, CIP projects were assigned need based on four types:

- **Capacity**: Projects that add system capacity to meet future demand growth. These projects are typically funded with connection fees and are recommended to meet the analysis criteria detailed in Chapter 7.
- **Improvement**: Projects that improve the level of service (e.g., redundant pumping, backup power, pipe upsizing, fire flow, system reliability) of existing infrastructure. These projects are typically funded with rates and are needed whether demand increases or stays the same.
- **Replace and Repair (R&R)**: Projects that replace or maintain existing infrastructure without increasing capacity or level of service. These projects are typically funded with reserves and are meant to renew aging infrastructure that is in poor condition.
- **General/Programmatic**: Projects that are intended to be studies, consisting of future water system plans, storage analysis, and WTP project feasibility studies.

Individual projects may include elements of multiple capital project types, meaning that each project was defined as one or more of the four types and assigned a percentage of the total project cost to each type. The allocations between multiple types were made using professional judgment.

10.2 CIP Program Overview

This section summarizes the CIP program and illustrates the locations of recommended projects, both specific and programmatic. Tables 10.1 and 10.2 summarize the CIP projects by project category and priority, respectively. Figures 10.1 and 10.2 summarize the percent of each project identified by project category and project type, respectively. Specific project details are provided at the end of the chapter in Section 10.4.

When considering CIP costs by project category as shown in Table 10.1 and Figure 10.1, the majority of CIP costs (41 percent) are accrued from annual projects. Storage projects and WTP projects comprise the other high-cost categories and account for 28.0 percent and 24.2 percent of the CIP, respectively.

When considering CIP costs by priority (more detail in Section 10.4) as shown in Table 10.2 and Figure 10.2, approximately 41 percent of the CIP costs are annual programs, as previously stated. The total water CIP cost over the next 20 years is approximately $532 million, which equates to approximately $26.6 million per year for the planning period. Of the total cost, approximately $108 million is budgeted for the short-term, approximately $203 million is budgeted for the long-term, and approximately $220 million is budgeted for the annual category.

Table 10.1 CIP Summary Table by Cost Category

Project Category	Annual Cost	Total Cost	Percentage
Distribution Piping	$951,750	$19,035,000	3.6%
Annual Programs	$10,991,250	$219,825,000	41.4%
Pressure Zone	$6,050	$121,000	0.02%
Pump Station	$698,300	$13,966,000	2.6%
Storage	$7,439,100	$148,782,000	28.0%
General	$65,000	$1,300,000	0.2%
Treatment Plant	$6,428,100	$128,562,000	24.2%
Total Cost	**$26,579,550**	**$531,591,000**	**100.0%**

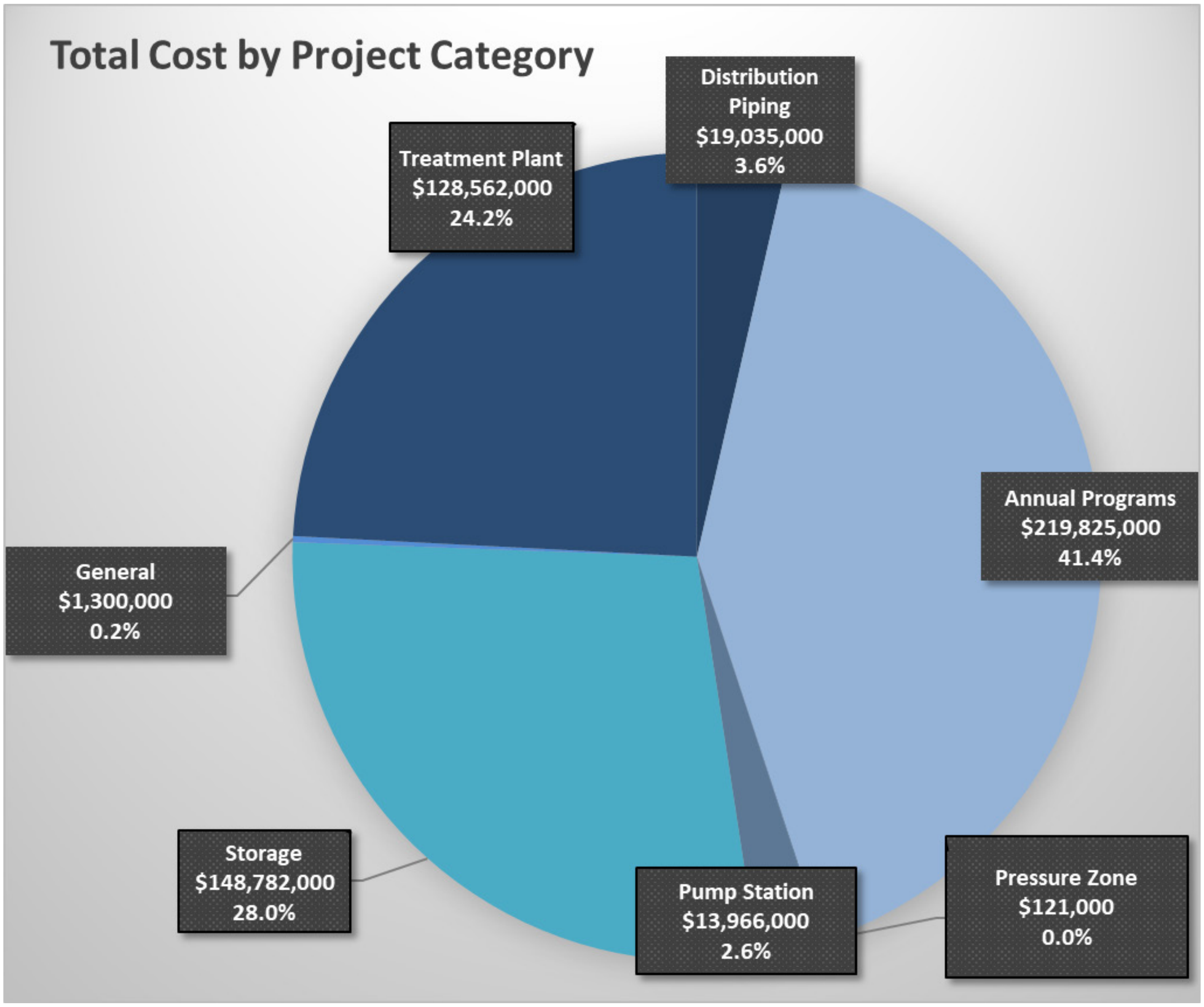


Figure 10.1 CIP Summary Table by Project Category

Table 10.2 CIP Summary Table by Project Priority

Project Priority	Total Cost	Percentage
0-10 years	$108,269,000	20.4%
10-20 years	$203,497,000	38.4%
Annual	$219,825,000	41.13%
Total Cost	**$531,591,000**	**100.0%**

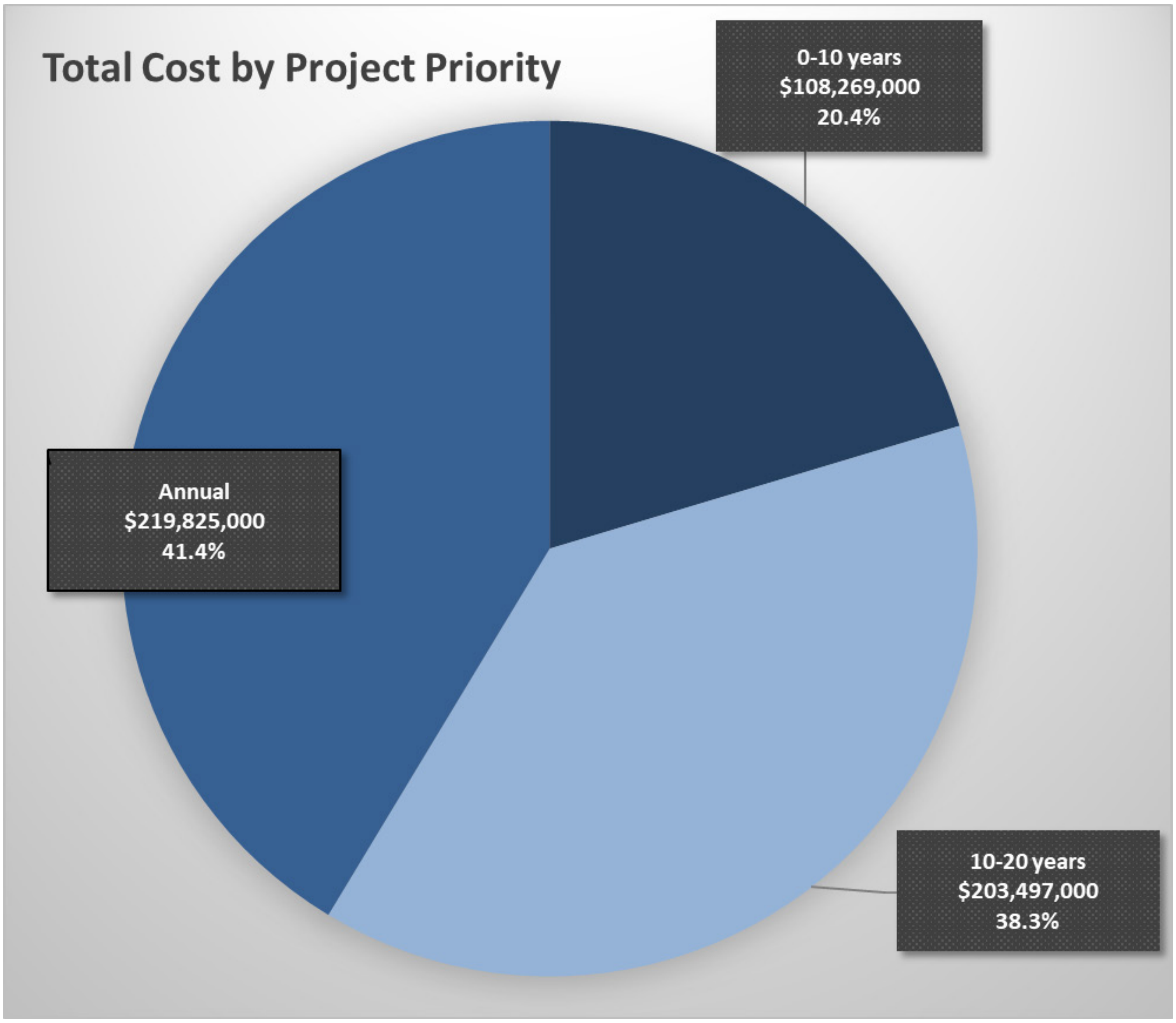


Figure 10.2 CIP Summary Table by Project Priority

10.3 Cost Estimating Assumptions

10.3.1 Cost Estimate Level

The CIP cost estimates in this chapter are Class 5 estimates (budget-level estimates from a -50 percent to +100 percent range). These costs were determined using both Carollo's understanding of project locations and current conditions and the City's costs of similar and recently constructed capital projects. Note that actual costs may vary from these estimates by -50 percent to +100 percent.

All costs are given in 2024 dollars. The Engineering News Report's U.S. 20-City Construction Cost Index for July 2024 is 15,632. As previously stated, the estimates are subject to change as the project design matures and because costs for labor, materials, and equipment may vary in the future.

10.3.2 Baseline Unit Cost

Baseline construction costs were estimated using unit costs with the assumptions presented in the following subsections.

10.3.2.1 Pipeline Unit Costs

Table 10.3 shows unit cost assumptions for pipelines provided by the City. These costs were developed from recent construction costs for various water pipeline projects and were rounded to the nearest dollar. These unit costs assume open-trench construction in improved areas.

The estimated construction costs cover excavation, hauling, reinforced pipe installation, bedding, and backfill material and installation, The unit costs are for typical field conditions for construction in stable soil at depths ranging between three to five feet.

The unit does NOT include:

- Surface restoration.
- Road or sidewalk restoration (repaving for concrete of asphalt) If you need an asphalt adder for LF I could develop one for you.
- Landscape restoration.
- Any fittings – hydrants and their connections; fittings like couplings, reducers; service connections and up to the property line.

Table 10.3 Pipeline Unit Costs

Pipe Size (inches)	Pipeline Unit Cost[(1)] ($/lf)
6	$239
8	$278
10	$322
12	$366
14	$461
16	$555

Pipe Size (inches)	Pipeline Unit Cost[1] ($/lf)
18	$773
20	$991
24	$1,371

Notes:
(1) The unit cost does not include the additional 35 percent for construction contingency, 50 percent for design and admin.

10.3.2.2 Pump Station Costs

Costs for pump stations were developed based on Carollo's and the City's experience with similar projects. A cost curve with preliminary pump station capacity as the x-axis, and cost as the y-axis was developed to estimate new pump station costs. It is shown in Figure 10.3. Rehabbed pump station costs were determined based on Carollo's history with similar projects.

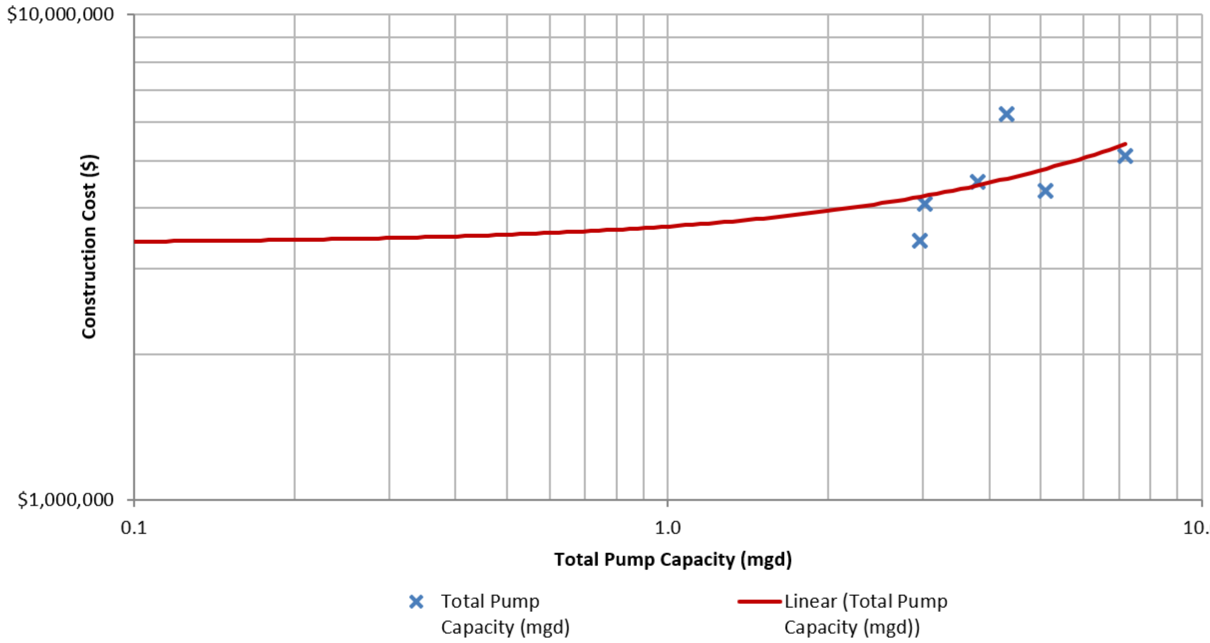


Figure 10.3 Pump Station Cost Curve

In some locations individual booster pump stations may be appropriate or more cost effective to supply residential water above 30 psi. Individual booster pump station able to supply 200 gpm and 110 feet of head were estimated to cost in the range of $5,000 to 10,000 based on quotes from PumpTech. For the purposes of this CIP, all individual booster pump stations were conservatively estimated to cost $10,000.

10.3.2.3 Storage Costs

Project costs for new storage were developed based on typical costs from past Carollo projects. Conceptual costs for reservoirs vary by type (ground, standpipe, or elevated) and are estimated based on reservoir volume in gallons, as presented in Table 10.4. Storage costs are sensitive to site-specific geotechnical and seismic considerations; therefore, Carollo recommends that the City conduct a reservoir siting study at the start of every new storage project.

Table 10.4 Reservoir Unit Costs

Reservoir Type	Storage Unit Cost(1) ($/gallon)
Ground	$5
Standpipe	$8
Elevated	$11

Notes:
(1) The unit cost does not include the additional 35 percent for construction contingency, 50 percent for design and admin.

10.3.2.4 Pressure-Reducing Valve Costs

Other costs for the CIP include those associated with PRV stations. The conceptual cost presented in Table 10.5 was estimated based on Carollo's recent projects.

Table 10.5 Valve Costs

	Cost(1) (Lump Sum)
PRV Station	$300,000
Isolation Valve	$15,000

Notes:
(1) The unit cost does not include the additional 35 percent for construction contingency or 50 percent for design and admin.

10.3.3 Construction Contingency

Contingency costs must be reviewed on a case-by-case basis because they will vary considerably with each project. Consequently, the preliminary layout of a project will contain uncertainties such as unexpected construction conditions, the need for unforeseen mechanical items, and variations in final quantities; because all these items increase project costs, allowances should be made for them in preliminary estimates. To assist the City with making financial decisions for these future construction projects, a 35 percent construction contingency cost is added to the baseline construction cost.

10.3.4 Design/Admin Costs

Design and administration costs include expenses associated with project engineering, professional services during the construction phase, and project administration. More specifically, engineering services associated with new facilities include the following tasks:

- Conducting preliminary investigations and reports.
- Preparing drawings and specifications during construction.
- Surveying and staking.
- Sampling of testing material.
- Providing start-up services.

Meanwhile, construction phase professional services cover items such as construction management, engineering services, materials testing, and inspection during construction. Finally, project administration costs cover items such as legal fees, financing expenses, administrative costs, and interest during construction.

In general, the City suggested that the projects in this CIP include a design and administration cost of 50 percent of the construction cost with contingency. This 50 percent contingency is allocated as follows: 10 percent for general conditions, 15 percent for contractor overhead and profit, and 25 percent for Engineering, Legal, and Administrative (ELA) fees.

10.3.5 Total Capital Improvement Cost

The costs presented in this CIP are high-level planning costs that will help the City make financial decisions.

The sample capital improvement project cost calculation shown below demonstrates how construction contingency as well as design and administrative costs were added to the baseline construction cost to determine the total project cost. The construction contingency plus design and administration costs make up 50 percent ($1,026,000/$2,026,000) of the total project cost estimate.

Example:

Baseline Construction Cost	**$1,000,000**
Construction Contingency (35%)	$350,000
Estimated Construction Cost	**$1,350,000**
General Conditions (10%)	$135,000
Contractor Overhead and Profit (15%)	$203,000
ELA (25%)	$338,000
Total Capital Improvement Cost	**$2,026,000**

10.4 CIP Development and Implementation

The capital improvement implementation was separated into three phases:

- Short-term: 0 to 10 years.
- Long-term: 10 to 20 years.
- Annual.

The City developed criteria to prioritize all projects and recommendations from this Plan between short-term and long-term. The City hired PRR, an independent communications firm, to support engagement efforts for the Plan update. The *Community Engagement Summary, July 2024 Report,* provided a summary describing the City's community engagement approaches, activities, and feedback gathered through community engagement efforts in May and June 2024. The results of these community engagement surveys were used to help prioritize the types of projects that should be short-term or long-term.

Table 10.6 summarizes the high-level prioritization matrix for different project types and purposes.

Table 10.6 Overall Prioritization Criteria

Project Types	0-10 years	10-20 years
Pipe upsize for fire flow only.		X
Pipe upsize for fire flow, maintenance, and past RUL.	X	
Pressure Zone projects (PZ-01 - PZ-02).	X	
General SFR Dead-end fire flow program.	Annual	
Non-SFR Dead-end fire flow program.	Annual	
Pipeline repair and replacement program.	Annual	
Pump station projects (PS-01, PS-03, and PS-05-PS-08).	X	
Pump station projects (PS-02 and PS-04).		X
Near-term storage projects (ST-01).	X	
Long-term storage projects (ST-02).		X
Storage rehabilitation projects.	X	X
Water treatment plant projects.	X	X
General projects.	X	X

Notes:
SFR - single-family residential.

The following sections summarize recommended projects identified in previous chapters and incorporated in the summary in Section 10.5. Figures and detailed tables are located at the end of this chapter.

10.4.1 Recommended Distribution Pipeline Projects

Distribution pipeline projects (D) were developed using the hydraulic model and were identified for areas not meeting velocity and pressure criteria, as detailed in Chapter 7. These projects also took City staff input into account during development.

The prioritization and selection of pipes are based on several factors including the degree of fire flow deficiencies identified from the hydraulic model, the remaining useful life of the pipes, and coordination with other City capital projects. This program reduces the likelihood of system failures, unplanned service interruptions, and claims for damages against the City.

10.4.1.1 D-1 through D-21 - Fire Flow Recommended Pipeline Projects

To address the fire flow deficiencies identified in Chapter 7, projects and recommendations presented in that chapter should be implemented. Namely, projects will upsize 4-inch and 6-inch pipes or add piping to create looped piping. Once implemented, these projects will help mitigate the identified deficiencies. Appendix Z details each fire flow pipeline project and references it according to its project identification. In the CIP, these are projects D-01 through D-21. These are shown in Figure 10.5. Given the results of the remaining useful life and risk analysis presented in Chapter 9, some of these projects are also recommended to address asset conditions.

In summary, approximately 20,487 linear feet of piping is recommended to be upsized or built to mitigate fire flow deficiencies. These projects are estimated to total $19.0 million (including design and admin and construction contingency) and are recommended in both short-term and long-term phases, as shown in the Prioritization Criteria in Table 10.6.

10.4.1.2 Distribution Pipeline Recommendations Summary

Table 10.7 summarizes the footage and the cost of different diameter piping that must be replaced in the short and long-term. This table includes all projects recommended in the above sections.

Table 10.7 Distribution Pipelines Projects Summary

Pipe Diameter	0-10 years		10-20 years	
	Length (LF)	Cost(1)	Length (LF)	Cost(1)
8-inch	2,772	$1.56 million	1,609	$0.91 million
12-inch	3,422	$2.54 million	9,033	$6.70 million
20-inch	0	$0 million	3,651	$7.33 million
Total	**6,194**	**$4.10 million**	**14,293**	**$14.94 million**

Notes:
(1) The cost includes 35 percent construction contingency, 10% general conditions, 15% contractor overhead and profit, and 25 percent ELA contingency.

10.4.2 Recommended Pressure Zone Projects

This CIP has two PZ projects, all of which are shown in Figure 10.5 and summarized in Table 10.8 with their respective priorities and costs.

Table 10.8 Pressure Zone Recommendations

Project Number	Project Name	Priority	Cost(1)
PZ-01	North to Cordata PZ 1	0-10 years	$30,000
PZ-02	North to Cordata PZ 2	0-10 years	$91,000

Notes:
(1) The cost includes 35 percent construction contingency, 10% general conditions, 15% contractor overhead and profit, and 25 percent ELA contingency.

10.4.2.1 PZ-01 - North to Cordata PZ 1

MDD condition modeling of the distribution system showed four nodes representing six customers with low pressures, less than 30 psi, in 2034. To address these low pressures, it is recommended that customers be served off the higher HGL Cordata Zone. To do so the Northwest Ave valve should be closed, and an isolation valve should be added at Mcleod Road and Northwest Ave.

It is anticipated that this project will cost $30,000 and it is to be implemented in the short-term.

10.4.2.2 PZ-02 - North to Cordata PZ 2

MDD condition modeling of the distribution system showed four nodes with low pressures representing five customers, less than 30 psi along East Bakerfield Road, in 2034. To address these low pressures, it is recommended that customers be served off the higher HGL Cordata Zone. To do so three isolation valves should be added along East Bakerfield Road.

It is anticipated that this project will cost $91,000 and it is to be implemented in the short-term.

10.4.3 Recommended Annual Repair and Replacement Programs

Three types of programmatic projects (P) are recommended: annual R&R pipeline projects and two dead-end programs.

10.4.3.1 P-01 - General SFR Dead-end Fire Flow Program

The City has multiple 4-inch and 6-inch dead-end pipes in single-family areas that are also old and do not have the capacity to provide the City’s current fire flow requirements of 750 gpm for single family zoning. This program involves upsizing these dead-end pipe sizes.

The estimated cost for the General SFR Dead-end Fire Flow Program (P-01) is approximately $3.9 million and it is recommended that $1.9 million be completed in the short-term and 2.0 million be completed in the long-term.

10.4.3.2 P-02 - General Non-SFR Dead-end Fire Flow Program

The City has multiple 4-inch, 6-inch, or 8-inch diameter dead-end pipes in non-single-family areas that are older and do not have the capacity to provide the City’s non-SFR fire flow requirements. In some cases, customers are protected by multiple hydrants on different water mains. As long as the total fire flow from the multiple hydrants meets the fire flow requirement, no improvements are necessary. In other cases where only one water main serves customers, looping may be required or the dead-end main may need to be upsized to 12 inches to meet the fire flow requirements.

It is recommended that the City evaluate each case of these dead-end pipes individually to determine how fire flows can be provided to customers. These areas should be reviewed when new development takes place and potentially looped or upsized. No cost was developed for the General Non-SFR Dead-end Fire Flow Program (P-01).

10.4.3.3 P-03 - Pipeline Repair and Replacement Program

As outlined in Chapter 9, the RUL analysis examined the pipes’ material and installation year, as well as their materials’ useful life, to determine the year during which each pipe would reach the end of its useful life. It is recommended that the City increase its annual pipe-replacement program and start replacing approximately 12,167 LF of pipe per year, targeting pipes that have reached the end of their useful life.

P-03 is estimated to cost approximately $215.9 million or $10.8 million annually over the 20-year period. No specific projects were identified as part of the Pipeline R&R Program (P-03). Instead, it is recommended that the City decide which pipes to replace every year. It is recommended that the City continue to enhance its asset management program to help prioritize and time the R&R of its aging water infrastructure by weighing the costs of continued maintenance against the costs of R&R. This will help prioritize which pipelines identified under Project P-03 need to be replaced each year and will include additional data beyond just the remaining useful analysis. These plans ultimately reduce operation and maintenance risks, thus resulting in lower costs overall, and consequently lower cost burdens for ratepayers.

10.4.4 Recommended Pump Station Projects

Table 10.9 summarizes eight PS projects, six of which are prioritized for the short-term and two are long-term.

Table 10.9 Pump Station Recommendations

Project Number	Project Name	Priority	Cost(1)
PS-01	Balsam Lane PS Upgrade	0-10 years	$1.0 million
PS-02	Reveille PS Replacement	10-20 years	$4.7 million
PS-03	Huntington PS Replacement	0-10 years	$4.0 million
PS-04	Samish Heights PS Replacement	10-20 years	$3.8 million
PS-05	Cordata Prkwy Individual Booster Pump Station	0-10 years	$0.04 million
PS-06	Academy St Individual Booster Pump Station	0-10 years	$0.26 million
PS-07	Lakeway Dr Individual Booster Pump Station	0-10 years	$0.14 million
PS-08	Bass St Individual Booster Pump Station	0-10 years	$0.02 million

Notes:
(1) The cost includes 25 percent construction contingency and 30 percent ELA contingency.

10.4.4.1 PS-01 - Balsam Lane PS Upgrade

The Alabama Hill pumping area has insufficient PHD pumping capacity and fire flow capacity for the 2024 demand scenario. Replacing or updating two of the Balsam Lane pumps to 1,200 gpm capacity fire pumps will solve the current and future fire flow problems.

The estimated cost for the Balsam Lane PS Upgrade (PS-01) is approximately $1.0 million and is recommended in the short-term.

10.4.4.2 PS-02 - Reveille PS Replacement

The Reveille PS is unable to supply fire flows for 2024 conditions, however, the area served by this station is not within City limits. If the area served by the Reveille pump station is annexed into the City, additional pumping capacity will be needed. Two additional 1,500 gpm capacity fire pumps should be constructed to mitigate these fire flow and pump capacity issues.

The estimated cost for the Reveille PS Replacement (PS-02) is approximately $4.7 million and is recommended in the long-term.

10.4.4.3 PS-03 - Huntington PS Replacement

The Huntington pumping area has insufficient fire flow pumping capacity for the 2024 demand scenario. Two additional 700 gpm capacity fire pumps will solve the current and future fire flow problems.

The estimated cost for the Balsam Lane PS Replacement (PS-03) is approximately $4.0 million and is recommended in the short-term.

10.4.4.4 PS-04 - Samish Heights PS Replacement

The Samish Heights PS is unable to supply fire flows for 2024 conditions. Two additional 550 gpm capacity fire pumps should be constructed to mitigate these fire flow and pump capacity issues.

The estimated cost for the Samish Heights PS Replacement (PS-04) is approximately $3.8 million and is recommended in the long-term.

10.4.4.5 PS-05 - Cordata Parkway Individual Booster Pump Stations

Modeling of the distribution system for 2034 MDD conditions identified four nodes representing two customers, with low pressures, less than 30 psi on the suction side of Short Street PS. To address these low pressures, it is recommended that individual booster pump stations be provided to the two homes along Cordata Parkway to bring the customer projected inlet service pressure into the City’s target level of service.

It is anticipated that this project will cost $40,000 and it is to be implemented in the short-term.

10.4.4.6 PS-06 – Academy Street Individual Booster Pump Stations

Simulating 2034 MDD condition in the distribution system identified six nodes representing 13 customers with low pressures, less than 30 psi along Sylvan Street and Academy Street. To address these low pressures, it is recommended that individual booster pump stations be provided to the 13 homes with customer projected inlet pressures below the City’s target level of service.

It is anticipated that this project will cost $260,000 and it is to be implemented in the short-term.

10.4.4.7 PS-07 - Lakeway Drive Individual Booster Pump Stations

Simulating 2034 MDD conditions in the distribution system identified seven nodes representing seven customers with low pressures, less than 30 psi along Lakeway Drive. To address these low pressures, it is recommended that individual booster pump stations be provided to the seven customers with projected inlet pressures below the City’s target level of service.

It is anticipated that this project will cost $140,000 and it is to be implemented in the short-term.

10.4.4.8 PS-08 - Bass Street Individual Booster Pump Stations

Simulating 2034 MDD conditions in the distribution system identified one node representing one customer with low pressures, less than 30 psi at Bass Street and Yew Street Road. To address this low pressures, it is recommended that an individual booster pump stations be provided for the one customer with projected inlet pressures below the City’s target level of service.

It is anticipated that this project will cost $20,000 and it is to be implemented in the short-term.

10.4.5 Recommended Storage Projects

This section summarizes the recommended storage projects (ST) that were identified through the storage analysis detailed in Chapter 7. Table 10.10 shows the two recommended storage capacity projects and the 12 recommended storage rehab projects.

Table 10.10 Storage Recommendations

Project Number	Project Name	Priority	Cost[(1)]
ST-01	King Mountain Tank 1	0-10 years	$22.8 million
ST-01	King Mountain Tank 2	0-10 years	$22.8 million
ST-01	Dakin and Yew Transmission Line with PRVs	10-20 years	$10.1 million
ST-01	Cordata Transmission Line with PRVs	0-10 years	$8.1 million
ST-01	Lower King Mountain PS	0-10 years	$5.0 million
ST-01	Storage Study	0-10 years	$0.25 million
ST-02	Upper Yew Tank	10-20 years	$27.4 million
ST-02	Upper Yew Transmission Lines with PRVs	10-20 years	$29.0 million
ST-03	Padden Reservoir Rehabilitation (2)	0-10 years	$1.1 million
ST-04	Whatcom Falls I Reservoir Rehab (2)	10-20 years	$6.3 million
ST-05	Dakin II Reservoir Rehab (2)	0-10 years	$1.0 million
ST-06	Kearney Reservoir Rehab (2)	10-20 years	$0.3 million
ST-07	Whatcom Falls II Reservoir Rehab (2)	0-10 years	$1.1 million
ST-08	40th Street Reservoir Rehab (2)	10-20 years	$3.1 million
ST-09	College Way Reservoir Rehab (2)	0-10 years	$1.4 million
ST-10	Consolidation Reservoir Rehab (2)	0-10 years	$1.4 million
ST-11	Dakin I Reservoir Rehab (2)	0-10 years	$1.4 million
ST-12	Reveille Reservoir Rehab (2)	0-10 years	$1.6 million
ST-13	Sehome Reservoir Rehab (2)	10-20 years	$4.4 million
ST-14	Parkhurst Standpipe Rehab (2)	10-20 years	$0.3 million

Notes:
(1) The cost includes 25 percent construction contingency and 30 percent ELA contingency.
(2) The cost was provided by City staff in 2020, then scaled using July 2024 Seattle ENR value.

10.4.5.1 ST-01 - King Mountain Reservoir

Two 2.5 MG reservoirs in the new King Mountain Zone are recommended to address the storage deficit in the Dakin and Yew Zone and part of the deficit in the North Zone. To ensure resilient storage between the zones a new transmission line is required as a part of this to connect from King Mountain to Dakin and Yew and King Mountain to Cordata. Each transmission line will be equipped with a PRV. A new PS, Lower King Mountain PS, is also needed to reliably fill the new King Mountain Reservoir. A general storage study is also a part of this project. The Storage Study will assess the impact of the new King Mountain and Upper Yew Reservoirs on system operations as a whole. This project also includes operational adjustments at the Whatcom Falls Reservoir and 40th St Reservoir.

The estimated cost for the King Mountain Reservoir (ST-01) is approximately $69.1 million and is recommended in the short-term, except the transmission line to Dakin and Yew, which can be pushed to the long-term.

10.4.5.2 ST-02 - Upper Yew Reservoir

One 3.0 MG reservoir in the Governor Road Zone is recommended to address the storage deficits in the remainder of the North Zone, South Zone, Padden Yew Zone, and Governor Road Zone. To ensure resilient storage between the zones a new transmission line is required as a part of this to connect from Governor Road to South and Governor Road to Padden Yew. Each transmission line will be equipped with a PRV. This project also includes operational adjustments at the Whatcom Falls Reservoir.

The estimated cost for the Upper Yew Reservoir (ST-02) is approximately $53.9 million and is recommended in the long-term.

10.4.5.3 ST-03 – ST-14 – Tank Rehab and Rehabilitation

In 2020, the City and Murraysmith performed field inspections, condition assessments, and recommended improvements for all the tanks in the water distribution system. The rehab and rehabilitation projects were all included in this CIP. The estimated costs were converted from 2020 to current dollars. ST-13 was originally slated to rehab the Sehome Reservoir. This reservoir is no longer in use, but the same cost dollar was assumed for the decommissioning of the Tank.

10.4.6 Recommended WTP Projects

This section summarizes the recommended WTP projects (WTP) that were identified through the WTP analysis detailed in Chapter 8. Table 10.11 shows the 17 recommended projects. Additional information on project descriptions is provided in Chapter 8.

Table 10.11 WTP Recommendations

Project Number	Project Name	Priority	Cost$^{(1)}$
WTP-01	Raw Water Intake Rehabilitation Improvement	0-10 years	$4.1 million
WTP-02	Redundant Raw Water Intake Feasibility Study	0-10 years	$0.5 million
WTP-03	Redundant Raw Water Intake	10-20 years	$100 million
WTP-04	Screenhouse Rehabilitation	0-10 years	$5.7 million
WTP-05	Filter Rehabilitation Project	0-10 years	$4.6 million
WTP-06	Soda Ash Feed System Replacement	0-10 years	$2.0 million
WTP-07	WTP Flow Metering Improvement Study	0-10 years	$0.3 million
WTP-08	WTP Flow Metering Improvement Project	0-10 years	$3.0 million
WTP-09	Alum System Replacement	0-10 years	$0.5 million
WTP-10	Powerhouse Demolition	0-10 years	$0.3 million
WTP-11	SCADA System Evaluation	0-10 years	$0.2 million
WTP-12	Polymer System Replacement	0-10 years	$0.3 million
WTP-13	Filter Mechanical Equipment Replacement	0-10 years	$5.5 million
WTP-14	MCC Replacement	0-10 years	$0.6 million
WTP-15	WTP Seismic Resilience and Life Safety Evaluation	0-10 years	$0.3 million

Project Number	Project Name	Priority	Cost(1)
WTP-16	Whatcom Falls WTP HVAC System Improvements Study	0-10 years	$0.2 million
WTP-17	Whatcom Falls WTP HVAC System Improvements Project	0-10 years	$0.5 million

Notes:
(1) The cost includes 25 percent construction contingency and 30 percent ELA contingency.

10.4.7 Recommended General Programs

Three general projects (G) were recommended for this CIP and are summarized in Table 10.12.

Table 10.12 Recommended General Projects Summary

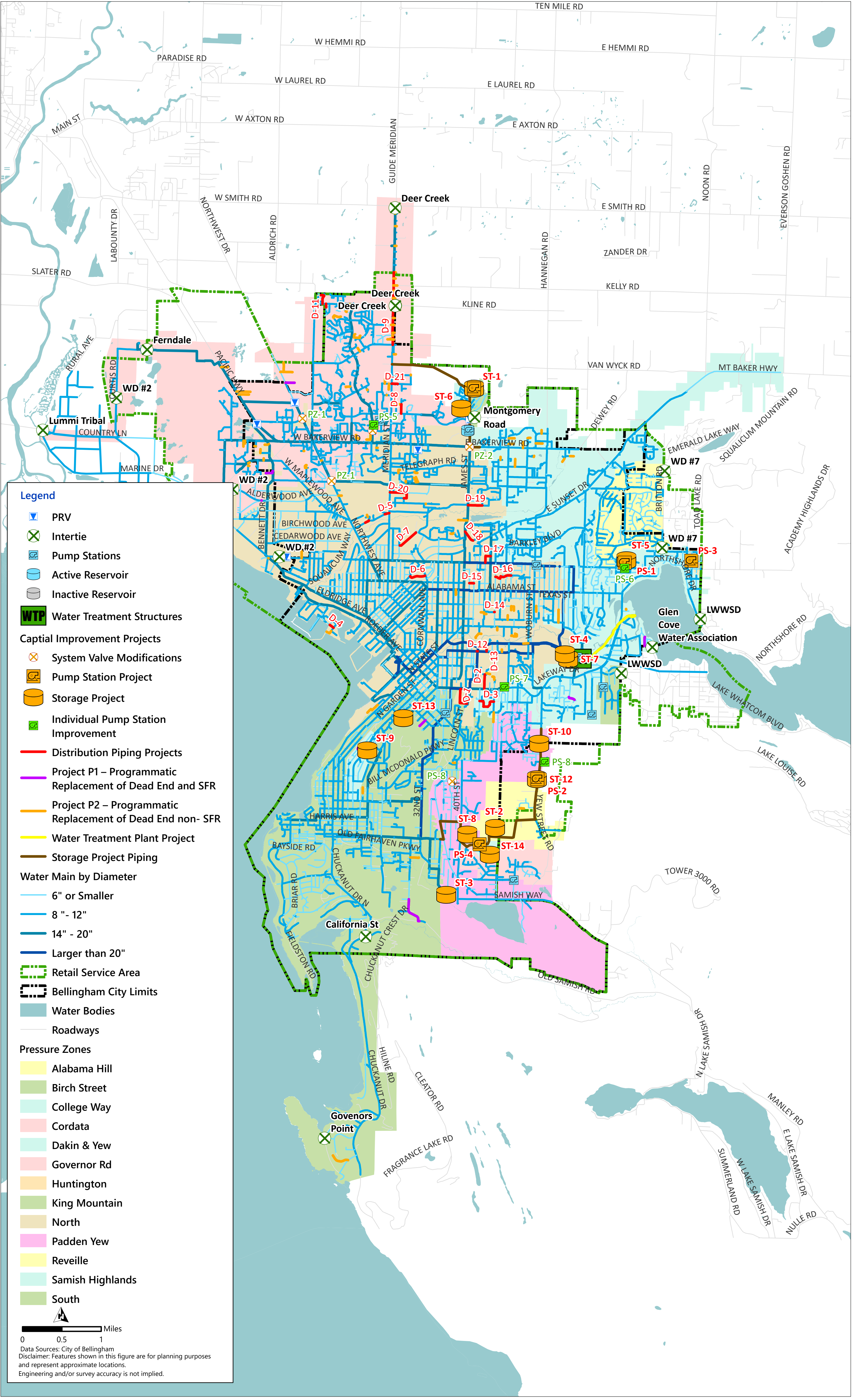
Project Number	Project Name	Priority	20-year Total Cost(1)
G-01	2034 WSP	0-10 years	$0.4 million
G-02	2044 WSP	10-20 years	$0.4 million
G-03	General Fund for Studies	0-10 years	$0.5 million

Notes:
WSP - Water System Plan.

10.5 CIP Program Detailed Summary

Section 10.1 summarizes the CIP projects and labels them as D, P, PZ, PS, ST, G, or R, with each project assigned a unique CIP Identification. Figure 10.4 illustrates the locations of the specific projects identified, while Figure 10.5 illustrates these projects phased between short and long-terms.

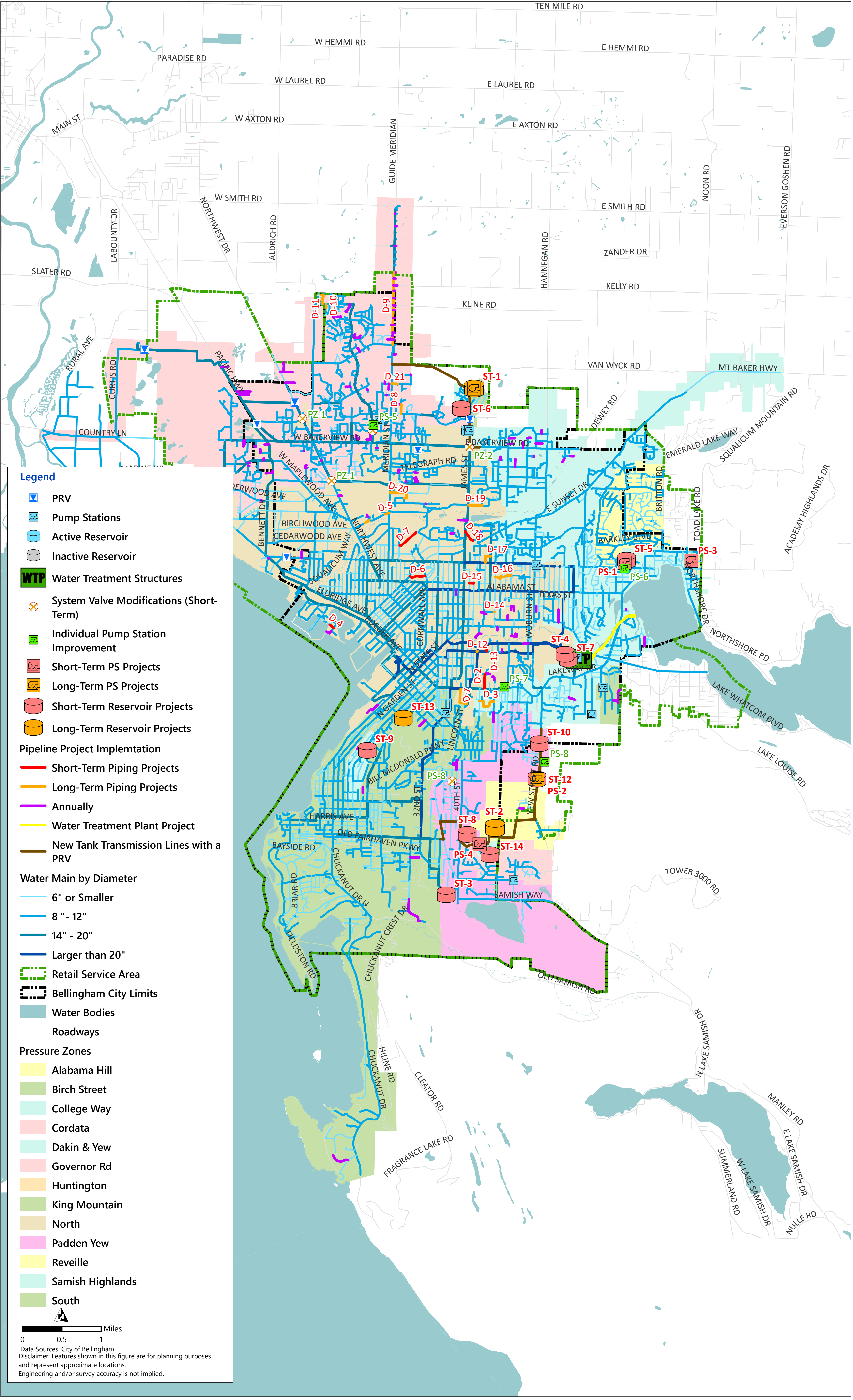
An individual project sheet was generated for each CIP project and includes project identifier, description, costs, project type, timeline, and comments to help with future implementation. To help the City identify individual projects, project sheets are separated by project category. Appendix Z includes all the project sheets.



Last Revised: March 12, 2025 [ENTER PROJECT WISE PATH NAME TO MXD] For Example:pw:\\Carollo\Documents\Client\CA\ClientName\10265A00\Data\GIS\Figure_01_01.aprx

Figure 10.4 Recommended CIP Projects

CITY OF BELLINGHAM
WATER SYSTEM PLAN



Data Sources: City of Bellingham
Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations.
Engineering and/or survey accuracy is not implied.

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Figure 10.5 CIP Project Priority

CHAPTER 11 FINANCIAL PLAN

11.1 Introduction

This chapter was prepared by FCS, a Bowman company (FCS), to provide a financial program that allows the City water utility to remain financially viable during the planning period. This analysis considers the historical financial condition, current and identified future financial and policy obligations, O&M needs, and the financial impacts of the capital projects identified in this Plan. Additionally, the chapter reviews the utility's current rate structure, focusing on rate adequacy, customer affordability, and its effectiveness in promoting water conservation.

11.2 Financial History

This section summarizes the City's Statement of Revenues, Expenses, and Changes in Net Position and Statement of Net Position.

11.2.1 Statement of Revenues, Expenses, and Changes in Net Position

Table 11.1 Historical Statements of Revenues, Expenses, and Changes in Net Position presents the financial performance of the City's water utility from 2017 to 2022. The 2023 statements were unavailable during the chapter's development. Below are key insights into the utility's performance during that time:

- The City's water service charges increased from $27.0 million in 2017 to $33.3 million in 2022, an average annual rise of 4.3 percent, totaling 23.4 percent overall. Revenues grew each year except in 2020 when they fell by 0.7 percent.
- Operating expenditures rose by $2.0 million over six years, averaging a 2.1 percent annual increase.
- Operating income was positive each year. In 2018 and 2019, it was $6.5 million and $6.2 million, respectively. From 2017 to 2022, operating income experienced an annual growth rate of 9.1 percent.
- The operating ratio, calculated by subtracting total operating expenditures from total operating revenues, assesses the City's self-sufficiency as an enterprise. It measures whether annual operating revenues can cover annual operating costs. Including depreciation expense in this calculation provides insight into whether the City charges customers enough to fund asset replacement in addition to daily operating costs. Table 11.1 shows that the City covered operating costs and depreciation over the entire period. The annual operating ratios, including depreciation, ranged from 1.3 to 1.6.

Table 11.1 Historical Statements of Revenues, Expenses, and Changes in Net Position

	2017	2018	2019	2020	2021	2022
OPERATING REVENUES						
Charges for services	$ 26,968,245	$ 27,921,131	$ 28,840,430	$ 28,647,894	$ 31,016,623	$ 33,268,827
Total Operating Revenues	$ 26,968,245	$ 27,921,131	$ 28,840,430	$ 28,647,894	$ 31,016,623	$ 33,268,827
OPERATING EXPENSES						
Labor	$ 4,336,990	$ 4,593,146	$ 4,480,496	$ 4,234,005	$ 2,636,561	$ 3,516,913
Supplies	1,511,888	1,434,628	1,572,221	1,467,951	1,773,153	1,789,617
Services	5,164,447	6,844,264	7,382,500	5,770,148	4,912,232	5,010,153
Depreciation	2,459,938	2,502,128	2,987,807	3,043,751	3,110,127	3,488,001
Taxes	5,593,855	5,876,012	6,084,451	6,027,719	6,427,183	7,109,342
Insurance	95,181	95,181	94,239	94,239	184,856	308,469
Claims	-	-	-	-	-	-
Total Operating Expenses	**$ 19,162,299**	**$ 21,345,359**	**$ 22,601,714**	**$ 20,637,813**	**$ 19,044,112**	**$ 21,222,495**
Operating Gain (Loss)	**$ 7,805,946**	**$ 6,575,772**	**$ 6,238,716**	**$ 8,010,081**	**$ 11,972,511**	**$ 12,046,332**
NON-OPERATING REVENUES (EXPENSES)						
External operating grants and subsidies	$ -	$ 1,601,610	$ 234,553	$ 2,120,612	$ 341,180	$ 39,308
Operating assessments and tax levies	-	-	-	-	-	-
Investment interest	219,454	365,035	434,153	387,689	286,405	424,190
Net incr (decr) in fair value of investments	(59,863)	(49,963)	317,092	129,750	(443,416)	(2,056,868)
Interest expense and related charges	(251,756)	(282,862)	(313,833)	(296,988)	(230,377)	(208,669)
Gain (loss) on sale of capital assets	-	(2,397)	-	-	-	-
Other Non-Operating Revenue	164,205	120,800	167,446	33,724	131,588	157,398
Other Non-Operating Expense	-	-	-	(5,924,537)	(3,210,256)	(2,359,344)
Non-Operating Revenues Net of Expense	**$ 72,040**	**$ 1,752,223**	**$ 839,411**	**$ (3,549,750)**	**$ (3,124,876)**	**$ (4,003,985)**
Net Income (Loss) Before Transfers	**7,877,986**	**8,327,995**	**7,078,127**	**4,460,331**	**8,847,635**	**8,042,347**
Capital Grants and Contributions	1,473,659	2,051,449	871,143	9,027,861	6,608,375	2,628,573
Transfers In	575,000	575,000	-	-	-	-
Transfers Out	(1,123,522)	(1,897,500)	(916,008)	(114,077)	(182,628)	(407,604)
Change in Net Position	**8,803,123**	**9,056,944**	**7,033,262**	**13,374,115**	**15,273,382**	**10,263,316**
Net Position January 1	**114,447,736**	**123,250,859**	**132,307,803**	**139,341,065**	**152,715,180**	**167,988,562**
Prior Period Adjustment	8,803,123	9,056,944	7,033,262	13,374,115	15,273,382	10,263,316
Net Position December 31	**$123,250,859**	**$132,307,803**	**$139,341,065**	**$152,715,180**	**$167,988,562**	**$178,251,878**
Operating Ratio	1.4	1.3	1.3	1.4	1.6	1.6

11.2.2 Historical Statements of Net Position

Table 11.2 Summary of Statements of Net Position presents a summary of assets and liabilities, with the difference between the two reported as "net position." The following points provide additional information:

- The current ratio is a measure of short-term liquidity or the City's ability to pay its current bills—it is calculated by dividing unrestricted current assets (excluding inventories and prepaid items) by current liabilities. A ratio of 1.0 indicates that the utility has exactly enough to pay its bills; higher values are desirable as they suggest an ability to pay large or unanticipated bills. The City has attained current ratios varying from 5.9 to 14.7 over this period, suggesting that the City can meet its short-term financial obligations.
- Days of cash on hand measures how long the City can cover operating costs without additional revenue. It's calculated by dividing unrestricted cash by average daily operating costs (excluding depreciation). While there is no firm minimum standard for this metric, bond rating agencies have recently expressed a preference for a minimum of 180 days of cash on hand for utilities seeking the highest bond ratings. The City has been able to maintain 360-751 days of cash over this period.

Table 11.2 Summary of Statements of Net Position

	2017	2018	2019	2020	2021	2022
ASSETS						
Current Assets						
Cash and cash equivalents	$ 2,912,924	$ 5,547,831	$ 5,130,624	$ 4,104,342	$ 4,483,931	$ 5,499,714
Investments	13,576,419	16,198,336	20,121,146	15,277,869	19,055,678	30,996,532
Receivables, net	907,316	1,762,267	1,271,930	1,392,742	1,554,965	1,656,432
Due from other funds	-	1,608	173,000	-	-	-
Due from other governments	3,591,059	307,587	21	3,540,912	3,866,571	11,001
Prepaid items	2,637	-	-	-	-	-
Restricted cash and cash equivalents	843,582	86,036	70,851	358,866	321,809	243,253
Restricted investments	852,493	251,204	277,860	1,335,830	1,367,612	1,370,976
Total current assets	**$ 22,686,430**	**$ 24,154,869**	**$ 27,045,432**	**$ 26,010,561**	**$ 30,650,566**	**$ 39,777,908**
NONCURRENT ASSETS						
Restricted cash and cash equivalents	$ 742,375	$ 319,385	$ 474,113	$ 703,547	$ 471,630	$ 181,598
Restricted investments	815,072	932,529	1,859,369	2,618,859	2,004,321	1,023,493
Net pension asset - State	-	-	-	-	2,668,275	941,321
Capital assets, nondepreciable:						
Land	36,010,238	36,742,850	38,135,562	41,111,607	42,447,297	44,046,490
Construction in progress	11,756,704	557,991	158,261	9,859,805	18,277,853	439,491
Capital assets, net of depreciation:						
Buildings	6,085,676	5,833,907	5,582,139	5,330,370	5,078,601	4,826,832
Improvements	60,911,511	83,046,578	83,567,400	84,136,096	82,631,961	99,417,572
Machinery and equipment	464,930	398,399	348,353	306,499	264,645	222,792
Total non current assets	**$ 116,786,506**	**$ 127,831,639**	**$ 130,125,197**	**$ 144,066,783**	**$ 153,844,583**	**$ 151,099,589**
TOTAL ASSETS	**$ 139,472,936**	**$ 151,986,508**	**$ 157,170,629**	**$ 170,077,344**	**$ 184,495,149**	**$ 190,877,497**
DEFERRED OUTFLOWS OF RESOURCES						
Loss on refunding	$ 307,605	$ 265,940	$ 224,275	$ 172,858	$ 155,154	$ 137,451
Related to pensions	-	163,636	172,595	365,884	315,780	951,757
Total deferred outflows of resources	$ 307,605	$ 429,576	$ 396,870	$ 538,742	$ 470,934	$ 1,089,208
CURRENT LIABILITIES						
Accounts payable	$ 1,343,024	$ 2,268,281	$ 833,011	$ 1,585,033	$ 716,857	$ 547,346
Accrued wages and benefits	178,516	187,007	194,504	213,898	219,713	220,933
Deposits	-	-	-	-	1,150	2,596
Due to other funds	-	-	62,652	-	-	-
Due to other governments	54,048	-	-	-	-	-
Other current liabilities	20,892	36,633	20,939	117	-	-
Unearned revenue	-	-	-	20,892	-	24,026
Current portion of noncurrent liabilities:						
Bonds payable, net	1,393,000	673,000	707,000	766,000	783,000	805,000
Compensated absences	238,991	254,260	269,556	318,945	297,221	282,216
Intergovernmental loans	253,946	585,461	817,090	817,090	817,090	714,807
Total current liabilities	**$ 3,482,417**	**$ 4,004,642**	**$ 2,904,752**	**$ 3,721,975**	**$ 2,835,031**	**$ 2,596,924**
NONCURRENT LIABILITIES						
Bonds payable, net	$ 5,510,553	$ 4,808,374	$ 4,080,145	$ 3,278,000	$ 2,495,000	$ 1,690,000
Compensated absences	26,830	29,086	33,358	48,539	43,671	52,373
Intergovernmental loans	6,254,636	9,993,380	10,211,861	9,394,770	8,577,680	7,862,873
Net pension liability	1,220,279	916,836	632,214	1,103,246	254,588	541,617
Total noncurrent liabilities	13,012,298	15,747,676	14,957,578	13,824,555	11,370,939	10,146,863
TOTAL LIABILITIES	**$ 16,494,715**	**$ 19,752,318**	**$ 17,862,330**	**$ 17,546,530**	**$ 14,205,970**	**$ 12,743,787**
DEFERRED INFLOWS OF RESOURCES						
Related to pensions	$ 209,399	$ 355,964	$ 364,107	$ 354,379	$ 2,771,553	$ 971,040
Total deferred inflows of resources	**$ 209,399**	**$ 355,964**	**$ 364,107**	**$ 354,379**	**$ 2,771,553**	**$ 971,040**
NET POSITION						
Net investment in capital assets	$ 102,124,529	$ 110,785,450	$ 112,132,702	$ 126,661,375	$ 136,182,741	$ 138,017,947
Restricted:						
Debt service	1,228,168	599,246	614,140	605,672	618,783	593,991
Capital improvements	2,025,353	989,908	2,068,053	3,044,703	2,202,938	944,929
Pension asset	-	-	-	-	2,668,275	941,321
Unrestricted	17,872,809	19,933,198	24,526,167	22,403,426	26,315,823	37,753,690
TOTAL NET POSITION	**$ 123,250,859**	**$ 132,307,802**	**$ 139,341,062**	**$ 152,715,176**	**$ 167,988,560**	**$ 178,251,878**
Current Ratio	6.0	5.9	9.2	6.5	10.2	14.7
Debt to Net Position Ratio	11%	12%	11%	9%	8%	6%
Days of Cash on Hand	360	421	470	402	539	751

11.3 Available Funding Assistance and Financing Resources

Besides cash financing, the City can fund the water utility's capital program using various sources described below.

11.3.1 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. The remaining miscellaneous grant programs are generally lightly funded and vigorously pursued. Nonetheless, the benefit of low-interest loans makes the effort of applying worthwhile. Appendix BB includes a document published by the Washington State Department of Commerce that outlines State programs, eligibility requirements, and contact information.

11.3.2 System Development Charges

A connection charge such as the City’s system development charge (SDC) refers to a one-time charge imposed on new customers as a condition of connecting to the water system. The purpose of the SDC is two-fold: 1) to promote equity between new and existing customers, and 2) to provide a source of revenue, as growth occurs, to fund capital projects necessary for meeting growth demands. This revenue can only be used to fund utility capital projects or to pay debt service incurred to finance those projects. In the absence of a connection charge, growth-related capital costs would be borne in large part by existing customers. In 2024, the City charged new customers an SDC of $5,637 for a 5/8-inch meter. Larger meters pay a larger system development charge.

11.3.3 Bond and Loans

The City might also consider one or more debt-related tools to fund a portion of its capital program.

11.3.3.1 General Obligation Bonds

General obligation (G.O.) bonds are bonds secured by the full faith and credit of the issuing agency, committing all available tax and revenue resources to debt repayment. With this high level of commitment, G.O. bonds have relatively low interest rates and few financial restrictions. However, the authority to issue G.O. bonds is restricted in terms of the amount and use of the funds, as defined by the Washington Constitution and statute. Specifically, the amount of debt that can be issued is linked to assessed valuation.

Revised Code of Washington (RCW) 39.36.020 states:

> *(2)(a)(ii) Counties, cities, and towns are limited to an indebtedness amount not exceeding one and one half percent of the value of the taxable property in such counties, cities, or towns without the assent of three-fifths of the voters therein voting at an election held for that purpose.*
>
> *(b) In cases requiring such assent counties, cities, towns, and public hospital districts are limited to a total indebtedness of two and one-half percent of the value of the taxable property therein.*

While bonding capacity can limit the availability of G.O. bonds for utility purposes, these can sometimes play a valuable role in project financing. A utility rate savings may be realized through two avenues: the lower interest rate and related bond costs, and the extension of repayment obligation to all tax-paying properties (not just developed properties) through the authorization of an ad valorem property tax levy.

11.3.3.2 Revenue Bonds

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 have higher interest rates than G.O. bonds and may require security conditions related to the maintenance of dedicated reserves (a bond reserve) and financial performance (added bond debt service coverage). The City agrees to satisfy these requirements by resolution as a condition of bond sale.

Revenue bonds can be issued in Washington without a public vote. There is no bonding limit, except perhaps the practical limit of the utility's ability to generate sufficient revenue to repay the debt and provide coverage. In some cases, poor credit might make issuing revenue bonds problematic.

11.3.3.3 Water Infrastructure Finance and Innovation Act

The Water Infrastructure Finance and Innovation Act (WIFIA), established in 2014 and administered by the United States Environmental Protection Agency (USEPA), provides an alternative to revenue bonds for funding water and wastewater infrastructure projects. WIFIA loans offer flexible terms, including repayment periods of up to 35 years or the project's useful life and the option to defer repayments for up to five years after project completion, giving utilities time to strengthen financial capacity. Despite these benefits, this rate study conservatively assumes all debt funding will be sourced from revenue bonds. Additional WIFIA details are available at https://www.epa.gov/wifia.

11.4 Revenue Requirement Overview

11.4.1 Methodology

The financial analysis (i.e., revenue requirement) aims to create a viable plan to fund planned capital projects, support ongoing operations, and maintain affordable rates. It identifies the revenue required to meet the water utility's financial obligations, including:

- O&M costs.
- Administrative and overhead costs.
- Policy-based needs (e.g., reserve funding).
- Capital costs.
- Existing and new debt service.

Operating as an enterprise, the City relies on water rates – not taxes or external resources – to cover these expenses. The rate-setting process comprises two key components:

- Revenue Requirement Analysis: Determines the annual revenue needed to fund operations, maintenance, and administration while ensuring long-term financial stability.
- Capital Funding Plan: Develops strategies to fund the CIP through rate revenues, reserves, SDCs, debt financing, and other resources (e.g., grants or developer contributions when applicable). This plan impacts the revenue requirement by influencing debt service payments and direct cash funding for projects.

11.4.2 Fiscal Policies

11.4.2.1 Background

The framework for assessing utility revenue requirements includes fiscal policies. Important policy topics to consider when managing utility finances include cash reserves, debt management, and system reinvestment funded by rates (planned rate-funded capital).

11.4.2.2 City Policies

According to the City's adopted *Financial Management Guidelines* (Resolution No. 2024-08), the following fiscal policies apply to the Water utility, as it is an enterprise fund with outstanding revenue bond debt:

- Maintain cash reserves equal to at least 270 days of operating expenditures (equivalent to 74 percent of annual operating costs).
- Ensure a debt service coverage ratio of 1.70.

While FCS does not recommend changes to the City’s existing reserve or debt service coverage policies, the sections below on Operating Reserves, Capital Reserves, and Debt Service Coverage provide insights into general industry trends for the City’s reference.

11.4.2.3 Cash Reserves

When evaluating reserve levels and objectives, it is important to recognize that the value of reserves lies in their potential use. A reserve strategy that deliberately avoids any use of reserves negates their purpose. The fluctuation of reserve levels may indicate that the system is working, while the lack of variation over many years strongly suggests that the reserves are, in fact, unnecessary.

Operating Reserve

An operating reserve provides a liquidity cushion, protecting the utility from short-term revenue or expense timing variations. The most common industry standard operating reserve target for water utilities is between 60 days to 90 days of operating expenses (16 percent to 25 percent of annual expenditures). The lower end is more appropriate for utilities with stable revenue streams and the higher end is more appropriate for utilities with significant seasonal or consumption-based fluctuations.

Capital Reserve

A capital reserve provides emergency funding for unexpected asset failures or unplanned capital needs, such as project cost overruns. It is not intended for catastrophic system failure or extreme natural events. Typically, water utilities aim for capital reserves between 1-2 percent of the original cost of the plant-in-service.

11.4.2.4 Debt Management

It is prudent to consider policies related to debt management as part of a broader utility financial policy structure. Debt management policies should be evaluated and formalized, including the level of acceptable outstanding debt, debt repayment, bond coverage, and total debt coverage targets. The City currently has two outstanding water revenue bonds, a low-interest Department of Health Pretreatment loan, and must repay 25 percent of the City's utility-related Public Works Long Term General Obligation Bonds.

Debt Reserve

A debt reserve is sometimes required for bond issuance and rarely for state loan programs. It protects bondholders or lending agencies from borrower defaults and is usually tied to average or maximum annual debt service. The policy should follow the terms in debt obligation contracts.

Debt Service Coverage

Debt service coverage is typically a requirement for revenue bonds and serves as a key measure of risk in a utility’s capital funding plans. It is calculated as a factor applied to annual debt service. Typically, revenue bonds require a minimum coverage of 1.25. This means the utility must collect enough revenue to cover operating expenses, pay debt service, and gather an additional 25 percent as a cushion, helping to ensure timely debt service payments.

The City’s revenue bond covenants require a minimum coverage of 1.25. However, the City has an internal target of 1.70, which exceeds this requirement. Exceeding the minimum coverage positively impacts bond ratings and can lead to better borrowing terms. Therefore, many utilities, including the City, set higher policy targets than the required 1.25.

11.4.2.5 Rate Funded System Reinvestment

Rate-funded system reinvestment involves regularly funding long-term infrastructure replacement through predictable rate provisions, reducing reliance on debt. Benchmarks for annual funding include depreciation expense (original or replacement cost), asset management plans, or directly budgeted replacements. Many utilities begin with historical depreciation expense as a baseline for reinvestment, meeting standards for:

- Financial Integrity: Avoids system asset value decline.
- Rate Equity: Charges customers fairly based on their use of infrastructure.
- Capital Funding Adequacy: Ensures a baseline level of replacement funding.

For the City, the 2022 annual water utility depreciation expense was approximately $3.5 million. In the short term, rates should cover operating costs, debt service, and depreciation. Over time, the City should aim to at least cash-fund annual repair and replacement programs, such as the "Pipeline Repair and Replacement Program" and fire flow programs, which total about $11 million annually (pre-inflation). By striving to cash-fund these scalable repair and replacement programs, the City "saves" debt capacity to borrow for larger, more discrete capital projects.

11.4.2.6 Summary of Fiscal Policies

Table 11.3 provides a summary of the recommended fiscal policies for the water utility, consistent with the City's adopted fiscal policies for cash reserves and debt service coverage.

Table 11.3 Summary of Fiscal Policy Recommendations

Policy	Recommended Target
Cash Reserves	Maintain cash reserves to meet the City's target of having 270 days' worth of operating expenditures.
Debt Service Coverage	Meet or exceed the City's policy target of 1.70.
Rate Funded System Reinvestment	In the short term, rate revenue should fully cover depreciation costs. Over time, aim to at least cash-fund regular maintenance and replacement projects, conserving debt capacity for larger capital projects.

11.4.3 Economic and Inflation Factors

The operating and maintenance expenditure forecast largely relies on the City's 2025 adopted budget for the Water Fund (Fund 410). Each line item in the budget is then adjusted annually by utilizing one of the following factors:

- **General Cost Inflation** - Assumed to be 3.0 percent per year based on both the Washington State Economic & Revenue Forecast Council's projection for the Consumer Price Index (CPI) as well as the recent historical performance of the Seattle-Tacoma-Bellevue CPI.
- **Construction Cost Inflation** - Assumed to be 3.0 percent per year based on the historical Engineering News-Record's (ENR) Construction Cost Index (20-City Average).
- **Labor Cost Inflation** - Assumed to be 3.0 percent per year based on industry experience in the region as well as by referencing the Employment Cost Indices (ECI) for wages and salaries.
- **Benefit Cost Inflation** - Assumed to be 5.0 percent per year based on industry experience in the region as well as by referencing the ECI for benefits.
- **Taxes** - State Excise tax rate of 5.029 percent, State Business and Occupation tax rate of 1.75 percent, and City Utility tax rate of 18.25 percent.
- **Fund Earnings** - Ranges between 1-2 percent per year based on the Local Government Investment Pool (LGIP) for Washington as well as discussions with City staff.
- **Customer Growth** - Based on discussions with City staff, a 1.0 percent annual customer growth rate is assumed throughout the forecast.
- **City Engineering Labor** - After discussions with City staff, it is assumed that City engineering labor costs will be 5.0 percent of annual capital spending, which is added to Carollo's capital numbers.

These economic and inflation factors were reviewed with City staff during a December 2024 meeting.

11.4.4 Cash Balances

The Water Fund (Fund 410) tracks the water utility's operating, capital, and debt-related activities. As of January 1, 2024, its estimated beginning balance was around $26 million. For the forecast, roughly $0.9 million of that total is set aside for a debt service reserve related to the utility's revenue bond obligations.

11.4.5 Existing Debt Obligations

The Water Utility has two water revenue bonds (2015 and 2020) maturing in 2024 and 2026, plus a low-interest Department of Health Pretreatment loan. It also repays 25 percent of the City's utility-related Public Works Long Term General Obligation Bonds (2021 and 2024 issuances). The long-term general obligation bonds helped fund public works facilities. Debt service will be about $2 million annually in 2025-2026, dropping to $1.5 million annually starting in 2027.

11.4.6 Scenarios

This chapter presents two revenue requirement scenarios:

- Scenario 1: Fully funds the capital plan outlined in the utility's water system plan, including programmatic annual R&R capital spending of approximately $11 million per year (2024 dollars). This level of R&R funding is significantly higher than historical revenue levels.
- Scenario 2: Phases in annual R&R programs and defers certain storage projects beyond the 10-year study period, reducing capital spending by approximately $40 million (escalated) as compared to Scenario 1. By doing so, this scenario incorporates a ramp-up period to allow City staff to adjust staffing levels and/or secure contracted engineering assistance, offering a more realistic implementation timeline based on a conversation with City staff.

11.5 Scenario 1 - Revenue Requirement Forecast (Full CIP)

As previously noted, this scenario considers the 2025-2034 CIP that was provided by the City and its consulting engineer, Carollo, in its entirety. Costs were provided by project, by year, and are in 2024 dollars. To estimate the actual spending by year, costs are escalated to the estimated year of construction.

11.5.1 Scenario 1 - Capital Program

Figure 11.1 shows the planned annual capital spending, in escalated dollars, totaling $285 million.

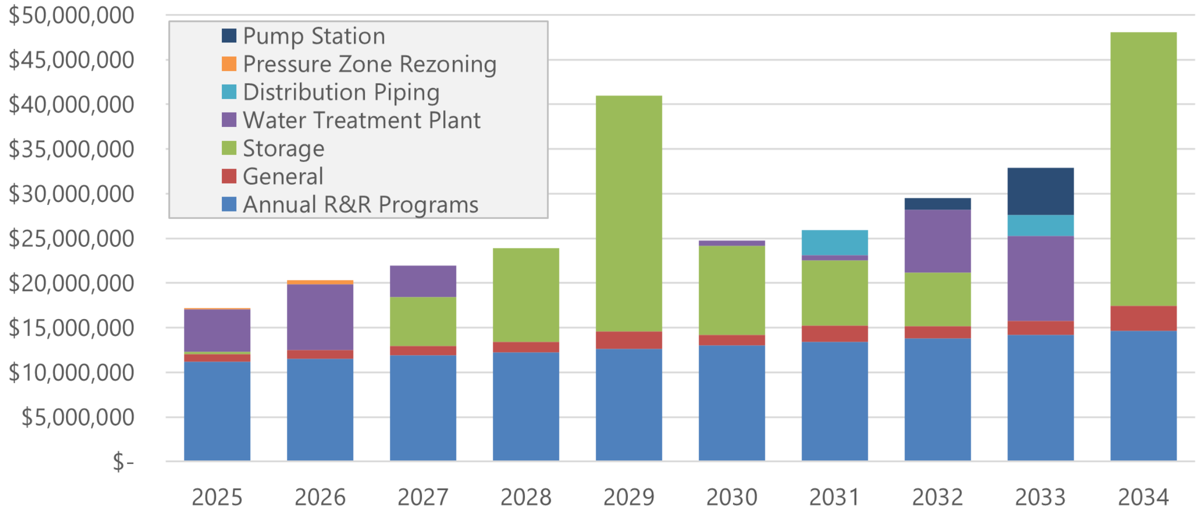

Figure 11.1 Capital Expenditure Forecast (Full CIP) - Escalated Dollars - Scenario 1

11.5.2 Scenario 1 - Capital Funding Strategy (Full CIP)

The 2025-34 capital plan totals $285 million with cost escalation, of which $12 million is expected to be funded through connection charge revenues, $127 million is expected to be funded through revenue bond proceeds, and the remaining cost of $147 million is to be funded through rates and cash reserves. The capital funding strategy is summarized in Figure 11.2.

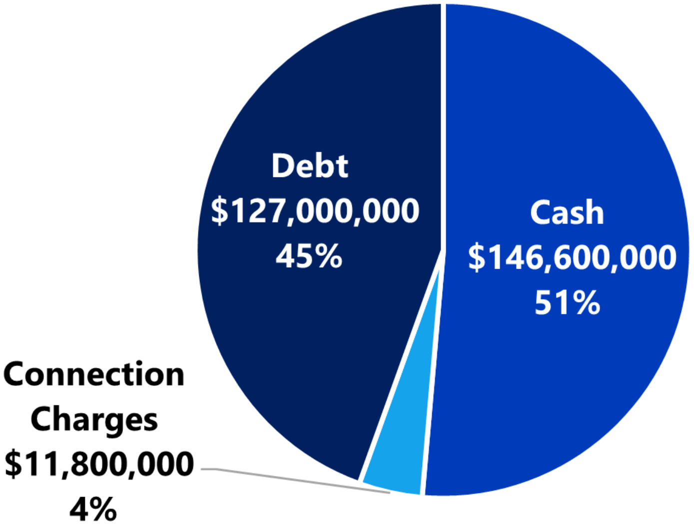

Figure 11.2 Capital Funding Strategy (Full CIP) - Scenario 1

11.5.3 Scenario 1 - Revenue Requirement Results (Full CIP)

Figure 11.3 graphically represents the revenue requirement forecast through 2034. The bars represent costs of the utility such as operating expenses and annual rate revenue designated for capital projects. Additional observations are provided below:

- **Solid line:** Revenue at existing rates.
    - Rate revenue is expected to be roughly $27.4 million in 2024 and is expected to increase with customer growth, before future rate adjustments. This line also includes miscellaneous revenues in addition to rate revenue.
- **Dashed line:** Revenues with rate increases.
    - Revenues with increases are expected to grow to $87.5 million by 2034.
- **Blue bar:** O&M expense.
    - Operating expenses are based on the 2025 budget and increase with the annual cost escalation assumptions previously discussed.
- **Green bar:** Existing debt service.
    - Existing debt service is approximately $2 million per year in 2025-26, then decreases to $1.5 million per year through the end of the forecast.
- **Orange bar:** New debt service.
    - Debt is an important component of the capital funding strategy and a crucial factor in the revenue requirement forecast. The forecast assumes new debt service will start in 2026 at $2.4 million per year, increasing to $10 million annually by 2034. Debt issuance is projected to occur every other year.
- **Red bar:** Rate revenue that is available for capital projects.
    - This amount increases gradually after 2024 as revenues increase with rate increases and growth. For example, by 2030, nearly $13 million per year would be available for capital projects.

The figure shows data labels including the assumed percentage rate adjustment, the monthly single-family bill (assuming 700 cubic feet of consumption and the smallest meter size), and the estimated debt service coverage. Note that in each year, debt service coverage on bonded debt is at or above 2.6.

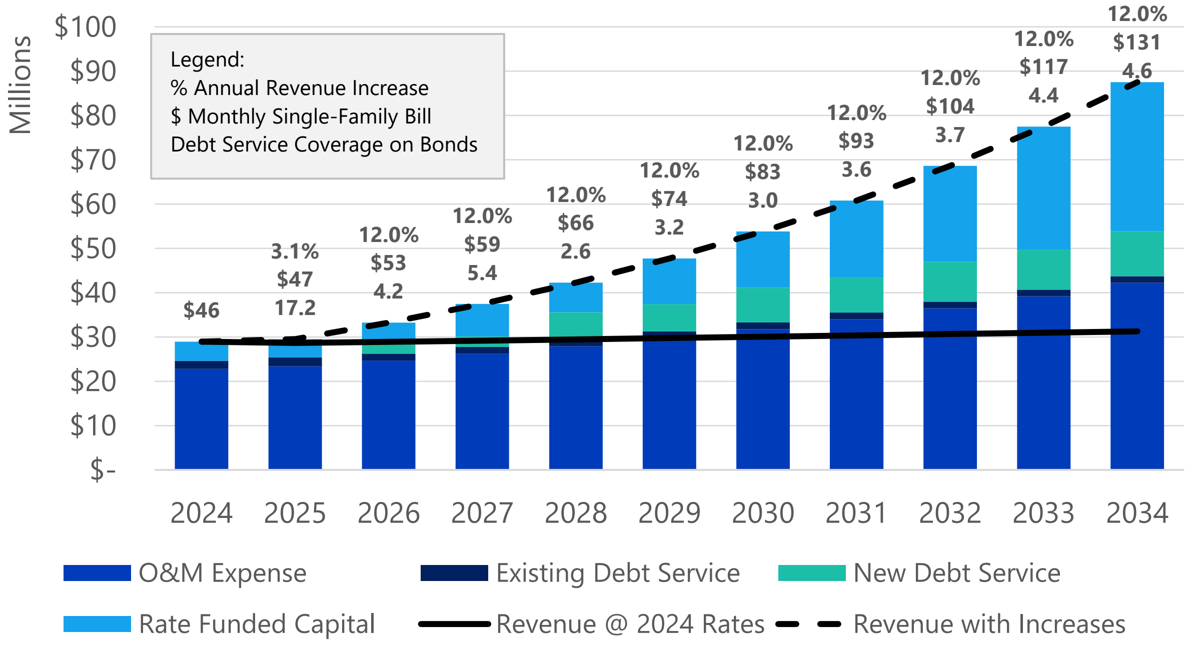

Figure 11.3 Revenue Requirement Forecast (Full CIP) - Scenario 1

11.5.4 Scenario 1 - Forecasted Reserve Balances (Full CIP)

The City aims to keep a cash reserve equal to at least 270 days of O&M expenditures for its water utility. Figure 11.4 shows that the utility is expected to meet or exceed this target each year in the forecast.

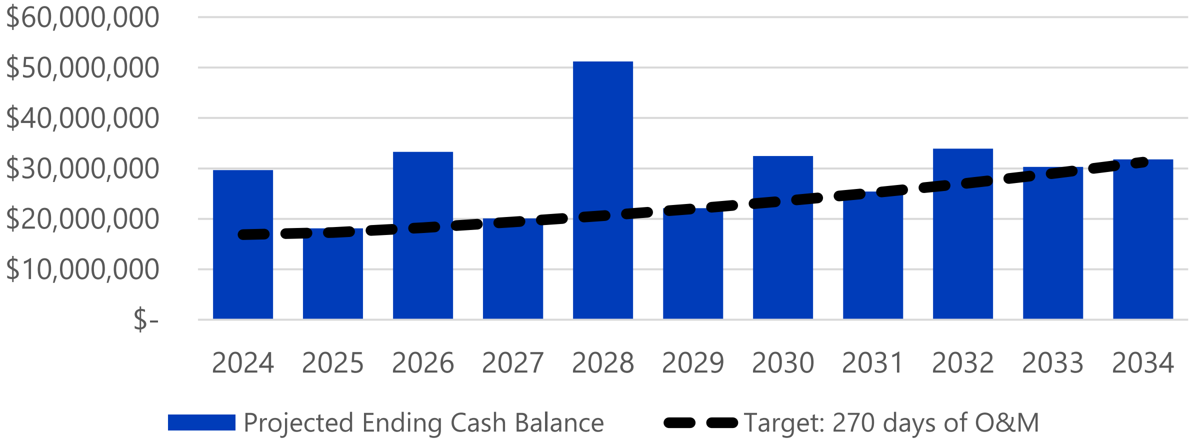

Figure 11.4 Combined Reserve Forecast (Full CIP) - Scenario 1

11.6 Scenario 2 - Revenue Requirement Forecast (Delayed CIP)

An alternative Scenario 2 revenue requirement was developed with Carollo and City staff. Recall that Scenario 1 starts annual R&R programs at $11 million per year. Scenario 2 begins at $2 million per year, increasing by $2 million annually to reach nearly $13 million by 2029. Additionally, some low-priority storage projects were deferred beyond the 2025-34 study period. Examples include the following with the unescalated project costs shown:

- ST-04 Whatcom Falls I Reservoir Rehab ($6.3 million).
- ST-06 Kearney Reservoir Rehab ($0.3 million).
- ST-08 40th Street Reservoir Rehab ($3.1 million).
- ST-14 Parkhurst Standpipe Rehab ($0.3 million).

Figure 11.5 illustrates the projected annual capital expenditure, in escalated dollars, amounting to $247 million, which represents a reduction of nearly $40 million compared to Scenario 1. The decreased capital spending in this scenario results in lower rate adjustments and reduces the need for borrowing overall.

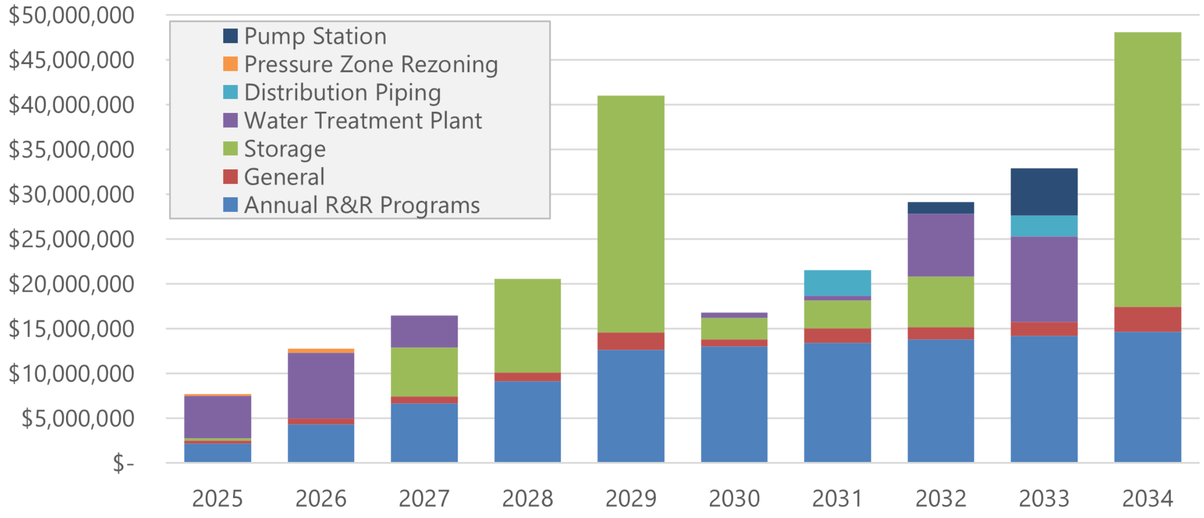

Figure 11.5 Capital Expenditure Forecast (Delayed CIP) – Scenario 2

11.6.1 Scenario 2 - Capital Funding Strategy (Delayed CIP)

The 2025-34 capital plan totals $247 million with cost escalation, of which $12 million is expected to be funded through SDC revenues, $97 million is expected to be funded through revenue bond proceeds, and the remaining cost of $138 million is to be funded through rates and cash reserves. The capital funding strategy is summarized in Figure 11.6.

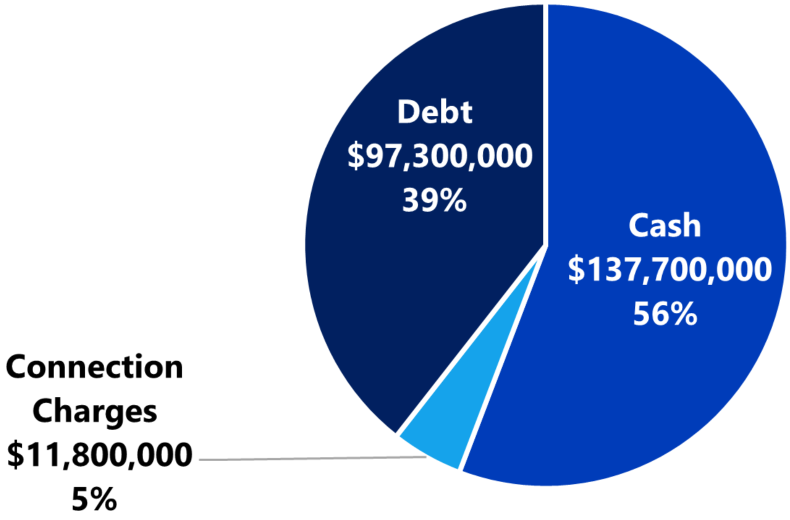

Figure 11.6 Capital Funding Strategy 2024-34 (Delayed CIP) - Scenario 2

11.6.2 Scenario 2 - Revenue Requirement Results (Delayed CIP)

Figure 11.7 graphically represents the revenue requirement forecast through 2030. The bars represent costs of the utility such as operating expenses and annual rate revenue earmarked for capital projects. Additional observations are provided below:

- **Solid line:** Revenue at existing rates.
  - As previously noted, rate revenue is expected to be roughly $27.4 million in 2024 and is expected to increase with customer growth. This line also includes miscellaneous revenues in addition to rate revenue.
- **Dashed line:** Revenues with rate increases.
  - Revenues with increases are expected to grow to $73.8 million by 2034.
- **Blue bar:** O&M expense.
  - Operating expenses are based on the 2025 budget and increase with the annual cost escalation assumptions previously discussed.
- **Green bar:** Existing debt service.
  - Existing debt service is approximately $2 million per year in 2025-26, then decreases to $1.5 million per year through the end of the forecast.
- **Orange bar:** New debt service.
  - Again, debt is a significant tool in the capital funding strategy and therefore is also a key variable in the revenue requirement forecast. New debt service begins in 2026 at $0.3 million per year and eventually increases to $8 million per year by 2034. Debt issuance is assumed every other year.
- **Red bar:** Rate revenue that is available for capital projects.
  - This amount increases gradually after 2024 as revenues increase with rate increases and growth. For example, by 2030, $13 million per year would be available for capital projects, which is

approximately the same as Scenario 1. Despite lower rate adjustments, less annual debt service would allow the utility to cash fund about the same amount in 2030.

The figure shows data labels including the assumed percentage rate adjustment, the monthly single-family bill (assuming 700 cubic feet of consumption and the smallest meter size), and the estimated debt service coverage. Note that in each year, debt service coverage on bonded debt is at or above 4.1.

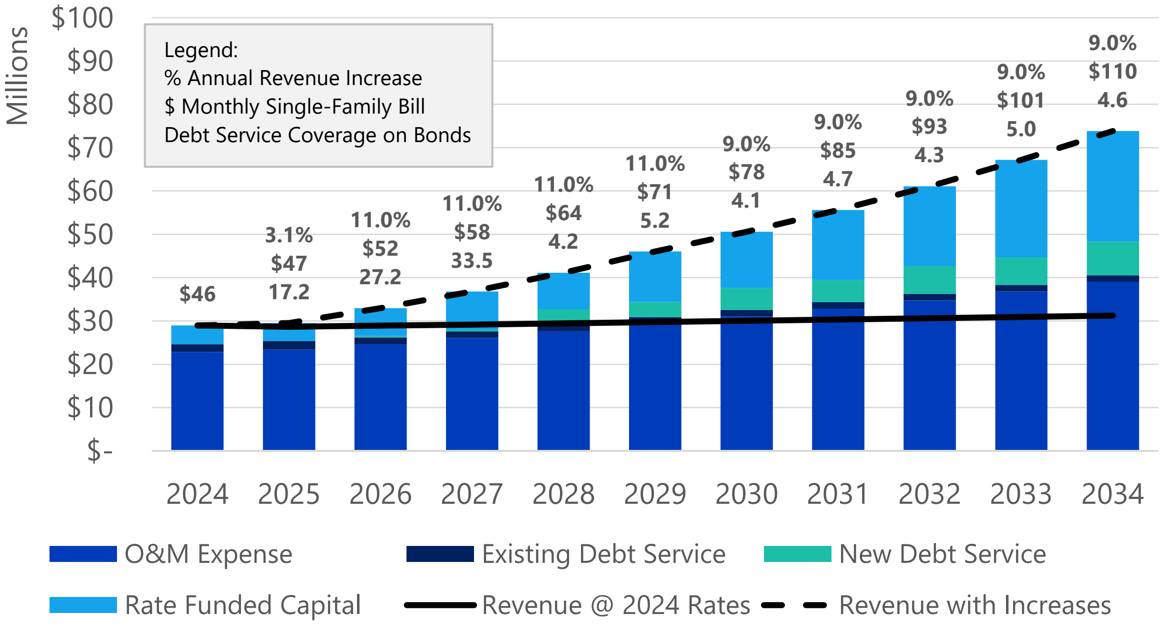

Figure 11.7 Revenue Requirement Forecast (Delayed CIP) - Scenario 2

11.6.3 Scenario 2 - Forecasted Reserve Balances (Delayed CIP)

Again, for its water utility, the City targets having a cash equivalent of 270 days of O&M expenditures, or more. Figure 11.8 shows that in each year of the forecast, the utility is expected to meet or exceed the combined target.

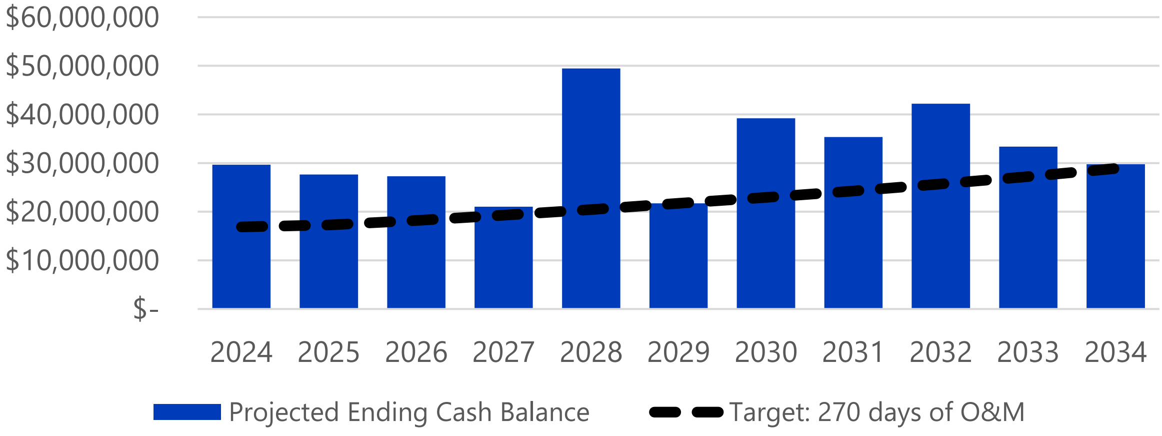

Figure 11.8 Combined Reserve Forecast (Delayed CIP) - Scenario 2

11.7 Single-Family Residential Rate Comparison

As a resource to the City and its customers, a rate survey of regional water utilities is provided below. Figure 11.9 shows each jurisdiction's 2024 monthly SFR rate unless the 2025 rate was available at the time of the survey. Note that each jurisdiction has a unique set of geographic traits, customers, and system characteristics that can have a significant impact on rates. The survey assumes the smallest meter size and 700 cubic feet of water consumption per month.

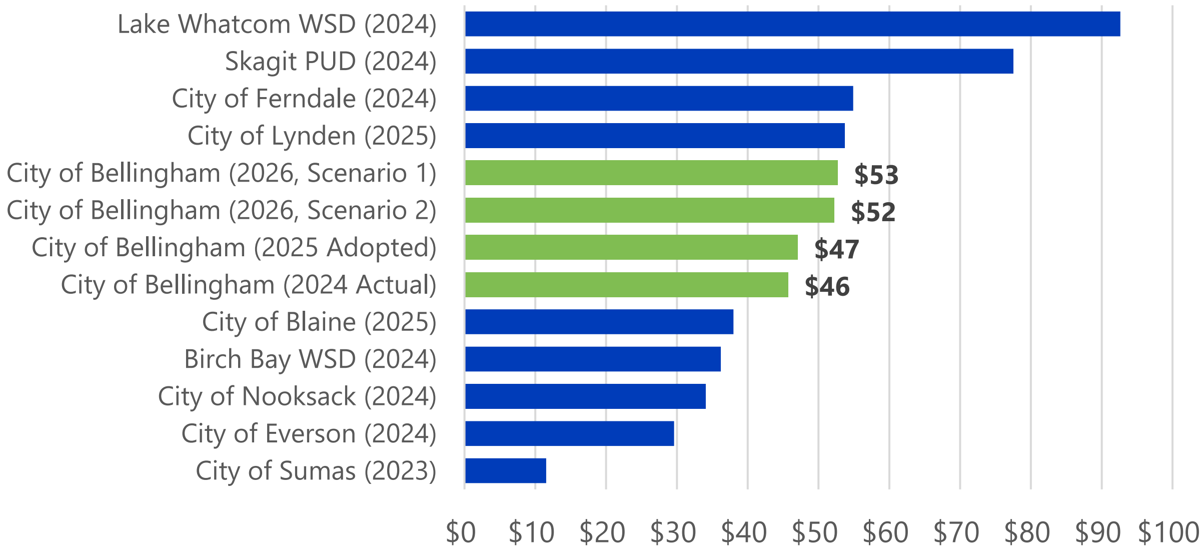

Figure 11.9 Monthly Single-Family Residential Water Rates

Some cities embed their city utility tax in their rates, while others separately itemize the tax on customer bills above the stated rates. FCS does not have complete data on the billing practices of other cities, so there may or may not be a tax embedded in the utility rates for other jurisdictions. Lastly, some of these jurisdictions may have already adjusted rate increases in 2025, so the City's current position may change relative to changes in other jurisdictions; 2025 rates were documented in the comparison when available.

The City's existing water rates are near the middle of the survey group, more expensive than Blaine, Nooksack, Sumas, Everson, and Birch Bay Water Sewer District but less expensive than Lynden (2025), Ferndale, Skagit PUD, and Lake Whatcom Water Sewer District. The City's water rates will remain in the middle position following the 3.1 percent increase adopted for 2025, and additionally in 2026 utilizing both scenarios outlined earlier in this chapter.

11.8 Affordability

As noted at the outset of this chapter, a key objective of this financial plan is to evaluate the City's ability to execute the planned capital improvement projects while maintaining affordable rates. While the definition of the term "affordable" is relatively subjective, state and federal agencies that offer low-cost loans to utilities often use an affordability index to define a threshold beyond which utility rates impose financial hardship on ratepayers (helping to prioritize low-cost loan awards).

Washington Department of Health's *Water System Planning Guidebook* notes the following:

> *Community affordability is a metric for the relative financial impact water rates have on a community as a whole. The EPA considers 2.5 percent of a community's Median Household Income (MHI) as the upper threshold for affordable water service. The Drinking Water State Revolving Fund, our drinking water loan program, uses affordability metrics to establish eligibility for principal forgiveness and grants.*

The 2024 median household income for Bellingham is estimated to be $67,796 based on a survey from the Census Bureau in 2023 (Census Table B19013 - 2023 5 Year Estimates). The median income is forecasted to include a 3.0 percent annual escalation; a year of inflation has been added to the Census Bureau survey's 2023 figure. Table 11.4 presents an average single-family bill with the projected annual rate increases for the forecast period, tested against the 2.5 percent threshold. Using this single metric, Bellingham's rates are forecasted to remain well under the threshold through 2034, with a high of 1.45 percent in 2034.

Table 11.4 Affordability Table – Assuming Scenario 2 Rate Adjustments

Year	Inflation	Median Household Income	Scenario 2 Projected Monthly Bill	Scenario 2 Projected Annual Bill	% of Median HH Income
2024	3.00%	$67,796	$46	$549	0.81%
2025	3.00%	$69,829	$47	$565	0.81%
2026	3.00%	$71,924	$52	$627	0.87%
2027	3.00%	$74,082	$58	$696	0.94%
2028	3.00%	$76,305	$64	$772	1.01%
2029	3.00%	$78,594	$71	$857	1.09%
2030	3.00%	$80,952	$78	$935	1.15%
2031	3.00%	$83,380	$85	$1,019	1.22%
2032	3.00%	$85,881	$93	$1,110	1.29%
2033	3.00%	$88,458	$101	$1,210	1.37%
2034	3.00%	$91,112	$110	$1,319	1.45%

In addition to the table above, a December 2021 FCS GROUP memo, *City of Bellingham Utility Affordability Analysis – Technical Memo*, outlined four metrics to evaluate the affordability of the City's combined water, sewer, and stormwater rates. Three metrics compared the monthly utility cost to household income, while one compared it to the minimum wage. An updated memo is planned for 2025, incorporating information from this plan.

11.9 Conclusion

11.9.1 Revenue Requirement and Rate Schedule

After discussions with City staff in December 2024, it was determined that Scenario 2 is more realistic than Scenario 1. Therefore, Scenario 2's rate adjustments are featured in Tables 11.4 (Affordability) and 11.5 (Rate Schedule). Table 11.5 shows the water rate forecast over the 10-year planning period, applying the Scenario 2 rate increases shown in Figure 11.7 across the board to the City's existing water rate structure. These recommended rate adjustments allow the City to meet the following objectives:

- Continue to fund existing operations, plus inflation.
- Allow the utility to complete its 10-year CIP with the delays identified in Scenario 2.
- Pay for existing and new debt service while maintaining a debt service coverage ratio above 1.7.
- Maintain utility reserves at a healthy level throughout the forecast.

Appendix CC shows a summary of the financial forecast for Scenario 2.

Table 11.5 Water Utility Across-the-Board Rate Schedule Forecast – Scenario 2

Across-the-Board(1) Rate Schedule	Actual	Adopted	Across-the-Board								
	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Annual System-Wide Rate Increase		3.10%	11.00%	11.00%	11.00%	11.00%	9.00%	9.00%	9.00%	9.00%	9.00%
Monthly Fixed charge Single-Family - Outside City Multiplier: 1.5											
5/8-inch	$28.07	$28.94	$32.12	$35.66	$39.58	$43.93	$47.89	$52.20	$56.89	$62.01	$67.60
3/4-inch	$38.61	$39.81	$44.19	$49.05	$54.45	$60.43	$65.87	$71.80	$78.26	$85.31	$92.99
1-inch	$59.70	$61.55	$68.32	$75.84	$84.18	$93.44	$101.85	$111.01	$121.00	$131.89	$143.76
1 1/2-inch	$112.46	$115.96	$128.72	$142.87	$158.59	$176.04	$191.88	$209.15	$227.97	$248.49	$270.85
2-inch	$175.73	$181.20	$201.13	$223.26	$247.81	$275.07	$299.83	$326.82	$356.23	$388.29	$423.24
3-inch	$344.54	$355.27	$394.35	$437.73	$485.88	$539.32	$587.86	$640.77	$698.44	$761.30	$829.82
4-inch	$534.45	$551.09	$611.71	$679.00	$753.69	$836.59	$911.89	$993.96	$1,083.41	$1,180.92	$1,287.20
6-inch	$1,061.90	$1,094.97	$1,215.42	$1,349.11	$1,497.51	$1,662.24	$1,811.84	$1,974.91	$2,152.65	$2,346.39	$2,557.56
Monthly Fixed charge Non-Single-Family and Irrigation - Outside City Multiplier: 1.5											
5/8-inch	$40.35	$41.60	$46.18	$51.26	$56.89	$63.15	$68.84	$75.03	$81.78	$89.14	$97.17
3/4-inch	$57.56	$59.35	$65.88	$73.13	$81.17	$90.10	$98.21	$107.04	$116.68	$127.18	$138.63
1-inch	$91.96	$94.82	$105.25	$116.83	$129.68	$143.94	$156.90	$171.02	$186.41	$203.19	$221.47
1 1/2-inch	$177.96	$183.50	$203.69	$226.09	$250.96	$278.57	$303.64	$330.96	$360.75	$393.22	$428.61
2-inch	$281.19	$289.94	$321.83	$357.24	$396.53	$440.15	$479.76	$522.94	$570.01	$621.31	$677.22
3-inch	$556.42	$573.75	$636.86	$706.92	$784.68	$870.99	$949.38	$1,034.83	$1,127.96	$1,229.48	$1,340.13
4-inch	$866.04	$893.01	$991.24	$1,100.28	$1,221.31	$1,355.65	$1,477.66	$1,610.65	$1,755.61	$1,913.61	$2,085.84
6-inch	$1,726.16	$1,779.92	$1,975.71	$2,193.04	$2,434.27	$2,702.04	$2,945.23	$3,210.30	$3,499.23	$3,814.16	$4,157.43
8-inch	$2,758.25	$2,844.00	$3,156.84	$3,504.09	$3,889.54	$4,317.39	$4,705.96	$5,129.49	$5,591.15	$6,094.35	$6,642.84
10-inch	$4,306.27	$4,440.41	$4,928.86	$5,471.03	$6,072.84	$6,740.86	$7,347.53	$8,008.81	$8,729.60	$9,515.27	$10,371.64
12-inch	$5,854.66	$6,037.03	$6,701.10	$7,438.22	$8,256.43	$9,164.64	$9,989.45	$10,888.50	$11,868.47	$12,936.63	$14,100.93
Monthly Volume Charge: per ccf of water usage - Outside City Multiplier: 1.5											
SF per CCF	$2.52	$2.59	$2.87	$3.19	$3.54	$3.93	$4.29	$4.67	$5.09	$5.55	$6.05
Non SF per CCF	$2.56	$2.63	$2.92	$3.24	$3.60	$3.99	$4.35	$4.74	$5.17	$5.64	$6.14
Irrigation per CCF	$3.38	$3.48	$3.86	$4.29	$4.76	$5.28	$5.76	$6.28	$6.84	$7.46	$8.13

Notes:

(1) "Across-the-Board" means that all stated rates increase by the same percentage (both the fixed and volume charges), which maintains the existing rate structure.

11.9.2 Rate Structure Evaluation

Per WAC 246-290-100, water systems must evaluate rate structures that promote water demand efficiency. While the City currently employs a uniform volume charge by customer class, which supports conservation to some extent, FCS recommends evaluating inclining block rates, particularly for single-family residential customers. This aligns with the broader water utility rate study FCS is conducting, including a rate structure evaluation that includes a review of conservation-driven rates.

Additionally, the Washington DOH's *Water System Planning Guidebook* highlights the advantages of inclining or seasonal block rate structures, which help:

- Reduce inefficient water use to preserve state resources.
- Increase financial capacity by generating additional revenue (presumably if a revenue-neutral design is not used).
- Conserve financial resources by delaying infrastructure expansion.

11.9.3 Updating this Study's Findings

It is recommended that the City revisit the study findings during the forecast period to check that the assumptions used (such as customer growth and the City's ability to execute the capital program) are still appropriate and that no significant changes have occurred that would alter the results of the study.

The City should use the study findings as a living document, routinely comparing the study outcomes to actual revenues and expenses. Any significant or unexpected changes may require adjustments to the rate strategy recommended in this report.

APPENDIX A

NOTICE OF DETERMINATION OF NON-SIGNIFICANCE

~ To be included in a future submittal. ~

APPENDIX B SEPA CHECKLIST

APPENDIX C

LOCAL GOVERNMENT CONSISTENCY DETERNMINATION FORM

~ To be included in a future submittal. ~

APPENDIX D

AGENCY COMMENT LETTERS AND RESPONSES

~ To be included in a future submittal. ~

APPENDIX E ORDINANCES AND APPROVALS

~ To be included in a future submittal. ~

APPENDIX F

WATER SYSTEM PLAN SUBMITTAL FORM

~ To be included in a future submittal. ~

APPENDIX G

DOH WATER SYSTEM PLAN CHECKLIST

~ To be included in a future submittal. ~

APPENDIX H

SERVICE AREA AND INTERLOCAL AGREEMENTS

APPENDIX I WATER FACILITIES INVENTORY FORM

APPENDIX J

RESERVOIR INSPECTIONS, EVALUATIONS, AND RECOMMENDED IMPROVEMENTS REPORT

APPENDIX K DEMOGRAPHIC AND DEMAND FORECAST

APPENDIX L BELLINGHAM 2025-2030 WUE PROGRAM

APPENDIX M RECORD OF PUBLIC ENGAGEMENT AND COMMENT

APPENDIX N

GRAVITY FLOW METER ASSESSEMENT

APPENDIX O WATER RIGHTS CERTIFICATES

APPENDIX P

HYDRAULIC MODEL DEVELOPMENT AND CALIBRATION TECHNICAL MEMORANDUM

APPENDIX Q

WATER QUALITY SAMPLING PROCEDURES AND PROGRAM

APPENDIX R COLIFORM MONITORING PLAN

APPENDIX S WATER QUALITY DATA

APPENDIX T

WATER TREATMENT INFRASTRUCTURE REMAINING USEFUL LIFE ANALYSIS

APPENDIX U

WATER SHORTAGE RESPONSE PLAN AND SERVICE RELIABILITY

APPENDIX V

OPERATIONS AND MAINTENANCE MANUAL

APPENDIX W WATER OPERATIONS STAFF CERTIFICATIONS

APPENDIX X

EMERGENCY RESPONSE PLAN

APPENDIX Y CROSS-CONNECTION CONTROL PROGRAM

APPENDIX Z RISK ASSESSMENT RESULTS

APPENDIX AA CIP PROJECTS

APPENDIX BB

FUNDING PROGRAMS FOR DRINKING WATER AND WASTEWATER PROJECTS

APPENDIX CC SCENARIO 2 FINANCIAL FORECAST

APPENDIX DD

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