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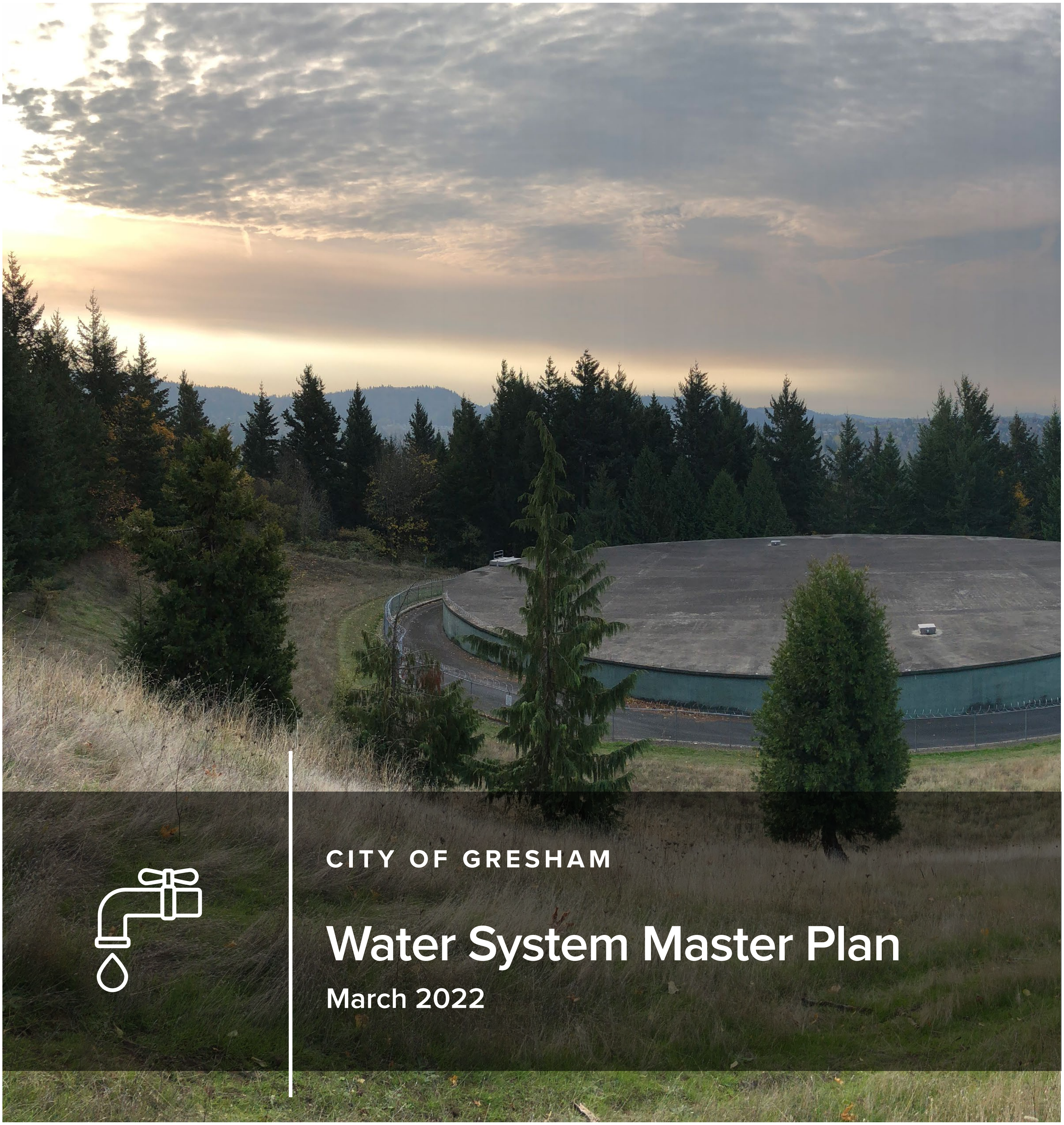

CITY OF GRESHAM

Water System Master Plan

March 2022

Water System Master Plan

City of Gresham

March 2022

Murraysmith

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Acronyms & Abbreviations

A	
ADD	average day demand
AMI	Advanced Metering Infrastructure
ATS	automatic transfer switch
AWWA	American Water Works Association
B	
bgs	below ground surface
C	
cfs	cubic feet per second
CGA	Cascade Groundwater Alliance
CI	cast iron
CIP	capital improvement program
City	City of Gresham
COF	Consequence of Failure
D	
DI	ductile iron
E	
EDU	equivalent dwelling unit
ENR	Engineering News-Record
EPS	extended period simulation
F	
fps	feet per second
G	
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
H	
HGLs	hydraulic grade lines
I	
I-84	Interstate 84
IGA	ingergovernmental agreement
K	
kW	kilowatt
L	
LOF	Likelihood of Failure

M	
MCC	motor control center
MDD	maximum day demand
MG	million gallons
mgd	million gallons per day
N	
NCV	normally closed valve
O	
OAR	Oregaon Administrative Rules
OHA	Oregon Health Authority Drinking Water Program
P	
PHD	peak hour demand
PRC	Population Research Center
PRV	pressure reducing valve
psi	pounds per square inch
PWB	Portland Water Bureau
R	
RWPUD	Rockwood Water People's Utility District
S	
SCADA	Supervisor Control and Data Acquisition
SDC	system development charge
SGA	Sand and Gravel Aquifer
U	
UGB	urban growth boundary
V	
VFD	variable frequency drives
W	
WMCP	Water Management and Conservation Plan
WSMP	Water System Master Plan

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Section 1

Section 1

Existing Water System

1.1 Introduction

The purpose of the Water System Master Plan (WSMP) is to perform an analysis of the City of Gresham's (City's) water system and:

- Document the existing water system including improvements completed since the 2012 WSMP
- Document the City's supply strategy and potential change from a primary reliance on purchased water from the Portland Water Bureau (PWB)
- Estimate future water requirements including the Pleasant Valley and Springwater areas
- Identify deficiencies and recommend water facility improvements that may correct system deficiencies and provide for growth
- Calibrate the existing hydraulic model
- Recommend an updated water system capital improvement program (CIP)
- Develop a document which will support future review of system development charges (SDCs) and water rates based on the updated CIP.

In order to identify system deficiencies, existing water infrastructure inventoried in this section will be assessed based on the existing and future water needs summarized in **Section 2** and water system performance criteria described in **Section 3**. The results of this analysis are presented in **Section 4** and **Section 5**. **Section 6** provides recommendations for system improvements and a 20-year CIP. The planning and analysis efforts presented in the WSMP are intended to provide the City with the information needed to inform long-term water supply and distribution infrastructure decisions.

This plan complies with water system master planning requirements established under Oregon Administrative Rules (OAR) for Public Water Systems, Chapter 333, Division 61.

1.2 Service Area

The City owns and operates a public water system which supplies potable water to slightly more than half of the City's residents. An overview map of the water service area can be found in **Figure 1-1** at the end of this section and in Plate 1 in **Appendix A**. The water service area includes the southern and eastern portions of the City limits, as well as the South Shore area on the northern boundary of the City between the Interstate 84 (I-84) freeway and the Columbia River. The South Shore is not hydraulically connected to the rest of the City's service area. The City's urban growth boundary (UGB) includes the Pleasant Valley and Springwater Plan Districts. Both areas are on the southern border of the service area and are comprised of mostly rural and undeveloped land. City residents outside of the water service area receive water service from the Rockwood Water People's Utility District (RWPUD). The City's service area has a population of approximately 72,000 people and 17,000 residential, commercial, and industrial service connections.

1.3 Supply Sources

The City's supply sources and current operation are described in the following paragraphs. Future supply options, strategy, and limitations are discussed in more detail in Section 4. The locations of all supply connections are shown in Figure 1-1. Master metered connections are summarized in Table 1-1.

Table 1-1 | Master Meter Summary

Name	Water Source	Location	Service Level	Tap Size (inches)	Meter Size (inches)	Meter Type	Approximate Capacity (gpm)	Year Installed
Main Street Pump Station	Conduit 3	219 S Main Ave	Intermediate	12	10	Turbine	5,000	1974
Division Street Pump Station	Conduit 4	2255 NE Division St	Intermediate	12	10	Turbine	5,500	1974
Powell & Barnes Pump Station	Conduit 3	4050 Powell Valley Rd	Lusted	8	8	Turbine	3,500	1974
Sandy & 181st	Powell Butte	SE corner of NE Sandy Blvd & 181st Ave	South Shore	12	10	Turbine	5,500	1991
South Meter Station	Conduit 3	3375 NW 1st St	Grant Butte	16	16	Turbine	8,000	1990
	Cascade[1] Groundwater			16	16	Electro-magnetic	35,001	2006
North Meter Station	Conduits 2 & 4	3148 NW Division St	Grant Butte	12	10	Turbine	4,000	1992
	Cascade[1] Groundwater			16	16	Electro-magnetic	35,001	2006
Sandy at Boeing	RWPUD	19501 NE Sandy Blvd	South Shore	8	6	Turbine	2,000	1994
185th & Riverside	PWB Parkrose Tanks	18510 NE Riverside Dr	South Shore	8	8	Turbine	3,500	2001
170th & Sandy	PWB Parkrose Tanks	17014 NE Sandy Blvd	South Shore	12	10	Compound	6,500	2001
172nd & Sandy	PWB Parkrose Tanks	17116-17186 NE Sandy Blvd	South Shore	12	10	Compound	6,500	2003

Note:
1. Capacity is currently limited by Gresham-RWPUD IGA to 5 mgd (3,500 gpm)

1.3.1 Portland Water Bureau Supply

The City currently receives most of its water supply from PWB's Bull Run conduits through wholesale master metered connections serving its main system. The Bull Run Watershed is located 26 miles east of Gresham at the base of the Cascade Mountains. Water is supplied from Bull Run Lake and Bull Run Reservoirs No. 1 and No. 2, with a combined storage capacity of approximately 17 billion gallons. Water is delivered to the City of Portland and various wholesale customers in the Portland metro area through three large-diameter conduits. These transmission mains fill PWB storage facilities located on Powell Butte.

The City maintains five master meters from the Bull Run supply located upstream of PWB's storage facilities. The South Meter Station connection to PWB Conduit No. 3 and the North Meter Station connection to PWB Conduit Nos. 2 and 4 supply the Gresham's Grant Butte Reservoir by gravity. The Grant Butte Reservoir has a capacity of 10 million gallons (MG) and is the City's primary storage facility.

The South Shore well field, maintained and operated by PWB, contains 26 wells. These wells draw from three aquifers and have a combined production capacity of approximately 100 million gallons per day (mgd). Groundwater is pumped to the storage facilities at Powell Butte. This water supplements supply from Bull Run during high-demand periods. Groundwater can also be fed from the Powell Butte Reservoir through the main supply conduits east to Gresham during an emergency or high-turbidity event. The City maintains four master metered connections with PWB's well field.

1.3.2 Groundwater System

A portion of the City's supply comes from groundwater through an intergovernmental agreement (IGA) with RWPUD. The City is actively expanding its groundwater supplies to reduce or eliminate dependence on PWB supply. In 2020, the Groundwater Development Master Plan was completed by Murraysmith jointly for the City and RWPUD. This document provides a roadmap for groundwater development.

The City currently has one groundwater well, Cascade Well No. 5, located at NE Halsey Street and NE 192nd Avenue. This well pumps to the Cascade Groundwater Treatment Facility and Reservoir located at NE Halsey Street and the NE 196th Avenue alignment. Currently, the City is drilling a well in Kirk Park, south of NE Halsey Street along NE 188th Avenue. This well will also be pumped to the Cascade site.

The City owns the Cascade Groundwater Treatment Facility and finished water reservoir jointly with RWPUD. Water from Cascade Wells No. 3 and No. 4, owned by RWPUD, is also treated and stored at this site. Recently, RWPUD drilled a test well, Cascade Well No. 7, with a capacity of approximately 5 mgd. This well is expected to be complete and in service in 2022. Water from the Cascade Reservoir is transmitted to both entities' distribution systems through a 30-inch diameter transmission main that terminates at Gresham's North and South Meter Stations and RWPUD's

Bella Vista Reservoir. In addition, Cascade Well 9 was drilled in 2021 at Kirk Park. While well development is still underway, this well is expected to have a capacity of approximately 4 mgd.

Operation of the Cascade groundwater system is defined in an IGA between the City and RWPUD. This agreement as well as other relevant IGAs are included in **Appendix B**. Water rights for the wells supplying the Cascade facility are regulated under permit G-8719. Currently the City owns rights to 5 mgd of water through Cascade Well No. 5. The City has the option to expand groundwater rights from this facility to 18 mgd with the development of additional groundwater wells.

The City is planning to drill a groundwater well near NE 223rd Avenue south of NE Stark Street (Cascade Well 6) in 2022. A test well at this site produces approximately 1 mgd and it is anticipated that a finished production well at this site will produce 4 mgd. This well will supply the distribution system directly and feed into the Intermediate service level.

In 2021, the City drilled a test well at Southwest Community Park, which is south of the City's Grant Butte Reservoir and north of Highway 26. The results of this exploratory drilling effort will help inform the strategy for additional groundwater development, as described in **Section 4**.

1.3.3 Water Quality

In 2020, Confluence Engineering Group completed a New Source Water Quality Evaluation. This study was commissioned specifically to provide an analysis of the changes in water quality that will occur with the change from PWB supply to groundwater. This evaluation is included as **Appendix C**.

While the City currently meets all drinking water standards, PWB has primary responsibility for source water treatment, monitoring and compliance reporting. With the transition to a local groundwater supply managed and operated by RWPUD and the City, the City will be responsible for meeting drinking water standards from the source through distribution to customers. The City and RWPUD are currently completing further investigations to guide the design and operation of the expanded groundwater supply and the transition from the PWB surface water supply to groundwater supply. This analysis includes:

- Transition from chloramine disinfection to free chlorine disinfection
- Pilot testing to inform treatment system design and operation
- Corrosion control requirements to ensure compliance with the Lead and Copper Rule
- Best practices for the supply transition, including a flushing program

1.3.4 South Shore Supply

The City supplies an area known as the South Shore service level located between the I-84 freeway and the Columbia River. This area consists of industrial customers and is completely disconnected from the City's main distribution system. Water is supplied through five master meters with PWB and RWPUD on NE Sandy Boulevard and NE 185th Drive. Flows through the meters are demand-based as there are no storage or pumping facilities within the service level.

1.4 Distribution System

The City's existing water distribution system includes seven main service levels, seven active storage reservoirs, eight active pump stations, and seven active PRV stations throughout the City's service area. **Figure 1-2**, located at the end of this section, presents a hydraulic schematic of the City's water system facilities. The City's existing distribution system and current operational strategy are described in more detail later in this report. Plate 1 in **Appendix A** illustrates the City's water service area limits and water system facilities.

1.4.1 Service Levels

Service levels, or pressure zones, are defined by ground topography and their hydraulic grade lines (HGLs) are determined by overflow elevations of water storage reservoirs, discharge pressure at pump stations, or outlet settings of pressure reducing valves (PRVs). Service level boundaries are defined in order to maintain an acceptable range of service pressures to all customers.

The City's water distribution system is divided into seven main service levels. These are labeled Gabbert, Grant Butte, Hunters Highland, Intermediate, Wheeler, South Hills, and South Shore. The Gabbert and South Hills service levels each have two pressure reduced service sub-levels fed through PRVs. The topography in The City's water service area is defined by rolling hills, causing service pressure to vary widely within a service level. In many cases, creating new sub-zones through PRVs is not a viable option due to the grid of distribution system piping and/or the complexity of operating multiple PRVs servicing one service level. In these areas, if system pressures exceed 80 pounds per square inch (psi), individual PRVs are installed on the customer side of the meter. The maximum recommended service pressure is 80 psi as defined by the American Water Works Association (AWWA, M32) and the Oregon Plumbing Specialty Code.

Figure 1-1 shows the geographical locations of service levels. **Table 1-2** summarizes approximate ground elevations served, HGLs, and service pressures as well as facilities supplying each service level.

Table 1-2 | Service Level Summary

Service Level	Current Elevation Range Served (feet)	Supply Source	Pressure Control (Reservoir/Pump Station/PRV)	Controlling HGL (feet)	Approximate Pressure Range (psi)
Gabbert	660 to 860	Gabbert Pump Station	Gabbert Reservoir	1,047.5	82 to 169
Gabbert 895	660 to 760	Gabbert Reservoir	Gabbert Road PRV	895	58 to 102
Gabbert 730	450 to 630	Gabbert Reservoir	Regner Road PRV	730	43 to 121
Grant Butte	200 to 410	PWB Conduits, Cascade Groundwater, Linneman Avenue PRV	Grant Butte Reservoir	497.5	39 to 130
Hunters Highland	410 to 610	Hunters Highland Pump Station	Hunters Highland Reservoir	717	48 to 134
Intermediate	285 to 490	Main Street and Division Street Pump Stations	Butler and Regner Reservoirs	575	37 to 126
Wheeler	385 to 530	Salquist and Powell &Barnes Pump Stations	Wheeler Reservoir	620	39 to 102
South Hills	620 to 850	South Hills Pump Station	South Hills Reservoir	940	39 to 139
South Hills 3	450 to 670	South Hills Reservoir	Butler Road PRV	745	32 to 128
South Hills Deer Glen	460 to 660	South Hills Reservoir	29th and Elliott Drive PRV	754	41 to 127
South Shore	7 to 180	PWB Parkrose Tanks, RWPUD	PWB Parkrose Tanks	260	35 to 110

1.4.2 Storage Reservoirs

The City's water system includes seven active storage reservoirs with a total capacity of 27.2 MG. Key information on these reservoirs can be found in Table 1-3. See Plate 1 in Appendix A for the geographical locations of the reservoirs. An eighth reservoir, the Lusted Reservoir, is not in service but can act as a backup to serve the Wheeler service level if the Wheeler Reservoir is taken offline for maintenance.

The largest reservoir, Grant Butte Reservoir, has a capacity of 10 MG. It is filled by gravity from the PWB conduits and the Cascade groundwater system. This reservoir serves the Grant Butte service level. It also can feed the Intermediate service level through the Division and Main Street Pump Stations.

The Intermediate service level is served by gravity from the Regner and Butler Reservoirs. Pump stations from the Intermediate service level fill the Hunters Highland, South Hills, and Wheeler Reservoirs. The Wheeler Reservoir can also be filled by PWB Conduit 3 through the Powell and Barnes Pump Station. Gabbert Reservoir is the highest reservoir. It is filled from the South Hills service level through the Gabbert Pump Station.

Both the Hunters Highland and Gabbert Reservoirs are standpipe reservoirs that must maintain a certain level to provide adequate pressures. During low demand periods, the Hunters Highland Reservoir does not have adequate turn over and mixing; a SolarBee mixing system was installed to prevent water from stagnating. The Gabbert Reservoir was rehabilitated and seismically retrofitted in 2013.

The Lusted Reservoir is a standpipe storage facility previously owned and operated by the City. The City has ceased the operation of this facility and its corresponding pump station. The City has executed an IGA with the Lusted Water District for usage of the facilities. They are in the process of negotiating a potential land sale.

Table 1-3 | Reservoir Summary

Reservoir Name	Service Level	Overflow Elevation (feet)	Volume (MG)	Diameter (feet)	Height to Overflow (feet)	Material	Year Constructed
Grant Butte	Grant Butte	497.5	10	220	36	Concrete	1990
Butler	Intermediate	575	4	140	36	Concrete	2000
Regner	Intermediate	575	6	180	31.5	Concrete	1975
Wheeler	Wheeler	620	3.2	126	35	Concrete	2001
Lusted[1]	Wheeler	610	1.2	48	89	Steel	1988
Hunters Highland	Hunters Highland	717	1.2	46	90	Steel	1994
South Hills	South Hills	940	2.6	122	30	Concrete	1994
Gabbert[2]	Gabbert	1,047.5	0.2	24	59	Steel	1969

Notes:

1. Not in service
2. Rehabilitated and seismically retrofitted in 2013

1.4.3 Pump Stations

The City's existing water system includes nine pump stations. Two of these pump stations, Walters and Lusted, are out of service and are only used in emergencies. **Table 1-4** presents a summary of all existing pumping facilities. See Plate 1 in **Appendix A** for the geographical locations of the pump stations.

The Intermediate service level is pressurized by the Cedarville, Main Street, and Division Street Pump Stations from the Grant Butte service level. The Main Street and Division Street Pump Stations also pump water from PWB Conduits 3 and 4, respectively, into the Intermediate service level. If needed, these pump stations can also pump from the Grant Butte service level through a connection that is normally isolated with a closed valve. Similarly, the Powell & Barnes Pump Station pumps from PWB Conduit 3 to the Wheeler service level and can also pump from the Intermediate service level through a connection that is normally isolated with a closed valve.

The Salquist Pump Station pumps from the Intermediate service level to the Wheeler service level. This pump station is located adjacent to the alignment of the proposed PWB Conduit 5. It was anticipated that this pump station would pump directly from this new conduit, although proposed changes to the City's supply sources, namely, the increased reliance on the Cascade groundwater system described in **Section 4**, would eliminate the need for this connection. Other pump stations that pump from the Intermediate service level include the Hunters Highland and South Hills Pump Stations, which pump to the Hunters Highland and South Hills service levels, respectively. The South Hills Pump Station is adjacent to the Regner Reservoir and pumps directly from the reservoir's fill/drain line.

The Gabbert service level is supplied by the Gabbert Pump Station, which is pumped from the South Hills service level. The Walters Pump Station is available in emergencies to supply the Gabbert service level directly from the Intermediate service level.

All active pump stations include transfer switches for use of portable generators. The South Hills Pump Station has a 450 kilowatt (kW) trailer-mounted generator that is currently hard-wired to the electrical system at the site. The Cedarville Pump Station has a fixed 300 kW generator. The Hunter's Highland Pump Station has an external automatic transfer switch (ATS); a trailer mounted 300 kW generator is typically stored at this site.

Table 1-4 | Pump Station Summary

Pump Station	Service Level	Pumping From	Pump No.	Approximate Capacity (gpm)	VFD or Constant Speed	Year Constructed
Main Street	Intermediate	Conduit 3	1,2	2,200	VFD	1975
		Grant Butte	1,2	850	VFD	
Division Street	Intermediate	Conduit 4	1,2	1,800	Constant	1975
		Grant Butte	1,2	1,700	Constant	
Cedarville	Intermediate	Grant Butte	1	1,300	VFD	2015
			2	1,300	VFD	
			3	1,300	VFD	
Powell & Barnes	Lusted	Conduit 3	1,2	700	VFD	1974
		Intermediate	1,2	700	VFD	
Hunters Highland	Hunters Highland	Intermediate	1	700	VFD	1992
			2	700	Constant	
			3	220	Pressure Boost	
Salquist[1]	Lusted	Intermediate	1	1,200	VFD	2003
			2	1,200	VFD	
			3	1,200	Constant	
			4	1,200	Constant	
South Hills[2]	South Hills	Intermediate (Regner Reservoir)	1	1,100	Constant	1994
			2	1,100	VFD	
			5	300	Constant	
			6	175	Constant	
Walters	Gabbert (Emergency)	Intermediate	1	300	Constant	1969
			2	300	Constant	
Gabbert	Gabbert	South Hills	1	150	VFD	2004
			2	550	VFD	
			3	550	VFD	
			4	550	Constant	

Notes:

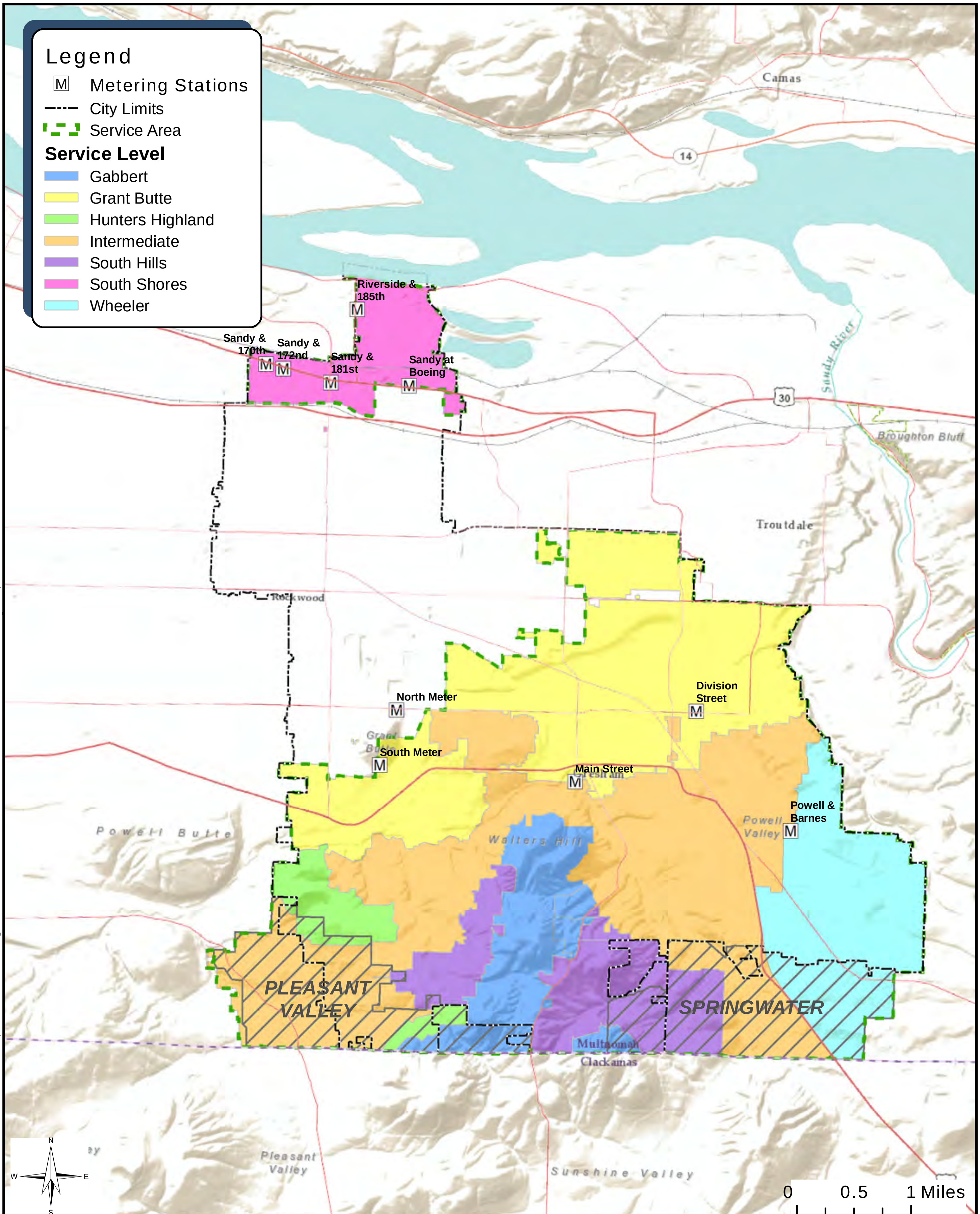
1. Salquist Pump Station can accommodate a future pump for connection to future PWB Conduit 5.
2. South Hills Pump Station has space and piping to accommodate two future pumps.

1.4.4 Distribution Pipes

The City's water transmission and distribution system contains approximately 280 miles of piping and is composed of various pipe materials ranging in sizes up to 30 inches in diameter. Most of the pipes are ductile iron (DI) (70 percent) or cast iron (CI) (28 percent). Most of the piping is 6, 8, and 12 inches in diameter. **Table 1-5** presents an inventory of existing pipes by diameter.

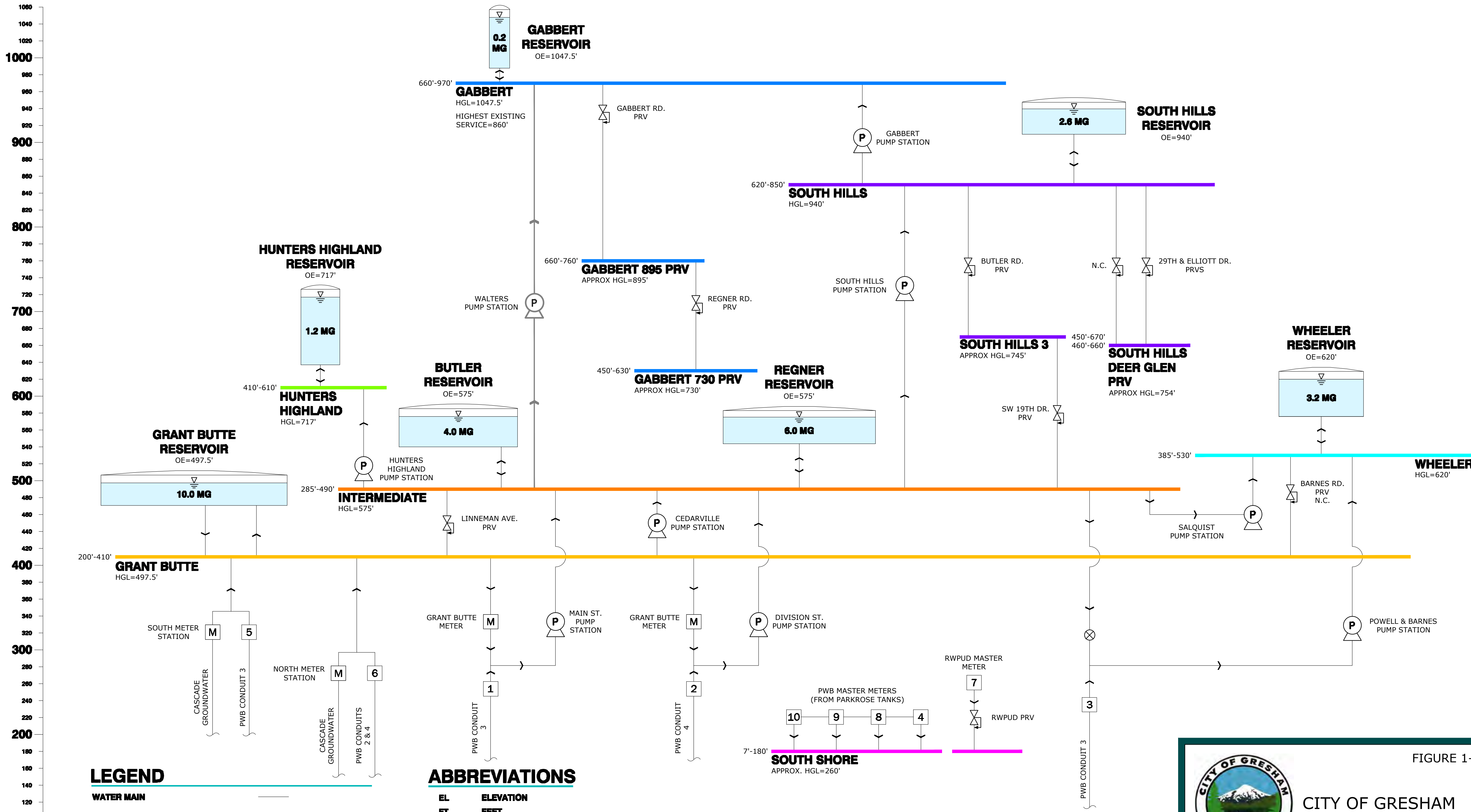
Table 1-5 | Distribution System Pipe Summary

Diameter (inches)	Length (miles)	Percentage of All Pipe
4-inch and smaller	29.1	10.4%
6	77.3	27.6%
8	88.7	31.6%
10	15.0	5.3%
12	36.8	13.1%
14	1.0	0.4%
16	14.6	5.2%
18	5.7	2.0%
20	5.6	2.0%
24	3.2	1.1%
30	3.6	1.3%
TOTAL	**280.6**	**100%**



City of Gresham, Oregon
Water System Master Plan

Figure 1-1
Service Area



LEGEND

- WATER MAIN
- HIGHEST GROUND ELEVATION SERVED BY SERVICE LEVEL
- RESERVOIR — 1.0 MG, OE=240' (OVERFLOW ELEVATION, CAPACITY)
- PRESSURE REDUCING VALVE
- GATE VALVE
- PUMP STATION W/ GRESHAM OPERATIONS ID NUMBER
- MASTER METER W/ GRESHAM OPERATIONS ID NUMBER — M

ABBREVIATIONS

EL	ELEVATION
FT	FEET
GPM	GALLONS PER MINUTE
HGL	HYDRAULIC GRADE LINE
MG	MILLION GALLONS
OE	OVERFLOW ELEVATION
PRV	PRESSURE REDUCING VALVE
PS	PUMP STATION
N.C.	NORMALLY CLOSED
PWB	PORTLAND WATER BUREAU
RWPUD	ROCKWOOD WATER PEOPLE'S UTILITY DISTRICT

NOTE: FACILITIES SHOWN IN GRAY ARE OUT OF SERVICE.

FIGURE 1-2

CITY OF GRESHAM

Water System Master Plan

Existing Water System Hydraulic Schematic

March 2022

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20-2749

G:\PDX_Projects\20\2749 - Gresham Water Master Plan Update\CAD\20-2749-OR Hydraulic Schematic.dwg FIG 1-2 4/29/2021 9:22 AM TAYLOR.SPENCER 23.0s (LMS Tech)

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Section **2**

Section 2

Water Requirements

This section characterizes current water demands and summarizes future growth scenarios, population projections, and projected future water demands for the City's water service area. Water demand forecasts in this section are used with performance criteria in Section 3 to evaluate the existing water system's capacity to serve current customers and future growth. Demand forecasts are developed from historical water consumption and production records, regional planning data, current land use designations, and previous City water planning efforts.

2.1 Water Service Area

2.1.1 Existing Service Area

The City's existing water service area includes approximately two-thirds of the land within the city limits. Residents and businesses outside the City's service area are currently served by the RWPUD. The service area is shown in Figure 1-1.

2.1.2 Future Service Area

Based on existing development types in the area, some re-development and densification is expected within the existing water service area, particularly in the southern portion of the city. The Pleasant Valley development is located in the southwestern portion of the service area and is expected to have a mix of residential and commercial customers. The Springwater development, in the southeastern portion of the city is expected to be primarily industrial development. Geographies of these proposed future service areas are illustrated in Figure 1-1.

2.2 Planning Period

The planning period for this WSMP is 20 years, through the year 2042, which meets the requirements for Water System Master Plans outlined in OAR 333-061. Water supply capacity is evaluated for a longer planning horizon, through 2050, to accommodate long-range supply development planning. Distribution storage and pumping capacity are generally analyzed at system build-out, which occurs when all existing developable land within the service area has been developed to its ultimate capacity according to current land use and zoning designations. However, population projections show a build-out beyond 2100. Most significant development is expected to occur within the next 30 years and future infrastructure will be sized to accommodate projected demands within that timeframe.

2.3 Water Demand Description

Water demand refers to all potable water required by the system including residential, commercial, industrial, city, and public uses. Water demands are described using three water use metrics: average daily demand (ADD), maximum day demand (MDD), and peak hour demand (PHD). Each of these metrics is stated in mgd.

- ADD is the total annual water volume used system-wide divided by 365 days per year.
- MDD is the largest 24-hour water volume for a given year. This typically occurs each year between July 1st and September 30th.
- PHD is estimated as the largest hour of demand on the peak water use day.

Water demand can be calculated using either water consumption or water production data. Water consumption data is taken from the City's Advanced Metering Infrastructure (AMI) data and includes all revenue metered uses. This data can be analyzed by geographical location and customer type, which is useful for quantifying typical water use for different service levels and land uses. However, consumption data does not capture any water loss or unmetered uses making it less useful in determining system-wide peak demands.

Water production is calculated as the sum of water supplied from PWB and groundwater from RWPUD. Water production includes unaccounted-for water such as water loss through minor leaks and unmetered, non-revenue uses such as hydrant flushing. Total water production is recorded daily, making it useful for analyzing seasonal water demand trends, supply, and storage capacity.

2.4 Historical Water Demand

For the purposes of this WSMP, daily water production data is used to calculate system-wide historical water demand in order to account for all water uses including those which are not metered by the City and to develop peaking factors. Customer consumption and water service location data are used to distribute water demands throughout the hydraulic model, discussed in Section 5, to estimate demands by service level and to quantify average water use by customer type for future demand projections described later in this section.

2.4.1 System-wide Water Production

System-wide historical water production is presented in **Table 2-1**. The historical ratio of MDD:ADD, or peaking factor, is used to estimate future maximum (peak) day demands (MDD) from ADD. Based on the last nine years of historical system-wide water production, the average ratio of MDD:ADD is approximately 1.65.

Table 2-1 | Historical System-wide Water Production

Year	Production ADD (mgd)	Production MDD (mgd)	MDD:ADD Peaking Factor
2011	6.31	10.82	1.71
2012	6.46	10.80	1.67
2013	6.54	10.26	1.57
2014	6.45	10.11	1.57
2015	6.71	11.18	1.67
2016	6.41	10.22	1.59
2017	6.42	11.39	1.77
2018	6.40	10.89	1.70
2019	6.16	9.53	1.55
Average	**6.43**	**10.58**	**1.65**

2.4.2 Water Consumption by Service Level

As described in **Section 1**, water systems are divided into service levels to provide adequate service pressure to customers at different elevations. Each service level is served by specific facilities such as reservoirs, pump stations, or PRVs, which supply water to customers within an acceptable range of service pressure. To assess the adequacy of these facilities, it is necessary to estimate demand in each service level. System-wide water consumption from 2019 was distributed between the City's service levels based on meter address and metered water consumption from 2019 AMI data. The percentage of water consumption by service level is summarized in **Table 2-2**. The maximum day peaking factor was applied to these demands to determine MDD.

Table 2-2 | 2019 Water Consumption by Service Level

Service Level	Percent of Demand
Gabbert	0.5%
Grant Butte	48.7%
Hunter Highland	2.6%
Intermediate	29.2%
Lusted	9.4%
South Hills	5.4%
South Shore	4.3%

2.4.3 Water Consumption by Customer Type

City AMI data provided historical average daily water consumption by customer type including single-family residential, multi-family residential, commercial, industrial, public, and city use. The percentage of total 2019 average daily water consumption for each customer type is presented in **Figure 2-1**. Historical use by customer type is presented in **Table 2-3.**

Residential customer use makes up the majority of demand in the City. This category is assumed to be predominantly comprised of single-family homes, duplexes, and triplexes. Multi-family residential and commercial customers' use also contribute significantly to overall demand. Industrial use contributes to a small portion of demand, while combined city and public use constitutes less than four percent of the total customer use.

Figure 2-1 | 2019 Water Consumption by Customer Type

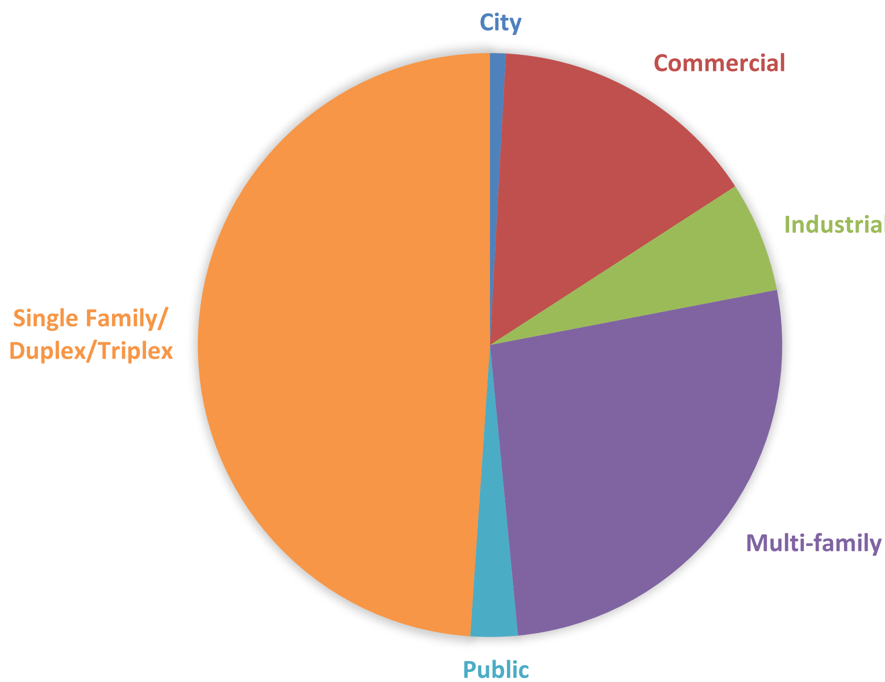

Table 2-3 | Historical Water Consumption by Customer Type

Year	Water Consumption by Customer Type (mgd)						
	City	Commercial	Industrial	Multi-family	Public	Single Family/ Duplex/Triplex	Total
2014							
2015							
2016	0.04	0.75	0.44	1.50	0.15	2.66	5.53
2017	0.05	0.78	0.71	1.45	0.15	2.79	5.94
2018	0.05	0.79	0.61	1.44	0.15	2.79	5.85
2019	0.05	0.79	0.32	1.39	0.14	2.57	5.25
2020[1]	0.05	0.80	0.30	1.50	0.15	2.80	5.60

Note:
1. 2020 consumption data is estimated.

2.4.4 Equivalent Dwelling Units

The City's public water system serves single-family residential customers and a significant number of multifamily housing developments and commercial customers. Single-family residential water services generally have a consistent daily and seasonal pattern of water use or demand. Water demands for multifamily residence, commercial, and industrial users may vary significantly from service to service depending on the number of multifamily units per service or the type of commercial enterprise. When projecting future water demands based on population change, the water needs of non-residential and multi-family residential customers are represented by comparing their water use volume to the average single-family residential unit. The number of single-family residential units that could be served by the water demand of these other types of customers is referred to as the number of "equivalent dwelling units" (EDUs). EDUs differ from actual metered service connections in that they relate all water services to an equivalent number of representative single-family residential services based on typical annual consumption.

In order to establish the average consumption per EDU, the total number of single-family residential service connections is compared to the total consumption by single-family residential customers. Residential ADD divided by the number of base size meters is the average demand per EDU (ADD/EDU in gpd/EDU). Average consumption per EDU (ADD/EDU) is anticipated to remain constant through time and based on the 2012 WSMP calculations using 2011 water consumption records, assumed to be 184 gpd/EDU.

2.5 Future Water Demand Forecast

Future water demands were projected based on historical data, population forecasts, and growth trends. Projections take into account anticipated growth in new development areas, specifically in the Pleasant Valley and Springwater areas, and estimated water loss. Table 2-4 presents future demand projections by customer type as well as the projected EDUs and projected MDD through 2050.

Table 2-4 | Future Water Demand Projections by Customer Type (mgd)

	Single-family Residential	Multi-family Residential	Commercial	Industrial	Public/City	Total ADD[1]	EDUs	MDD
2022	2.8	1.5	0.8	0.4	0.2	6.0	32534	10.2
2023	2.9	1.5	0.8	0.4	0.2	6.1	32884	10.3
2024	2.9	1.5	0.8	0.4	0.2	6.1	33275	10.4
2025	2.9	1.5	0.8	0.4	0.2	6.2	33713	10.5
2026	3.0	1.6	0.8	0.5	0.2	6.3	34122	10.7
2027	3.0	1.6	0.8	0.5	0.2	6.4	34540	10.8
2028	3.0	1.6	0.8	0.5	0.2	6.4	34966	10.9
2029	3.1	1.6	0.8	0.5	0.2	6.5	35402	11.1
2030	3.1	1.6	0.8	0.6	0.2	6.6	35850	11.2
2031	3.1	1.6	0.8	0.6	0.2	6.7	36297	11.4
2032	3.2	1.6	0.8	0.6	0.2	6.8	36759	11.5
2033	3.2	1.6	0.8	0.7	0.2	6.9	37237	11.6
2034	3.2	1.6	0.8	0.7	0.2	6.9	37731	11.8
2035	3.3	1.6	0.8	0.7	0.2	7.0	38244	12.0
2036	3.3	1.6	0.8	0.8	0.2	7.1	38756	12.1
2037	3.3	1.7	0.9	0.8	0.2	7.2	39292	12.3
2038	3.4	1.7	0.9	0.9	0.2	7.3	39854	12.5
2039	3.4	1.7	0.9	1.0	0.2	7.4	40445	12.7
2040	3.4	1.7	0.9	1.0	0.2	7.6	41068	12.8
2041	3.5	1.7	0.9	1.1	0.2	7.7	41663	13.0
2042	3.5	1.7	0.9	1.2	0.2	7.8	42300	13.2
2043	3.5	1.7	0.9	1.3	0.2	7.9	42984	13.4
2044	3.5	1.7	0.9	1.4	0.2	8.0	43719	13.7
2045	3.6	1.7	0.9	1.5	0.2	8.2	44514	13.9
2046	3.6	1.7	0.9	1.6	0.2	8.3	45359	14.2
2047	3.6	1.7	0.9	1.7	0.2	8.5	46259	14.5
2048	3.6	1.7	0.9	1.9	0.2	8.7	47216	14.8
2049	3.7	1.7	0.9	2.0	0.2	8.9	48237	15.1
2050	3.7	1.7	0.9	2.2	0.2	9.1	49327	15.4

Note:

1. Includes estimated water loss of 5%.

2.5.1 Residential Water Demand

Population projections were the basis for estimated residential water demand. Population forecasts for the City's Water Service Area published by the Population Research Center (PRC, Portland State University, August 2014) include U.S. census population data from 2010 and estimated population from 2013 through 2045. While these forecasts have not been updated for the City's Water Service Area since 2014, city-wide population estimates were updated through 2019, showing that actual population growth in the City has been slower than the 2014 forecast.

The PRC also provides growth rates for Multnomah County. These estimates indicate that within the county, growth is anticipated to occur at a rate of 1.14 percent through 2020, slowing to 0.7 percent by 2040. Within the City's Water Service Area, population growth has averaged 0.52 percent per year since 2010.

For the purposes of this WSMP, it is assumed that the City's Water Service Area growth over the next five years will be slow, near the current average growth rate of 0.52 percent, due to current uncertainties in the economy. After a period of slow growth, a period of high growth is estimated at 1.16 percent beginning in 2025 and gradually decreasing through 2050. This gradual reduction follows the original growth rate trend from the 2014 PRC population projections for the City's Water Service Area.

Using the 2019 city-wide population estimate and residential water consumption data provided by the City for 2016 through 2019, the average use per capita per day was calculated. Note that this is for combined single and multi-family consumption. The average per capita use was 59 gallons per capita per day (gpcd) between 2016 and 2019. To estimate future residential water demand, 60 gpcd is used.

2.5.2 Non-residential Water Demand

Commercial, Industrial, Public, and City water use projections are based on consumption data from 2016 through 2019. Commercial and Public/City demands are expected to increase proportional to residential demand, as described in **Section 2.5.1**: slow for the next five years followed by a period of higher growth that tapers off through 2050.

Industrial use has decreased in the past ten years; however, moderate growth is projected in the next five years. While significant industrial development is anticipated, these developments are currently in "concept" phase, and it is expected that growth in industrial demand will be slow but gradually increase through 2050, tapering off after that.

2.5.3 Non-revenue Water Demand

Non-revenue water is the amount of water produced that is not billed to a customer. This generally includes water losses in the distribution system, unauthorized use, and authorized unbilled use such as hydrant flushing for water quality. This water must be accounted for in demand projections to ensure proper infrastructure sizing. Non-revenue water is estimated as the difference between billed consumption and production.

Non-revenue water is projected using historical data. The percent of 2016 to 2019 water production that was non-revenue varied between three and six percent. Future non-revenue water is estimated as five percent of future production.

2.5.4 Maximum Day Peaking Factor

The average maximum day peaking factor from 2011 to 2019 was 1.65 and ranged from 1.57 to 1.77 as presented in **Table 2-1**. A peaking factor of 1.7 was used to project MDDs.

2.5.5 Build-out Water Demand

Population growth is expected to continue beyond the planning horizon of this WSMP and likely beyond the estimated build-out year 2100. Build-out population was projected in the 2012 WSMP by estimating available land for infill growth as well as the expected growth in the Pleasant Valley and Springwater development areas. Build-out projections from the 2012 WSMP are assumed to remain accurate for planning purposes, although the timing of growth is anticipated to be slower based on updated PRC population forecasts. For the residential, commercial, public, and city categories, growth is considered near build-out at the year 2050. Build-out for industrial demand is assumed to extend past 2050, given the substantial amount of industrial growth expected.

2.6 Future Water Demand by Service Level

Projected future water demand by service level is summarized in **Table 2-5**. These demands are used with the performance criteria presented in **Section 3** to analyze the capacity of water facilities supplying each zone. Additional demand assigned to each service level is based on known developable areas as well as infill proportional to the population projections. New developments may be served from future facilities described in the distribution system analysis presented in **Section 5**.

Table 2-5 | Estimated Future Water Demand by Service Level

Service Level	ADD (mgd)				MDD (mgd)			
	2025	2030	2040	2050	2025	2030	2040	2050
Gabbert	0.03	0.03	0.03	0.04	0.05	0.05	0.06	0.07
Grant Butte	2.78	2.79	2.88	3.24	4.73	4.75	4.89	5.50
Hunters Highland	0.19	0.22	0.23	0.24	0.33	0.38	0.39	0.40
Intermediate	2.02	2.28	2.57	2.91	3.43	3.88	4.37	4.95
Lusted	0.54	0.60	0.96	1.35	0.92	1.02	1.64	2.29
South Hills	0.32	0.35	0.50	0.62	0.54	0.59	0.84	1.05
South Shore	0.31	0.32	0.39	0.69	0.53	0.55	0.66	1.17
Total	**6.20**	**6.60**	**7.56**	**9.08**	**10.53**	**11.22**	**12.85**	**15.44**

Section 3

Section 3

Planning and Analysis Criteria

3.1 Introduction

This section documents the performance criteria used for water supply and distribution system analyses presented in Section 4 and Section 5 of this WSMP. Criteria are established for evaluating water supply, distribution system piping, service pressures, storage and pumping capacity, and fire flow availability. These criteria are used in conjunction with the water demand forecasts presented in Section 2 to complete the water system analysis.

3.2 Existing System

As described in Section 1, the City draws most of its water supply from PWB's Bull Run water supply system conduits, delivered through master metered connections. The City also receives water from PWB's South Shore well field that feeds the South Shore service level.

In addition to PWB supply, the City has one groundwater well, Cascade No. 5, that is part of the Cascade groundwater system jointly owned with RWPUD. The Cascade system consists of wells owned by both the City and RWPUD, a treatment facility, a finished water reservoir, and a 30-inch diameter transmission main that delivers water to the City's North and South Meter Stations and RWPUD's Bella Vista Reservoir. The City is currently exploring options for expansion of the groundwater supply, both at the Cascade facility and elsewhere in the system.

Water enters the City's distribution system through 10 master metered connections with PWB Bull Run conduits. Two of these connections fill the Grant Butte Reservoir by gravity. This is the largest reservoir in the City's distribution system and it supplies the largest service level by gravity. Water from three of the master metered connections is pumped into the system at the Intermediate and Wheeler service levels. The remaining five connections all feed the South Shore area, which is hydraulically disconnected from the City's main system.

There are seven service levels within the distribution system that are served by gravity storage, pump stations, or PRVs. The distribution system has seven active pump stations and seven active storage reservoirs.

3.3 Performance Criteria

The water distribution system should be capable of operating within certain performance limits under varying customer demand and operational conditions. The recommendations of this plan are based on the performance criteria developed in this section and summarized in

Table 3-1 at the end of this section. These criteria have been developed through a review of City design standards, State requirements, AWWA acceptable practice guidelines, the *Ten States Standards*, the Washington *Water System Design Manual*, and practices of other water providers in the region.

3.3.1 Supply

Supply adequacy is measured based on firm capacity. For a treatment plant, this is the total plant capacity with one treatment train out of service. For a well field, this is the total capacity of all wells with the largest well out of service. The City's primary supply is purchased water from PWB. In this case, the assumption is that sufficient capacity is available to the City under firm supply conditions. As the City further develops its groundwater supply system, consideration should be given to the firm capacity of the groundwater well field.

3.3.2 Service Pressure

Water distribution systems must provide water to customers within a limited pressure range, generally 40 to 80 psi. To do this, systems are divided into service levels which provide water to customers within a band of ground elevations. Service levels are typically served by one or more reservoirs with the same overflow elevation. The ground elevation band is limited by the pressure available from the HGL within each level. The HGL in each service level is set by the water level in the reservoirs or settings of PRVs serving the level. Areas of the system can also be hydraulically connected to another service level by a PRV or pump station.

Most of the City's water customers are served by the Grant Butte service level, which receives pressure from the Grant Butte Reservoir. Grant Butte Reservoir is filled by the North and South meter stations from the PWB conduits or the groundwater system jointly owned with RWPUD. Meter stations also supply the Intermediate and Lusted service levels by pumping from the PWB conduit connections. From the Intermediate service level, a series of pump stations pressurize water to the higher elevation service levels of Hunters Highland, Gabbert, and South Hills. Gabbert and South Hills provide water through PRVs to lower elevation sub-levels.

The City's acceptable service pressure range under normal operating conditions, or ADD, is 35 to 80 psi per the City's Public Works Standards. However, due to ground elevations in some service levels, some customers receive service pressures outside this range. Where mainline pressures exceed 80 psi, services are equipped with individual PRVs to maintain their static pressures at no more than 80 psi in compliance with the Oregon Plumbing Specialty Code. During a fire flow event or emergency, the minimum service pressure is 20 psi as required by Oregon Health Authority, Drinking Water Program (OHA) regulations.

3.3.2.1 Distribution System Evaluation

The distribution system is evaluated for adequacy under two key demand scenarios: MDD plus fire flow and PHD. The distribution system should provide the required fire flow to a given location under MDD conditions while maintaining a minimum residual service pressure of 20 psi at any customer meter in the system, as required by OHA regulations. The distribution system should supply PHD while maintaining service pressures no lower than 35 psi according to the City's Public Works Standards. At all times, pipes should maintain a flow velocity of less than 8 feet per second (fps) in CI pipes and 14 fps in DI pipes.

3.3.2.2 Main Size

Typically, new water mains should be no smaller than 8 inches in diameter. However, 8-inch mains may cause water quality concerns in areas with small, non-emergency demands and minimal looping. According to the City's Public Works Standards, 4-inch diameter pipe is allowed if the pipe length is less than 250 feet and no more than 12 services are connected. Additionally, 6-inch diameter pipe is allowed if it is directly connected to an 8-inch or larger loop and no hydrants are connected to the 6-inch diameter pipe. For areas with commercial or industrial use or fire flows exceeding 1,000 gallons per minute (gpm), a minimum of 10-inch diameter pipe is required.

3.3.3 Storage Capacity

Water storage reservoirs should provide capacity for four purposes: operational storage, equalization storage, fire storage, and standby or emergency storage. A brief discussion of each storage element is provided below. Total storage should be evaluated factoring in any dead space, which is the reservoir volume that cannot provide minimum design pressures to all customers. Similarly, the top of a reservoir may be reserved for seismic sloshing in the event of an earthquake and should also be excluded from the usable storage volume. Adequate storage capacity must be provided for each set of hydraulically connected pressure zones.

Operational storage is the storage in reservoirs between the on and off set points for the supply sources under normal operating conditions. It is calculated by actual reservoir geometries and a typical variation in tank level of 3 to 5 feet.

Equalization storage is the volume of water dedicated to supplying demand fluctuations throughout the day. Per the *Washington Water System Design Manual,* water systems must provide equalization storage when source pumping capacity cannot meet the PHD.

Water stored for fire suppression is typically provided to meet the single most severe fire flow demand within each pressure zone. The fire storage volume required is determined by multiplying the fire flow rate by the duration of that flow.

Standby, or emergency, storage is provided to supply water during emergencies such as pipeline failures, equipment failures, power outages, or natural disasters. The amount of emergency storage provided can be highly variable depending upon an assessment of risk and the desired degree of system reliability.

3.3.4 Pump Stations

Pumping capacity requirements vary depending on the water demand, volume of available storage, and the number of pumping facilities serving a particular service level.

3.3.4.1 Pumping to Storage

When pumping to storage reservoirs, a firm pumping capacity equal to the service level's MDD is recommended. Firm pumping capacity is defined as a pump station's pumping capacity with the largest pump out of service. When there are multiple pump stations serving the same zone, firm capacity will be considered as the combined capacity with only the largest pump out of service, rather than the largest pump at each station out of service.

3.3.4.2 Constant Pressure Pumping

Constant pressure stations are used to serve customers where no gravity storage is available. It is recommended that pump stations that are the sole source of supply to a service level have adequate pumping capacity to meet the PHD while simultaneously supplying the largest fire flow demand in the zone with the largest duty (regularly operated) pump offline. Note that fire pumps do not count as duty pumps. The City's water system does not currently include any constant pressure pump stations supplying service levels without gravity storage.

3.3.4.3 Backup Power

It is recommended that pump stations supplying gravity storage reservoirs include, at a minimum, manual transfer switches and connections for a portable back-up generator. The emergency storage volume in each reservoir will provide short term water service reliability in case of a power outage at the pump station. Back-up power generators with ATS are recommended for all constant pressure pump stations which serve as the sole source of supply to a service level. In general, every service level should have at least one ATS, as should well sites. On-site back-up generators are recommended for pump stations critical to the operation of the system.

3.3.5 Required Fire Flow

The water distribution system provides water for domestic use and fire suppression. The amount of water required for fire suppression purposes at a specific location is associated with the local building size and construction type. Zoning and land use are used as analogs for building size when evaluating required fire flows for planning within the City's water service area.

Fire flow requirements are typically much greater in magnitude than the MDD in any local area. Therefore, fire flow must be considered when sizing pipes to ensure adequate hydraulic capacity is available for these potentially large demands. Gresham Fire and Emergency Services has generally adopted the 2019 Oregon Fire Code (OFC) as its own standard.

3.3.5.1 Single-Family and Two-Family Dwellings

The 2019 OFC guidelines specify a minimum fire flow of 1,000 gpm for single-family and two-family dwellings with square footage of 3,600 square feet or less. For residential structures larger than 3,600 square feet, the minimum fire flow requirement is 1,500 gpm. The actual fire flow requirement is based on building construction and size and can be found in the Table B105.1(2) in Appendix B of the OFC.

For the purposes of this WSMP, distribution piping fire flow capacity will be tested in the water system hydraulic model with a minimum requirement of 1,500 gpm to accommodate the range of potential future residential development in the City. Where deficiencies are identified in the existing system based on this requirement, existing homes that are less than 3,600 square feet will be evaluated at a 1,000 gpm fire flow to confirm if a potential deficiency exists for current customers.

3.3.5.2 Other Dwelling Types

For buildings that are not single and two-family residential dwellings, the fire flow requirement is based on building type and size and can be found in Table B105.1(2) in Appendix B of the OFC. The fire flow rate and duration requirements are reduced if a building has an automatic sprinkler system. Section B106.1 of the OFC sets the maximum fire flow requirement at 3,000 gpm. This applies to any new, altered, moved, enlarged, or repaired building. Buildings that require more than 3,000 gpm need approval from the fire code official. The City's Public Works Standards set the maximum fire flow for new developments at 3,500 gpm, above which special approval is needed.

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Table 3-1 | Performance Criteria Summary

Water System Component	Evaluation Criterion	Value	Design Standard/Guideline
Water Supply	Primary Source Capacity (PWB)	Not applicable at this time as firm supply is provided from PWB	Ten States Standards, Washington Water System Design Manual, Murraysmith recommended
Service Pressure	Normal Range, during ADD[1]	35-80 psi	AWWA M32, City Standard
	Maximum (without PRV)	80 psi	AWWA M32, Oregon Plumbing Specialty Code, Section 608.2
	Minimum, PHD[2]	35 psi	City Standard
	Minimum, during emergency or fire flow	20 psi	AWWA M32, OAR 333-061
Distribution Mains	Maximum Pipe Velocity	Not to exceed 8 fps for CI pipes and 14 fps for DI pipes	City Standard
	Minimum Pipe Diameter	8-inch unless specific criteria is met	City Standard
Storage	Operational Storage	Tank level set points	Washington Water System Design Manual
	Equalization Storage[3]	$(PHD - Q_{supply})$ * 150 minutes, 30 psi minimum pressure	
	Standby Storage	(no. of ERU_{MDD}) x (locally adopted SB flow in gpd/ERU) x (Adopted no. of days), minimum recommended = 200 gallons per ERU, minimum pressure 20 psi	
	Fire Storage	Required fire flow x flow duration	
	Dead Storage	Volume that cannot provide minimum design pressure to all customers	
Pump Stations	Backup Power Constant Pressure	ATS and on-site generator	Murraysmith recommended
	Firm Capacity Pump to Storage	MDD	
	Backup Power	ATS and on-site generator (if critical facility)	
Required Fire Flow and Duration	Single- or Two-Family Residential <3,600 square feet	1,000 gpm for 2 hours	2019 OFC, Gresham Public Works Standards
	Residential >3,600 square feet and other Buildings	Use OFC criteria for building size and type up to a maximum of 3,500 gpm for 3 hours	

Notes:
1. ADD: Average daily demand, defined as the average volume of water delivered to the system or service area during a 24-hour period = total annual demand/365 days per year.
2. PHD: Peak hour demand, defined as the maximum volume of water delivered to the system or service area during any single hour of the MDD.
3. MDD: Maximum day demand, defined as the maximum volume of water delivered to the system or service area during any single day.

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Section 4

Section 4

Water Supply Analysis

4.1 Introduction

In 2020, the City and RWPUD completed the Groundwater Development Master Plan (Murraysmith), outlining the required improvements needed to transition from a combination of local groundwater supply and wholesale water purchase from PWB, entirely to a local groundwater supply.

The City needs to develop sufficient firm capacity to meet the anticipated system MDD in 2026 of 11.0 mgd, when the existing PWB wholesale contract will expire. The recommended improvements needed to achieve this objective are detailed in the Groundwater Development Master Plan and the City's share of these improvements are included in the Capital Improvements Plan presented in Section 6.

Further expansion of the groundwater supply is required beyond 2026 as demands continue to increase with population growth within the City's service area. Currently the City has 7.5 mgd of total operational capacity, and 4.5 mgd of firm capacity (with Cascade Well No. 4 out of operation). This section provides a summary of the groundwater capacity expansion activities completed since the previous WSMP, the total operational and pending capacity increments in development, and recommendations for additional source capacity development.

4.2 Groundwater Supply Discussion

Two test wells and three production wells have been constructed in the years since the previous WSMP was completed. The insights from the drilling into the nature of the Sand and Gravel Aquifer (SGA) and implications for developing additional groundwater capacity are discussed in the following sections.

4.2.1 Test Well Drilling

Test Well 1 was constructed in 2016 at a site located southeast of the intersection of SE Stark Street and SE 223rd Avenue. Using the results of pumping tests, a yield estimate of 4.4 mgd for a new production well was projected for that site. The concentration of manganese detected in Test Well 1 has guided subsequent decisions to assume that future developed groundwater capacity will need treatment.

Test Well 2 was drilled to a total depth of 1,800 feet below ground surface (bgs) in 2020 at Southwest Community Park to explore the potential for developing source capacity in the southern edge of the service area. The SGA was encountered at a substantially greater depth (below 1,420 feet bgs, approximate EL -1140) in this area than in wells drilled in more northern portions of the service area. The borehole was completed as a small-diameter observation well. Potential production well yield and aquifer hydraulic parameters could not be directly tested in Test Well 2. However, the coarse-grained section of the SGA at this location is atypically thick (>380 feet) and the predominance of unconsolidated gravel and sand suggests good yield potential. Water quality testing results revealed highly-mineralized sodium bicarbonate-type water with high salinity; however, the representativeness of the water quality testing results is uncertain based on evidence of the presence of drilling fluids and inadequate development of the well.

While drilling of Test Well 2 identified a thick and potentially productive section of the aquifer, the cost to develop a production well at this location will be substantially greater than more northerly locations because of the depth of the SGA. Also, because the water quality at this location is unconfirmed, the potential for developing additional capacity at this and other locations near the southern edge of the service area cannot be determined at this time. The City is currently evaluating methods to redevelop the test well to obtain a water quality sample that can be considered representative of the deep SGA at this location. Because of the current uncertainty regarding the water quality and yield at this location, capacity estimates for the Test Well 2 site are not incorporated in this analysis.

4.2.1.1 New Production Wells

Production wells Cascade 7, 8, and 9 were constructed between 2019 and 2021. Cascade Wells 7 and 9 are currently being outfitted with pumping systems. The yield of Cascade 8 has not been determined and the well is slated for additional development in Winter/Spring 2022 to improve its performance before confirming its design yield. In addition, a new production well, Cascade 6, will be constructed in 2022 at the Test Well 1 site.

4.3 Source Capacity

This section summarizes an assessment of source capacities, including existing operational wells, new wells that are in the process of being brought online, and future capacity increments. Each of these capacity categories has an associated confidence level with the greatest confidence associated with existing operational wells. The lowest confidence levels are associated with projected future wells that will be sited at yet-undetermined locations. Capacity estimates for new wells and current test well sites are summarized in **Table 4-1** below.

Table 4-1 | Source Capacity Summary

Capacity Increments	CGA Shared Groundwater Source			Gresham Allocation	
	Capacity Increment (mgd)	Total Capacity (mgd)	Firm Capacity (mgd)[1]	Total Capacity (mgd)	Firm Capacity (mgd)
Cascade Facility (Wells 3, 4, 5)	15	15	9	7.5	4.5
Cascade Wells 7 and 9	10[2]	25	19	12.5	9.5
Cascade 6	4.4	29.4	23.4	14.7	11.7
Future Well[3]	2	31.4	25.4	16.7	13.7
Future Well[3]	2	33.4	27.4	18.7	15.7

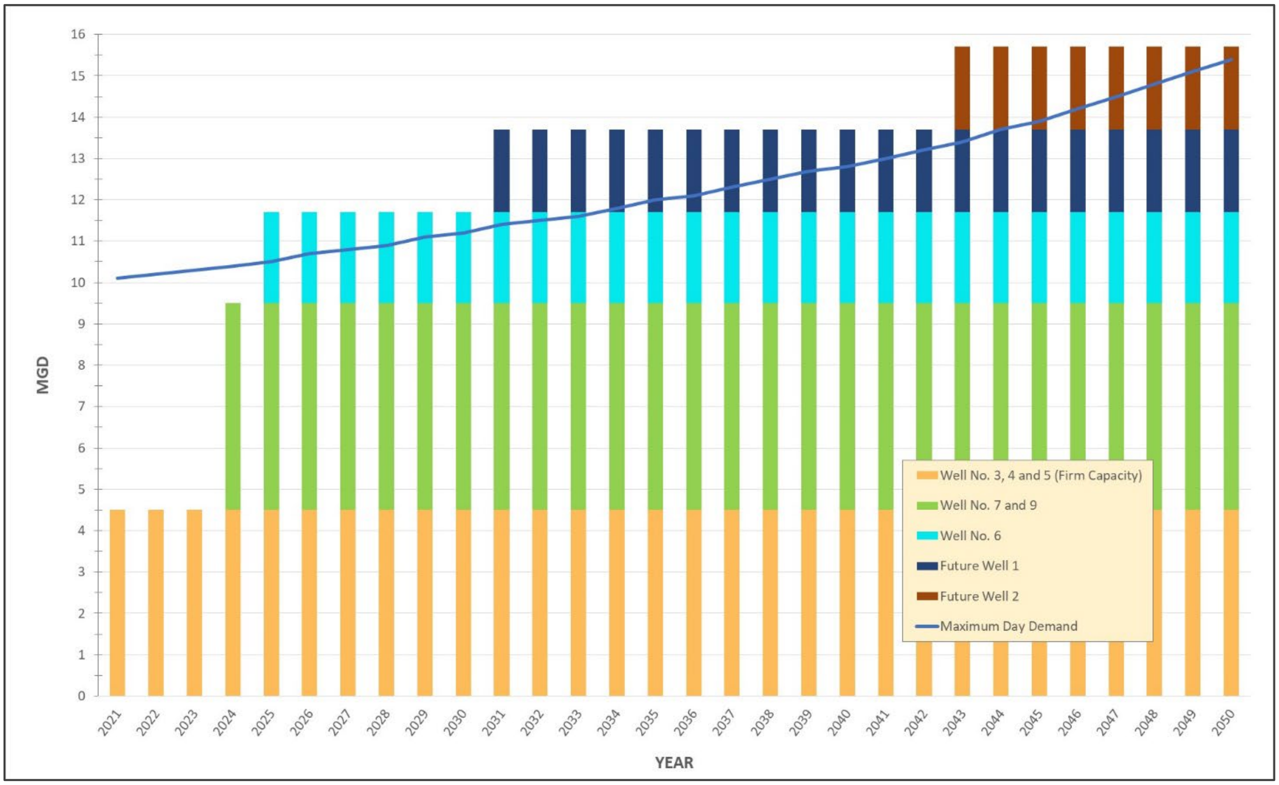
Notes:

1. Assumes Cascade 4 (6 mgd) is out of service
2. 5.6 mgd (Cascade 7) and 4.4 mgd (Cascade 9)
3. Future wells are assumed to be located within the City's service area and will only supply the City.

We have assumed that future wells would provide, on average, 2 mgd of additional capacity per well. Preliminary conservative estimates of well interference suggest that six wells will supply sufficient capacity to meet the projected 2026 MDD, including the City's allocated capacity from Cascade Wells 3, 4, 5, 7 and 9, and Cascade Well 6.

Beyond 2026, the City will need to develop additional incremental groundwater capacity to meet demands through 2050. As illustrated in **Figure 4-1**, the development of two additional groundwater wells, with an approximate yield of 2 mgd each will meet the City's long-term water supply needs.

Figure 4-1 | Groundwater Supply and Water Demand Comparison



4.4 Considerations for Future Capacity Development

The new production and test wells have increased the understanding of the depth, thickness, and extent of the SGA, which will aid in selection of future well sites. Key findings from recent drilling include:

- The thickness of the lower confining unit (CU2) and depth of the top of the SGA is greater than previously understood, particularly in westerly and southerly directions from the RWPUD Cascade site. Future capacity development in these directions will need to accommodate for these new insights.

- There are system advantages to locating sources in the southern portions of the service area and also to reduce the effects of well interference from existing wells. However, the costs for additional capacity increments may be significantly greater and there are still unresolved questions regarding the water quality in the SGA in this area.

Conceptual hydrogeologic cross sections for the Cascade Groundwater Alliance (CGA) service areas have been developed for using this new information in updating the conceptual hydrogeologic model of the region, and to complete substantial modifications to the Portland Basin Groundwater Model. The model will be used to simulate the dynamic aquifer response under various pumping scenarios and provide more reliable estimates of well interference. As a key component of the CGA's groundwater development strategy, the model will provide guidance for evaluating potential new well sites and for optimizing well operations. These conceptual cross sections are included in **Appendix F**.

4.4.1 Water Rights

The CGA holds water rights that authorize use of up to 63.5 cubic feet per second (cfs) or 41.02 mgd.

- Water right certificate 83629 authorizes the use of up to 10 cfs from Cascade Wells 3 and 4.
- Permit G-16917 has a total authorized rate of 53.5 cfs, of which 33.5 cfs is currently accessible.

The existing water rights are sufficient to meet the CGA's combined projected demands through 2050. An IGA between the City and RWPUD has defined the agreed terms for sharing groundwater rights between the two entities. The IGA grants the City access to a total of 18 mgd, which is sufficient to meet the City's projected demands through 2050.

A discussion of the relative priority of the water rights and the regulation of water rights in Oregon is presented in **Appendix G**.

4.5 Capacity Expansion Strategy

The goals for developing source capacity include developing sufficient firm capacity to:

1. Meet the City's MDD of 10.7 mgd in 2026 (short-term)
2. Meet the City's projected MDD of 15.4 mgd over the planning period through 2050 (long-term)

The first step to accomplishing the shorter-term goal is to confirm the reliable long-term source capacity at existing wells and currently targeted sites by completing well projects currently in progress or planned (i.e., Cascade 6) by completing the following actions.

1. Drill, complete and test Cascade 6 (Summer/Fall 2022).
2. Confirm the water quality at Test Well 2 (Spring 2022).
3. Model interference of existing operational, new, and potential candidate well sites to establish firm high-confidence long-term capacities and identify constraints and opportunities of new candidate sites (Spring/Summer 2022).

The next step to accomplishing the shorter-term goal for 2026 is to begin exploring the new candidate sites with a priority towards developing capacity in the vicinity of Cascade 6 first. In this regard, areas north of Cascade 6 should be avoided to reduce overlapping interference effects on and from Cascade 6 and the City of Fairview's wells. Instead, focus should be on areas to the east and west of Cascade 6. Potentially favorable locations in a more southerly direction from Cascade

6 also could be considered. However, the SGA may be significantly deeper in these locations. Regardless, an exploratory well should be completed for any site selected in this general area, prior to completing a production well, to evaluate yield potential, water quality, and potential well design parameters and cost.

North Gresham Elementary School has been identified as a potential production well site because of its proximity to the Cascade 6 site, providing the opportunity to treat water from both wells at Cascade 6. However, the potential effects on the capacities of a well at that site and Cascade 6 should be evaluated. The City is recommended to evaluate well interference at that location with the model and consider drilling an exploratory boring. An observation well should also be completed to confirm the presence of potentially productive aquifer, evaluate water quality, and obtain direct observations of water levels.

When considering sites for drilling wells to develop additional increments of capacity towards meeting long-term targets, use interference modeling and water quality sampling results after redevelopment of Test Well 2 to inform site selection. At present, focusing on the area north of SE Division Street and between Cascade Wells 8 and 9 is recommended for identifying one or two sites to explore for the next capacity increments, at least until the uncertainties surrounding the effects of interference on long-term well capacities and the water quality in deeper areas of the SGA near the southern portions of the service area are resolved.

The recommended approach and steps for developing additional capacity increments includes:

1. Identify potential well sites, and conduct preliminary evaluation for suitability for distribution, site plan, and regulatory requirements.

2. Evaluate well interference, impacts to other wells, and potential capacity gain using the numerical model currently in development.

If the preliminary evaluation is favorable, proceed with an exploratory well or production well, depending on the site location. An exploratory well is recommended for any site that is more than 1.5 miles away from an existing SGA supply well, and for sites located south of East Burnside Street. The exploratory well would provide information regarding depth, thickness, and texture of the aquifer materials, as well as water quality. If feasible, any exploratory well should be completed as a permanent observation well and instrumented for long-term monitoring of water levels. If the observed site conditions appear favorable, proceed with constructing a production well.

4.5.1 Long-Term Groundwater Expansion Strategy Infrastructure Needs

For the purposes of planning and capital improvement cost development, presented in **Section 6**, and based on the findings from Cascade Wells 7 and 9, a preliminary conceptual level cost estimate for each increment of long-term groundwater expansion is presented below in **Table 4-2**.

Table 4-2 | Groundwater Expansion Cost Estimate (per additional well)

Groundwater Development Phase/Element	Conceptual Level Project Cost
Exploratory Drilling	$500,000
Production Well	$1,700,000
Wellhead and Site Improvements	$1,750,000
Treatment	$3,500,000
Off-Site Piping	$900,000
TOTAL (per well, assuming 2 mgd capacity)	**$8,350,000**

4.6 Summary

This section presents an overview of the City's water supply expansion strategy to achieve independence from wholesale supply from the PWB. With the ongoing development of the improvements recommended in the Groundwater Development Master Plan, it is anticipated that the CGA partnership with RWPUD will have developed adequate groundwater supply capacity to meet the combined demands of the City and RWPUD through 2030. It is anticipated that the City will begin further groundwater exploration before 2025 to support the development of additional groundwater capacity further south in the City's service area, to meet long-term water supply needs associated with growth.

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Section **5**

Section 5

Distribution System Analysis

5.1 Introduction

This section provides an evaluation of the City's water service area distribution system including storage reservoirs, pump stations, control valves, backup power, and distribution mains. System facilities are analyzed for adequacy in both existing and future conditions within the 20-year planning horizon. These analyses help to inform the City's recommended CIP, presented in Section 6.

As discussed in Section 1, The City's water service area is defined by seven main service levels, seven active storage reservoirs, eight active pump stations, and various control valves. These facilities are shown in Plate 1 in Appendix A.

This section documents the distribution system analysis according to the specific criteria outlined in Section 3 and water demand forecasts summarized in Section 2. The analysis assesses overall system performance including service pressures, storage and pumping capacities, and emergency fire flow availability.

The section culminates in CIP projects recommended to address the distribution system's existing deficiencies and needs as well as those identified within this WSMP's 20-year planning period. The complete list of recommended projects is provided in Section 5.8. Plate 2 in Appendix A shows the geographic locations of the recommended projects and Figure 5-1 shows a hydraulic schematic of the proposed distribution system at buildout.

5.2 Hydraulic Network Modeling

As part of this WSMP, a hydraulic network analysis model was developed using Innovyze InfoWater software. The model was calibrated to 2019 demand and operational conditions, using data from the City's Supervisory Control and Data Acquisition (SCADA) system for extended period simulation (EPS) calibration.

Future modeling scenarios were configured for ADD and MDD conditions for the planning years 2020 (existing), 2025, 2030, and 2040. The future year scenarios consider projected demands presented in Section 2, incorporate additional supply needs and supply sources identified in Section 4, and include future improvements identified later in this section. The hydraulic model was used to identify deficiencies in system pressures and fire flow availability based on criteria established in Section 3.

5.3 Service Level Analysis

5.3.1 Existing Conditions

As presented in **Section 1**, the City's seven service levels, including Grant Butte, Intermediate, Wheeler, Gabbert, Hunters Highland, South Hills, and South Shore, supply customers between 7 and 860 feet in elevation. These service levels include several smaller pressure zones that are geographically or hydraulically isolated from other zones within the same service level. For instance, Gabbert 895 and Gabbert 730 pressure zones are both served by the same Gabbert service level even though they are located at different HGLs. These sub-pressure zones are supplied from the Gabbert service level and reservoir through a PRV. A similar condition exists for the South Hills service level, which feeds the South Hills 3 and South Hills Deer Glen subzones through PRVs. This chapter analyzes the Gabbert and South Hills service levels as single, combined service levels.

Apart from South Shore, all of Gresham's service levels are supplied by finished water storage reservoirs. The lowest elevation reservoir, Grant Butte, is filled by gravity from PWB conduits and the Cascade groundwater supply system. All other service levels are supplied by pumping from lower service levels or directly from PWB supply conduits.

Under existing MDD conditions, the City's seven main service levels provide adequate minimum service pressures of at least 35 psi throughout the distribution system. The maximum acceptable pressure within the system is 85 psi at the water main. Where water main pressures exceed 85 psi, PRVs are required on individual service connections.

5.3.2 Hunters Highland Service Level Expansion

Currently, the South Hills 3 subzone is fed from the South Hills Reservoir through the Butler Road PRV. Due to the large number of South Hills 3 services and the risks associated with the single supply connection at Butler Road, the City plans to incorporate South Hills 3 distribution piping and service connections into the Hunters Highland service level. The existing Butler PRV station is recommended be upgraded to enable remote operations (project D-9).

It is recommended that the Emerald Heights neighborhood be integrated into the future Hunters Highland service level to provide sufficient looping between the existing Hunters Highland service level and the South Hills 3 expansion area. At present, Emerald Heights, north of SW Butler Road between SE 190th Drive and SW Binford Way, is served by a single 8-inch diameter main from the Intermediate service level.

For the analyses presented in this section, the transfer of customers from the South Hills 3 to the Hunters Highland service level is assumed to occur by 2025. Prior to relocating South Hills 3 customers to Hunters Highland, an assessment is recommended of potential water quality impacts associated with decreased turnover in the South Hills Reservoir due to reduced demand.

The South Hills 3 expansion of the Hunters Highland service level requires the following changes in the distribution system.

- Change Butler PRV status for remote operation that allows emergency utilization of South Hills pump station capacity to flow water to the expanded Hunters Highland service level when the downstream pressure is less than 20 psi, and to maintain a water quality flow.
- Open the existing normally closed valves (NCVs) at SE 190th Drive and at SW 30th Street and east to SW Brixton Drive (isolating the existing Hunters Highland and Intermediate service levels) and install a new NCV at SW 31st Street and SW Willow Parkway to integrate part of the Intermediate service level into the expanded Hunters Highland service level and move the boundary of the Intermediate service level.
- Open the existing NCV at SW Butler Road and SW Binford Way, isolating existing Intermediate and South Hills service levels.

5.3.3 Future Service Area Expansion

Development is anticipated inside the City's UGB within this WSMP's 20-year planning horizon. The City will meet the increased water demands of these developments by expanding existing service levels.

5.3.3.1 Pleasant Valley

The boundaries of the Hunters Highland and Intermediate service levels will be expanded with distribution piping improvements to serve Pleasant Valley as development occurs. Development is expected in the near-term, and some distribution piping improvements are expected to occur within the 5-year planning horizon. The majority of the Pleasant Valley Plan District is comprised of single-family residentially zoned properties, with a uniform land use and hence, an assumed uniform distribution of demands.

Intermediate level service to Pleasant Valley will be provided by proposed transmission piping to provide looping with existing Intermediate facilities. Proposed transmission piping includes a recently built 16-inch diameter main from existing large-diameter Intermediate level piping at SW Eastwood Avenue west on SW Willow Parkway and south on SE 190th Drive through the Hunters Highland service level. In order to serve Pleasant Valley from the existing Butler Reservoir site, a second 16-inch diameter Intermediate transmission line is proposed. This transmission main will run from the reservoir west on SW Butler Road to create a loop in SE 190th Drive with the recently built 16-inch diameter piping.

5.3.3.2 Springwater

The Springwater Plan district consists mainly of industrial land east of Highway 26 and primarily of residential land west of the highway. Future demands were allocated to each service level in the Springwater Plan District in proportion to the type of land use. Future water customers in the

Springwater Plan District will be supplied through the existing South Hills, Intermediate, and Wheeler service levels. System improvements needed to serve this area are not anticipated within the near-term planning horizon but are expected to occur within the 20-year planning horizon.

5.4 Storage Analysis

This section details the City's existing and future storage capacity needs. Storage projects are identified to accommodate long-term demand projections and improve overall resiliency, reliability, and operational efficiency. A summary of this analysis is presented in **Table 5-1**.

5.4.1 Storage Capacity

As discussed in **Section 3**, required storage capacity is calculated as a sum of operational, equalization, fire, and standby or emergency storage. When estimating storage availability, it is also necessary to consider dead storage and freeboard needed for seismic considerations.

- **Operational storage** is the daily variation in reservoir levels that occurs under normal operating conditions as pumps are turned on and off to fill the reservoir. This is determined by the operational settings for each pump station supplying the reservoir. Note that this criterion does not apply to systems operating under continuous supply mode, as is the case for the PWB supply. However, as discussed in **Section 4**, the City plans to change its primary supply source to groundwater in the future. When this occurs, operational storage may need to be considered. For the purpose of this analysis, the future operational reservoir level change or drawdown is assumed to be five feet. The City plans to change its supply source by 2026. This change to storage criterion is reflected in the 2030 planning year presented in **Table 5-1**.

- **Equalization storage** is the volume of water needed to supply fluctuating demands throughout the day. This storage component is applied when supply sources or pumping capacity cannot meet PHD. This criterion was applied only to the Grant Butte service level. Grant Butte Reservoir is refilled directly from available supply and the reservoir supplies all the other service levels. The other service levels have enough pumping capacity to supply PHD, so equalization storage is not considered.

- **Fire storage** is equal to the maximum required fire flow for each service level served by a reservoir multiplied by the fire flow duration defined in the OFC, which is:

  - Single-family Residential: 1,000 gpm for 2 hours
  - Multi-unit Residential: 2,500 gpm for 2 hours
  - Commercial, Public, Industrial: 3,000 gpm for 3 hours

- **Standby or Emergency storage** is the storage needed during events such as pipeline failures, equipment failures, power outages, or natural disasters. The minimum recommended standby storage is the volume of water needed to supply 200 gallons per day to a water system's number of ERUs estimated for MDD.

- **Dead storage** is the volume of water at the bottom of a reservoir that is below the service level minimum HGL.

- **Seismic freeboard** is the top of the reservoir reserved for sloshing height, which is needed to minimize the risk of reservoir failures caused by hydrostatic or earthquake-induced hydrodynamic forces during a seismic event. The increased freeboard essentially lowers the overflow elevation, which is the maximum water level elevation above which excess flow to the reservoir is discharged from the reservoir to a drainage structure. Lowering the overflow elevation reduces the maximum water depth in the reservoir and correspondingly, the maximum storage capacity in the reservoir. Recommendations to reduce overflow elevations were provided in the *2016 Water System Seismic Resilience Study*, and described in the Seismic Resilience Plan Integration Technical Memorandum included in **Appendix D**.

Table 5-1 summarizes current and projected storage capacity analyses performed for each of the City's open service levels (those with one or more storage tanks). While the planning horizon of this WSMP is 20 years, the storage analysis considered a 30-year planning period for proposed future storage sizing.

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Table 5-1 | Storage Capacity Analysis

Service Level	Scenario[4]	Required Storage Volume (MG)						Required Storage (MG)	Existing Storage (MG)	Nested Fire Suppression Storage[5] (MG)	Existing Effective Storage[1] (MG)	Storage Volume Needed (MG)
		Equalizing	Operational[2]	Fire[3] Suppression	Standby	Seismic Freeboard	Dead					
Grant Butte	2019	0.58		0.63	3.48	1.57	4.35	4.69	10	0.63	4.71	0.00
	2020	0.66		0.63	3.33	1.57	4.35	4.62	10		4.71	0.00
	2025	0.74		0.63	3.39	1.57	4.35	4.76	10		4.71	0.05
	2030	1.09	1.43	0.63	3.42	1.57	4.35	6.56	10		4.71	1.85
	2040	1.17	1.43	0.63	3.56	1.57	4.35	6.79	10		4.71	2.09
	2050	1.30	1.43	0.63	4.04	1.57	4.35	7.40	10		4.71	2.69
Intermediate	2019	0.00		0.63	2.03	1.53	6.20	2.66	10	0.63	2.90	0.00
	2020	0.00		0.63	2.15	1.53	6.20	2.78	10		2.90	0.00
	2025	0.00		0.63	2.39	1.53	6.20	3.02	10		2.90	0.12
	2030	0.00	1.53	0.63	2.72	1.53	6.20	4.88	10		2.90	1.98
	2040	0.00	1.53	0.63	3.09	1.53	6.20	5.25	10		2.90	2.36
	2050	0.00	1.53	0.63	3.53	1.53	6.20	5.69	10		2.90	2.79
Wheeler	2019	0.00		0.63	0.67		1.33	1.30	3.2	0.63	2.50	0.00
	2020	0.00		0.63	0.65	0.47	1.33	1.28	3.2		2.03	0.00
	2025	0.00		0.63	0.66	0.47	1.33	1.29	3.2		2.03	0.00
	2030	0.00	0.47	0.63	0.73	0.47	1.33	1.83	3.2		2.03	0.00
	2040	0.00	0.47	0.63	1.19	0.47	1.33	2.29	3.2		2.03	0.27
	2050	0.00	0.47	0.63	1.68	0.47	1.33	2.78	3.2		2.03	0.76
Gabbert	2019	0.00		0.18	0.04		0.00	0.22	0.2	0	0.20	0.02
	2020	0.00		0.18	0.03	0.02	0.00	0.21	0.2		0.18	0.03
	2025	0.00		0.18	0.04	0.02	0.00	0.22	0.2		0.18	0.04
	2030	0.00	0.02	0.18	0.04	0.02	0.00	0.24	0.2		0.18	0.06
	2040	0.00	0.02	0.18	0.04	0.02	0.00	0.24	0.2		0.18	0.06
	2050	0.00	0.02	0.18	0.06	0.02	0.00	0.26	0.2		0.18	0.08
Hunters Highland	2019	0.00		0.3	0.29		0.61	0.59	1.2	0.29	0.87	0.00
	2020	0.00		0.3	0.33	0.05	0.61	0.63	1.2		0.82	0.00
	2025	0.00		0.3	0.38	0.05	0.61	0.68	1.2		0.82	0.00
	2030	0.00	0.07	0.3	0.44	0.05	0.61	0.81	1.2		0.82	0.00
	2040	0.00	0.07	0.3	0.45	0.05	0.61	0.82	1.2		0.82	0.00
	2050	0.00	0.07	0.3	0.47	0.05	0.61	0.84	1.2		0.82	0.02
South Hills	2019	0.00		0.3	0.23		0.81	0.53	2.6	0.30	2.09	0.00
	2020	0.00		0.3	0.23	0.35	0.81	0.53	2.6		1.74	0.00
	2025	0.00		0.3	0.23	0.35	0.81	0.53	2.6		1.74	0.00
	2030	0.00	0.44	0.3	0.26	0.35	0.81	1.00	2.6		1.74	0.00
	2040	0.00	0.44	0.3	0.37	0.35	0.81	1.11	2.6		1.74	0.00
	2050	0.00	0.44	0.3	0.47	0.35	0.81	1.21	2.6		1.74	0.00

Notes:

1. Effective storage equals existing storage minus dead storage plus nested fire suppression storage.
2. Based on existing system operation (2019 peak week SCADA) with a maximum of 5 feet of operating drawdown
3. Fire storage assumes largest required fire flow based on customer type for each service level. Commercial customers requiring 3,500 gpm for 3 hours for Grant Butte, Intermediate, and Wheeler; residential customers requiring 1,500 gpm for 2 hours for Gabbert; and high density residential customers requiring 2,500 gpm for 2 hours for Hunters Highland and South Hills.
4. Current demand is based on 2019 records, and years beyond 2019 use projected demands.
5. Fire suppression storage can be nested within the dead storage volume as long as 20 psi can be maintained at all services under emergency conditions.

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5.4.2 Storage Capacity Findings

The storage analysis found that much of the existing storage volume is unusable due to dead storage and reduced overflow height for seismic considerations. Dead storage is not uncommon in reservoirs as it is not always possible to locate reservoirs at ideal elevations. However, sizing reservoirs to accommodate large volumes of dead storage is also not ideal as large dead storage volumes contribute to slow and inefficient reservoir turnover that may cause water quality concerns. Additionally, this requires financing the construction of a larger reservoir to accommodate essentially unusable storage volume. A solution to this is to consider dead storage in one service level as the emergency storage to a lower service level. For the storage analysis presented in this section, it is assumed that fire suppression storage can be nested within the dead storage volume as long as 20 psi can be maintained at all services under emergency conditions.

Table 5-1 shows that the existing Butler and Regner Reservoirs in the Intermediate service level have a total of 6.2 MG of dead storage that can be used to address the future 5.48 MG deficiency in the Grant Butte service level. Wheeler and South Hills Reservoirs have 2.54 MG of combined dead storage volume that can be used towards the future emergency storage deficiency in the Intermediate service level. This would represent a fully integrated storage sharing scenario with the assumption of having adequate connections between higher and lower service levels to let the water flow down in emergency cases. In this scenario, building an additional 2.0 MG storage reservoir in Wheeler service level can address all the planning-term storage deficiencies in the system. A more conservative scenario to the fully integrated storage sharing scenario would be to build a smaller Intermediate service level reservoir in addition to the 2.0 MG additional storage reservoir in the Wheeler service level.

The storage capacity analysis shown in **Table 5-1** identified the following storage capacity deficiencies for the 20-year planning horizon.

1. **Grant Butte Service Level:** This service level is currently served by the existing 10.0 MG Grant Butte Reservoir with no existing storage deficiencies. The additional storage volume needed by 2050 is 5.48 MG of effective storage. An additional Grant Butte Reservoir would be located at the existing reservoir site and would therefore be at the same level as the existing Grant Butte Reservoir. For this reason, an additional 4.5 MG of dead storage must be considered, and the total storage capacity of the proposed North Grant Butte Reservoir would need to be 7.0 MG (project R-1-a). As described above, however, this deficiency can be addressed through Intermediate service level dead storage. In this alternative, no additional storage capacity is proposed in the Grant Butte service level (project R-1-b).

2. **Intermediate Service Level:** This service level, served by the Butler and Regner Reservoirs, shows a storage deficiency of 2.79 MG by 2050. Similar to the Grant Butter Reservoir, there is a large amount of dead storage in this service level, so a new reservoir would need to be oversized to account for this. However, a new reservoir located at the existing Butler Reservoir site could only have a maximum volume of 5 MG due to space restrictions. Furthermore, there is also an opportunity for using dead storage from higher service levels

to supply the emergency storage needs in this service level. If no storage sharing alternative is considered, future storage deficiencies will be addressed with the construction of the proposed 9.0 MG Pleasant Valley Reservoir (project R-2-a), near the Butler reservoir site. This reservoir will also serve the new development in Pleasant Valley District. However, in a fully integrated storage sharing scenario, buildout storage capacity deficiencies in this service level can be addressed by dead storage from Wheeler and South Hills Reservoirs that are located at a higher HGL. A new PRV station needs to be installed between Wheeler and Intermediate service levels at Southeast Orient Drive and Southeast Barnes Road to make the dead storage in Wheeler tanks available to Intermediate level customers (project R-2-b). The third option would be installing additional storage capacity of 5.0 MG at this service level that can be used for the emergency storage deficiency in the Grant Butte service level (project R-2-c).

3. **Gabbert Service Level:** This analysis shows a minor buildout storage capacity deficiency for this service level (approximately 0.08 MG). However, this small deficiency can be managed operationally, and no additional storage capacity is recommended at this time.

4. **Wheeler Service Level:** This analysis shows a storage deficit in this service level of approximately 0.76 MG by 2050. A new 2.0 MG reservoir, the North Wheeler Reservoir (project R-3), is recommended for this service level.

5.5 Pumping Capacity Analysis

As presented in **Section 3**, the City's required pumping capacity varies depending on the water demand, volume of available gravity storage, and the number of pumping facilities serving each pressure zone. The required firm capacity is defined as a pump station's total pumping capacity with the largest pump out of service.

Existing pump stations include pumps that operate either at constant speed or through variable frequency drives (VFDs). VFDs allow the flow rate of individual pumps to be reduced, giving operations staff flexibility to meet system demands while minimizing pump cycling. The Hunters Highland pump station has one constant speed pump and one pump with a VFD; it is recommended that both pumps have VFDs. This pump station is also in need of a new motor control center (MCC) (project D-9).

The City's water distribution system consists of 10 pump stations. Two of them, the Walters and Lusted Pump Stations, are currently out of service. All active pump stations in the City's system have transfer switches to accommodate portable generators for back-up power, if needed, in an emergency. It is recommended that the Gabbert and Salquist Pump Stations be equipped with an ATS and permanent generator (project D-9).

Table 5-2 summarizes the existing and projected requirements for the City's pumping capacity. Based on the results, the City had adequate distribution system pumping capacity and no additional capacity is recommended.

Table 5-2 | Pumping Capacity Analysis

Service Level	Scenario2	Pump/Well Capacity (gpm)				Zone Type	Criteria	MDD (gpm)	PHD (gpm)	Largest Fire Flow in Zone		Required Pump Capacity (gpm)	Pump Capacity Needed (gpm)
		Zone Total 1	Number of Pumps	Largest	Backup Power					Flow Rate (gpm)	Duration (minutes)		
Grant Butte	2019	5,939			Yes	Open	MDD	3074	4962	3,500	180	3,080	0
	2020	6,804						3522	5684	3,500	180	3,530	0
	2025	7,639						3953	6378	3,500	180	3,960	0
	2030	8,073						4178	6739	3,500	180	4,180	0
	2040	9,054						4686	7554	3,500	180	4,690	0
	2050	10,459						5413	8718	3,500	180	5,420	0
Intermediate (Division St. PS, Main St. PS, Cedarville PS)	2019	12,350	7	2,200	Yes	Open	MDD	1641	2667	3,500	180	1,650	0
	2020	12,350		2,200				1879	3051	3,500	180	1,880	0
	2025	12,350		2,200				2110	3420	3,500	180	2,110	0
	2030	12,350		2,200				2230	3610	3,500	180	2,230	0
	2040	12,350		2,200				2501	4043	3,500	180	2,510	0
	2050	12,350		2,200				2,889	4,664	3,500	180	2,890	0
Wheeler (Salquist PS, Powell & Barnes PS)	2019	6,200	6	1,200	Yes	Open	MDD	577	967	3,500	180	580	0
	2020	6,200		1,200				662	1,107	3,500	180	670	0
	2025	6,200		1,200				743	1,239	3,500	180	750	0
	2030	6,200		1,200				785	1,305	3,500	180	790	0
	2040	6,200		1,200				880	1,448	3,500	180	880	0
	2050	6,200		1,200				1,017	1,663	3,500	180	1,020	0
Gabbert (Gabbert PS)	2019	1,800	4	550	Yes	Open	MDD	58	149	1,500	120	60	0
	2020	1,800		550				66	169	1,500	120	70	0
	2025	1,800		550				75	186	1,500	120	80	0
	2030	1,800		550				79	195	1,500	120	80	0
	2040	1,800		550				88	213	1,500	120	90	0
	2050	1,800		550				102	232	1,500	120	110	0
Hunters Highland (Hunters Highland PS)	2019	1,620	3	700	Yes	Open	MDD	352	617	2,500	120	360	0
	2020	1,620		700				403	700	2,500	120	410	0
	2025	1,620		700				453	778	2,500	120	460	0
	2030	1,620		700				478	816	2,500	120	480	0
	2040	1,620		700				537	912	2,500	120	540	0
	2050	1,620		700				620	1,049	2,500	120	620	0
South Hills (South Hills PS)	2019	2,675	4	1,100	Yes	Open	MDD	237	428	2,500	120	240	0
	2020	2,675		1,100				272	489	2,500	120	280	0
	2025	2,675		1,100				305	545	2,500	120	310	0
	2030	2,675		1,100				323	571	2,500	120	330	0
	2040	2,675		1,100				362	626	2,500	120	370	0
	2050	2,675		1,100				418	713	2,500	120	420	0

Notes:
1. Total pumping capacity required in Grant Butte service level is equal to the summation of the maximum day demand (MDD) for all service levels except South Shore.
2. Demand projection was based on 2019 demands, and years beyond 2019 use projected demands.

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5.6 Hydraulic Performance Analysis

5.6.1 Fire Flow Availability

A fire flow analysis was performed on the distribution system using the hydraulic model. To perform this analysis, junctions in the model that were closest to a hydrant were selected as fire flow nodes. Recommended fire flows for each fire flow junction were determined based on customer type per the criteria in the OFC, as follows.

- 1,000 gpm for single-family residential
- 2,500 gpm for medium density (multi-unit) residential
- 3,000 gpm for commercial, public, and industrial

Fire flow availability is determined at a minimum pressure of 20 psi at the flowing hydrant, and a maximum flow velocity of 8 fps and 14 fps for CI and DI mains, respectively. Additionally, the minimum allowable pressure for any junction in the distribution system during a fire flow event is 20 psi. The lowest pressure junction during a fire flow becomes the critical junction, and fire flow is limited to the maximum flow available such that the critical junction pressure does not fall below 20 psi. For this analysis, junctions at or near pump stations or reservoirs or on transmission mains were excluded, since many of these junctions have pressures below 20 psi and are located on portions of pipe that do not have customer service laterals.

Fire flow analysis was performed on the 2020, 2025, 2030, and 2040 maximum day scenario. **Figure 5-2** at the end of this section shows deficient hydrant with less than 90 percent of the required fire flow. Some of these hydrants are located on small diameter dead-end mains.

In general, fire flow deficiencies are caused by head losses in the pipes, as pumping capacity and storage are sufficient to provide fire flows. As in the 2020 fire flow analysis, most of the deficient junctions are located on small diameter (6- or 8-inch), dead-end pipes.

A series of fire flow improvement projects was developed to address identified fire flow deficiencies over the planning horizon (project FF-1 through FF-21). These projects are then prioritized based on the number of fire flow deficiencies they address and their deficiency year. FF-1 and FF-2 are the two most significant projects defined to resolve the fire flow deficiencies in downtown Gresham, and the area bounded by NW Division Street to the South and NW Hogan Road to the east, respectively. **Table 5-6** includes a complete list of these projects, and **Figure 5-3** shows their spatial distribution.

5.6.2 Low Pressures

The hydraulic model was used to identify areas with low pressure using both the existing conditions and the 2040 model for MDD. Low pressure is defined as pressures below 30 psi during PHD conditions. While there are some model junctions showing low pressure, these are generally on transmission pipelines. **Figure 5-4** shows the location of identified high and low service pressure under the existing (2020) ADD scenario.

5.6.3 Pipe Head Losses

Pipes that are too small act as a throttle and produce excess friction resulting in a loss in head pressure across the length of the pipe. This creates the need for additional pumping energy to overcome the loss and can result in low pressures. The hydraulic model showed low head losses overall.

5.7 Pipeline Renewal and Replacement Program

A regular pipeline renewal and replacement program is necessary to prevent pipe failures, which lead to expensive repairs, property damage, disruptions in service, public disturbances, water loss, and potential for water quality emergencies. As distribution systems continue to age, the rate of failures will increase, so it is important to have a system for continuing pipe replacement to avoid exorbitant future expenses when older pipes start to fail more regularly.

The AWWA recommends that utilities perform a pipe condition assessment beginning with a desktop analysis, which can be followed by a leak detection program and pipe scans, although these tend to be cost prohibitive. In 2019, the AWWA released manual M77 – Condition Assessment for Water Mains, that considers the methods of pipeline condition assessments with the intent of identifying the physical condition of pipes. The AWWA defines a condition assessment as the determination of the likelihood that an asset could fail. With this, a utility can then determine an acceptable amount of risk, while weighing level of service goals against asset lifecycle costs. This allows a utility to make more defensible decisions regarding replacing underground assets.

Th City has already begun a pipe risk assessment and has employed Echologics to physically study certain segments of pipe. Results of the Echologics tests provide the City with a time to failure estimate based on pipe material and installation date. Echologics began surveying these pipes in 2017 to allow the City to develop a replacement plan that coincided with their road repaving schedule. Starting in 2019, Echologics began studying pipes outside of the repaving areas, with the plan to study all pipes installed prior to 1980.

5.7.1 Inventory

The water service area contains approximately 240 miles of pipe. Most of the pipes are constructed of either CI or DI. Pipes range in diameter from 2-inch to 30-inch, but the majority of pipes are 6, 8, and 12-inch diameter. Pipes range in age from one year up to 77 years. **Table 5-3** and **Table 5-4** summarize the length of pipe by diameter, material, and age.

Table 5-3 | Pipe Length by Material and Installation Decade

Decade	Material	Length (miles)
1940s	Cast Iron Pipe	0.25
1950s	Cast Iron Pipe	4.2
	Ductile Iron Pipe	0.59
1960s	Cast Iron Pipe	15.84
	Ductile Iron Pipe	1.55
1970s	Cast Iron Pipe	37.97
	Ductile Iron Pipe	42
1980s	Cast Iron Pipe	1.73
	Ductile Iron Pipe	29.52
1990s	Cast Iron Pipe	0.67
	Ductile Iron Pipe	51.58
2000s	Ductile Iron Pipe	30.94
2010s	Ductile Iron Pipe	17.42
2020s	Ductile Iron Pipe	1.65
Unknown	Cast Iron Pipe	1.54
	Ductile Iron Pipe	3.34

Table 5-4 | Pipe Length by Diameter

Diameter (inches)	Length (miles)
2	0.74
3	0.01
4	11.48
6	64.95
8	85.3
10	14.12
12	35.72
14	0.99
16	15.4
18	5.73
20	5.4
24	2.72

5.7.2 Risk Analysis Strategy

The AWWA M77 manual describes the risk of failure as the product of the likelihood that a pipe will fail (Likelihood of Failure, LOF) and the consequences of that pipe failing (Consequence of Failure, COF). The pipe risk, and therefore replacement priority, is calculated as:

$$RISK = [LOF] \times [COF]$$

Water utilities must define specific parameters that affect risk, and these are determined based on data availability and system relevance. The following sections describe the parameters chosen for this analysis.

5.7.3 Likelihood of Failure Parameters

Typical LOF parameters include age, material, and leak and break history. Additional parameters that can be considered include average velocities and pressures in pipe segments. For this analysis, only the age, material, and leak/break history were considered. While the hydraulic model can be used to assign velocity and pressure scores to pipes, the scoring data already compiled by the City did not have unique identifiers that would allow a direct match with model data. Rebuilding the model from current GIS data in the future will allow the City to more easily apply hydraulic parameters to this analysis.

As previously discussed, the City contracted with Echologics to study certain pipe segments, resulting in a score of one to four, with four being those pipes with the least remaining lifetime and those with a score of one having the most remaining lifetime. If a pipe segment has a recorded leak or break, an additional point is added to the score, so that the maximum LOF score a pipe can have is five.

5.7.4 Consequence of Failure Parameters

As with the LOF category, the COF category assigns weights to different parameters that affect the consequence of a pipe failing. The COF analysis assigns a COF score based on if each pipe is part of the seismic backbone and if it serves critical customers, with a score of five indicating the greatest consequence. While additional parameters such as average flow rate and population density can further refine the analysis, these parameters were not considered at this time.

The water system's seismic backbone piping is a series of large-diameter pipes that connect critical distribution system facilities, namely reservoirs and supply sources. Backbone pipe is important as it ensures that in an extreme emergency, such as a seismic event, water is still able to be delivered to tanks and, depending on how disastrous the event is, water may still be able to reach most areas of the system. In this case, the backbone was identified as part of the seismic resiliency analysis performed in the 2016 Water System Seismic Resilience Study. These pipes will need to be hardened to withstand the Cascadia Zone Earthquake. The pipes are divided into tiers according to priority, and these tiers correspond to the COF score. More detail on the backbone piping can be found in **Appendix D**.

Pipes were identified that could affect critical customers should they break or require shut-downs for maintenance. Note that a pipe-break analysis was not included in the scope of this master plan; this analysis would show all the pipes affecting a critical customer if they were to break. For this assessment, pipes surrounding a critical customer that are likely to affect that customer were identified as the critical pipes.

5.7.5 Results Matrix

Table 5-5 shows the priority replacement level based on the LOF/COF score; pipes in 5/5 category should be prioritized for replacement first. There are currently no pipes in this category and only one pipe segment resulted in a total risk score of 20. Although there are about 30 miles of pipe that have an estimated remaining lifetime of less than zero, only less than a mile of these pipes has a known leak or break. There are about 11 miles of pipe that have a COF score of 5, but none of these pipe segments are considered at high risk of failure.

Table 5-5 | Priority Matrix

	LOF - 1	LOF - 2	LOF - 3	LOF - 4	LOF - 5
COF - 1	Lowest Priority				Medium Priority
COF - 2				Medium Priority	
COF - 3			Medium Priority		
COF - 4		Medium Priority			
COF - 5	Medium Priority				Highest Priority

This method of assessing pipe risk is intended to help the City decide which pipes to replace first. However, this is a pipe replacement program, and pipe replacements may need to occur at different times due to new leaks/breaks, repaving projects, or other City utility projects. Also, it should be noted that, over time, an increasing number of pipes will move up in priority as they age. Similarly, changes in pressure zones and flows can change the likelihood and consequence of failure for some pipes. For these reasons, it is important to update this analysis frequently.

Figure 5-5 shows the overall results of this analysis. The visual list of pipe replacement projects shows that there are often gaps in risk level or that a small section of pipe is identified as high risk. This happens because parameter points might fall close to a score cut-off range, causing one pipe to score a 5, but a neighboring pipe to score lower. When choosing high risk pipes to replace, in many cases it makes sense to replace a longer stretch of pipe as this will be less expensive than piecemeal replacement. This is another reason why this analysis should be updated frequently.

The City should aim to implement an aggressive pipe replacement program to avoid having to replace a disproportionate amount of pipe in the future as the pipes age. For this reason, it is recommended that the City aim to replace 2.4 miles of pipe per year. This is a replacement rate of about one percent of pipe per year.

5.8 Summary of Recommended Projects

Table 5-6 presents the improvements identified in this section and Plate 2 in Appendix A shows their geographic location throughout the distribution system. Note that it does not include projects identified in other sections of this master plan. Cost estimates for these projects and those identified in other sections are presented in Section 6.

Table 5-6 | Distribution System Recommendations

Project Name	Section	Project Description	Project Purpose
FF-1	5.7.1	Install 15,820 LF of 8-, 10-, 12-, 16- and 20-inch diameter pipe in Grant Butte service level between NE 20th St, NE Hogan Rd, NW Division St and NW Civic Dr	Improve fire flow
FF-2	5.7.1	Install 10,740 LF of 8-, 12- and 16-inch diameter pipe in Downtown Gresham between NE 8th St, NE Powell Blvd, NW Miller Ave and NE Cleveland Ave	Improve fire flow
FF-3	5.7.1	Install 3,700 LF of 8-inch diameter pipe between NE Hogan Dr, NE 23rd St and NE Rene Ave	Improve fire flow
FF-4	5.7.1	Install 2,660 LF of miscellaneous 8-, 10- and 12-inch diameter pipe in Grant Butte service level	Improve fire flow
FF-5	5.7.1	Install 3,880 LF of 8-inch diameter pipe in SE 1st Ave, NE Village Squire Ave, and NE 4th and 5th St	Improve fire flow
FF-6	5.7.1	Install 3,300 LF of miscellaneous 8-in diameter pipe in Intermediate service level	Improve fire flow
FF-7	5.7.1	Install 4,180 LF of 8-inch diameter pipe between SE Rene Ave and SE Francis Ave	Improve fire flow
FF-8	5.7.1	Install 3,710 LF of 8-in diameter pipe between SE Kelly Ave, SE 19th St and SE Cleveland Ave	Improve fire flow
FF-9	5.7.1	Install 1,710 LF of 8-inch diameter pipe in NE Country Club Ave	Improve fire flow
FF-10	5.7.1	Install 2,950 LF of 8-inch diameter pipe between NE Village Squire Ct and NE Palmblad Dr	Improve fire flow
FF-11	5.7.1	Install 1,660 LF of 8-inch diameter pipe in NE 17th Dr	Improve fire flow
FF-12	5.7.1	Install 2,870 LF of 8-inch diameter pipe between NW 9th St and NW 6th St	Improve fire flow
FF-13	5.7.1	Install 1,270 LF of 8-in diameter pipe in SE 23rd St	Improve fire flow
FF-14	5.7.1	Install 1,380 LF of 8-inch diameter pipe in SE 4th and 5th St	Improve fire flow
FF-15	5.7.1	Install 2,590 LF of 8-inch diameter pipe in NE 2nd St, SE 1st St, SE El Camino Dr and SE Palomia Ave	Improve fire flow
FF-16	5.7.1	Install 3,820 LF of 12-in diameter pipe in E Powell Blvd	Improve fire flow
FF-17	5.7.1	Install 620 LF of 8-in diameter pipe in SE Glacier Ave	Improve fire flow
FF-18	5.7.1	Install 1,200 LF of 8-in diameter pipe in Gabbert service level	Improve fire flow
FF-19	5.7.1	Install 2,190 LF of 8- and 12-in diameter pipe in NE 185 Dr	Improve fire flow
FF-20	5.7.1	Install 2,440 LF of 8-inch diameter pipe in SE Library Ave	Improve fire flow
FF-21	5.7.1	Install 1,940 LF of 8- and 12-in diameter pipe in SE Chase Rd	Improve fire flow
PRR-1	5.8.	Pipe Renewal and Replacement Program	Pipe renewal
D-1	5.3.3	Pleasant Valley Service Extension (PV2), Install 3,360 LF of 16-inch diameter pipe	Improve fire flow
D-2	5.3.3	Pleasant Valley Service Extension (PV3), Install 2,710 LF of 12-inch diameter pipe	Service extension
D-3-A	5.3.3	Pleasant Valley Service Extension (PV4, South Line), Install 2,560 LF of 12- and 16-inch diameter pipe	Service extension

Project Name	Section	Project Description	Project Purpose
D-3-B	5.3.3	Pleasant Valley Service Extension (PV4, North Line), Install 4,730 LF of 12- and 16-inch diameter pipe	Service extension
D-4	5.3.3	Pleasant Valley Service Extension (PV5), Install 2,310 LF of 16-inch diameter pipe	Service extension
D-5	5.3.3	Pleasant Valley Service Extension (PV6), Install 2,920 LF of 12-inch diameter pipe	Service extension
D-6	5.3.3	Pleasant Valley Service Extension (PV7), Install 5,080 LF of 12- and 16-inch diameter pipe	Service extension
D-7	5.3.3	Pleasant Valley Service Extension (PV8), Install 9,630 LF of 16-inch diameter pipe	Service extension
D-8	5.3.3	Hunters Highland Pressure Zone Expansion, Install 550 LF of 12-inch diameter pipe	Service extension
D-9	5.3.3	Spring Water Service Extension (SW1), Install 530 LF of 16-inch diameter pipe	Service extension
D-10	5.3.3	Spring Water Service Extension (SW2), Install 10,270 LF of 16-inch diameter pipe	Service extension
D-11	5.3.3	Spring Water Service Extension (SW3), Install 5,520 LF of 16-inch diameter pipe	Service extension
D-12	5.3.3	Spring Water Service Extension (SW4), Install 9,840 LF of 16-inch diameter pipe	Service extension
D-13	5.3.3	Spring Water Service Extension (SW5), Install 8,210 LF of 12- and 16-inch diameter pipe	Service extension
D-14	5.3.3	Spring Water Service Extension (SW6), Install 2,030 LF of 12-inch diameter pipe	Service extension
D-15	5.3.3	Spring Water Service Extension (SW7), Install 1,930 LF of 12-inch diameter pipe	Service extension
D-16	5.3.3	Spring Water Service Extension (SW8), Install 5,060 LF of 16-inch diameter pipe	Service extension
D-17	5.3.3	Spring Water Service Extension (SW9), Install 2,140 LF of 12-inch diameter pipe	Service extension
D-18	5.7.1	Miscellaneous Distribution System Improvements	Service extension
R-1-a	5.4.2	North Grant Butte 7 MG Reservoir	Increase storage capacity in Grant Butte pressure zone
R-2-a	5.4.2	Pleasant Valley 9 MG Reservoir	Increase storage capacity in Intermediate pressure zone
R-2-b	5.4.2	Install a PRV station between Wheeler and Intermediate PZs, at SE Orient Dr and SE Barnes Rd	Increase reliability and available storage capacity in Intermediate zone
R-2-c	5.4.2	Pleasant Valley 5 MG Reservoir	Increase storage capacity in Intermediate pressure zone
R-3	5.4.2	North Wheeler 2 MG Reservoir	Increase storage capacity in Intermediate pressure zone

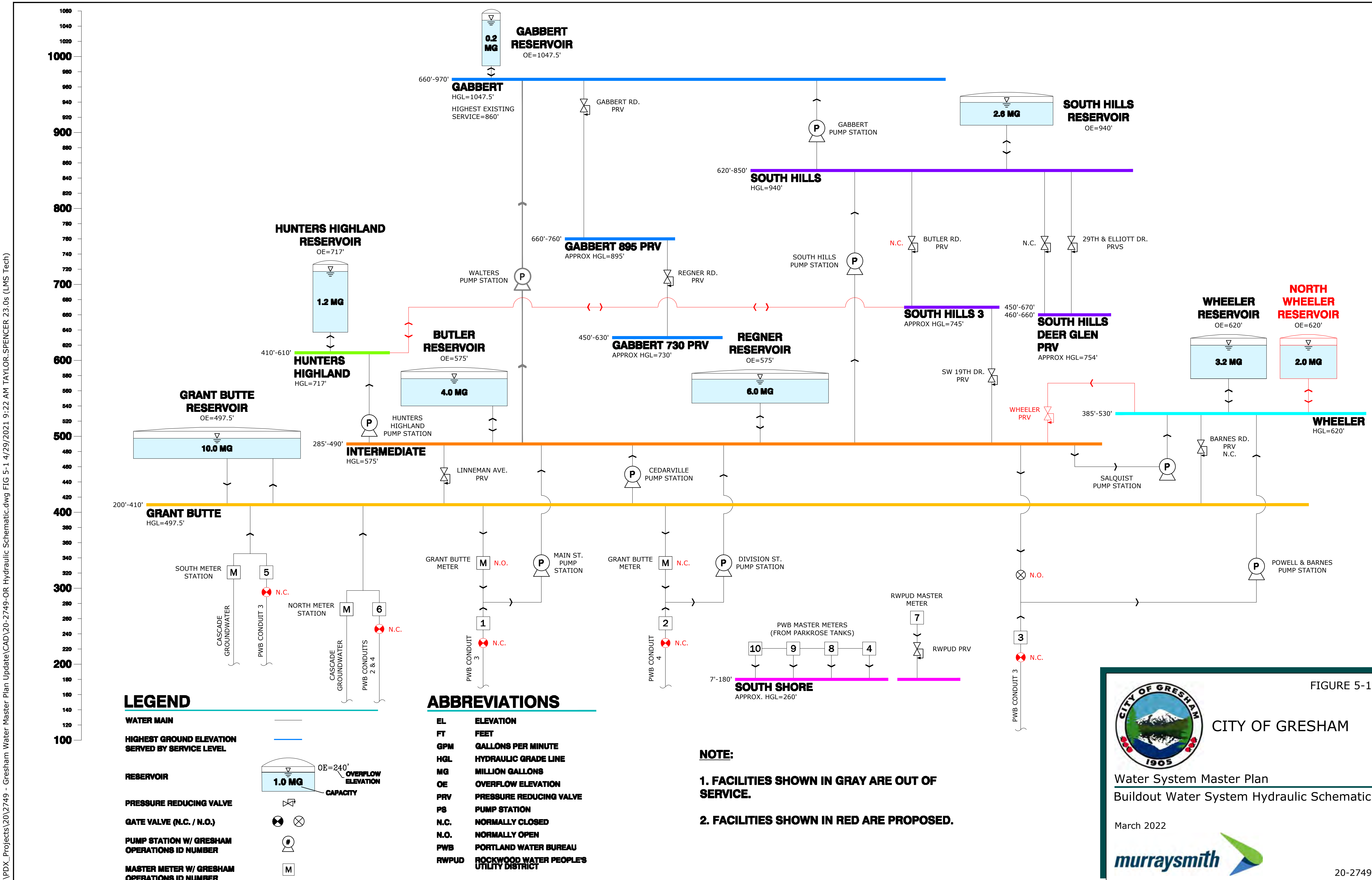

FIGURE 5-1

CITY OF GRESHAM

Water System Master Plan

Buildout Water System Hydraulic Schematic

March 2022

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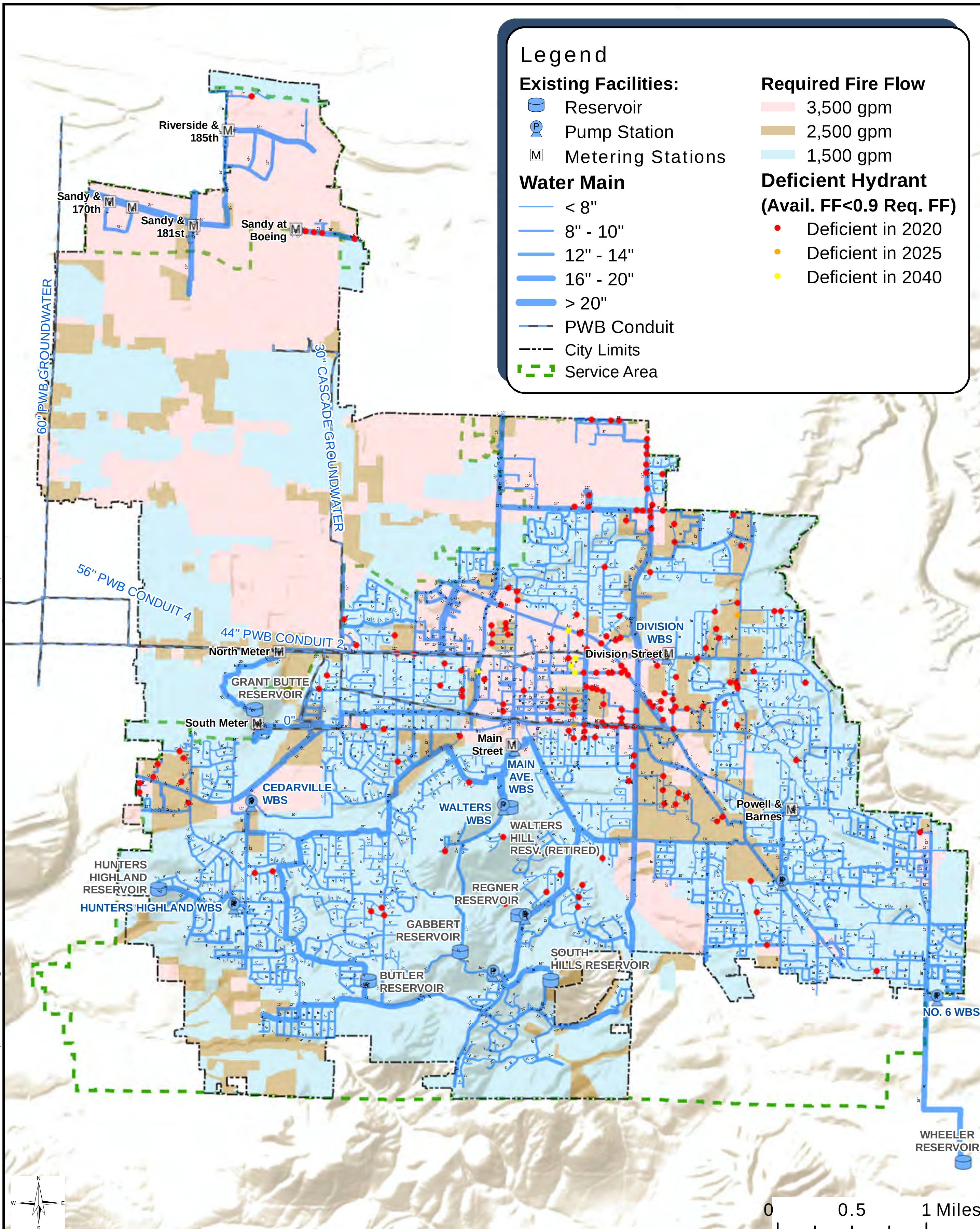
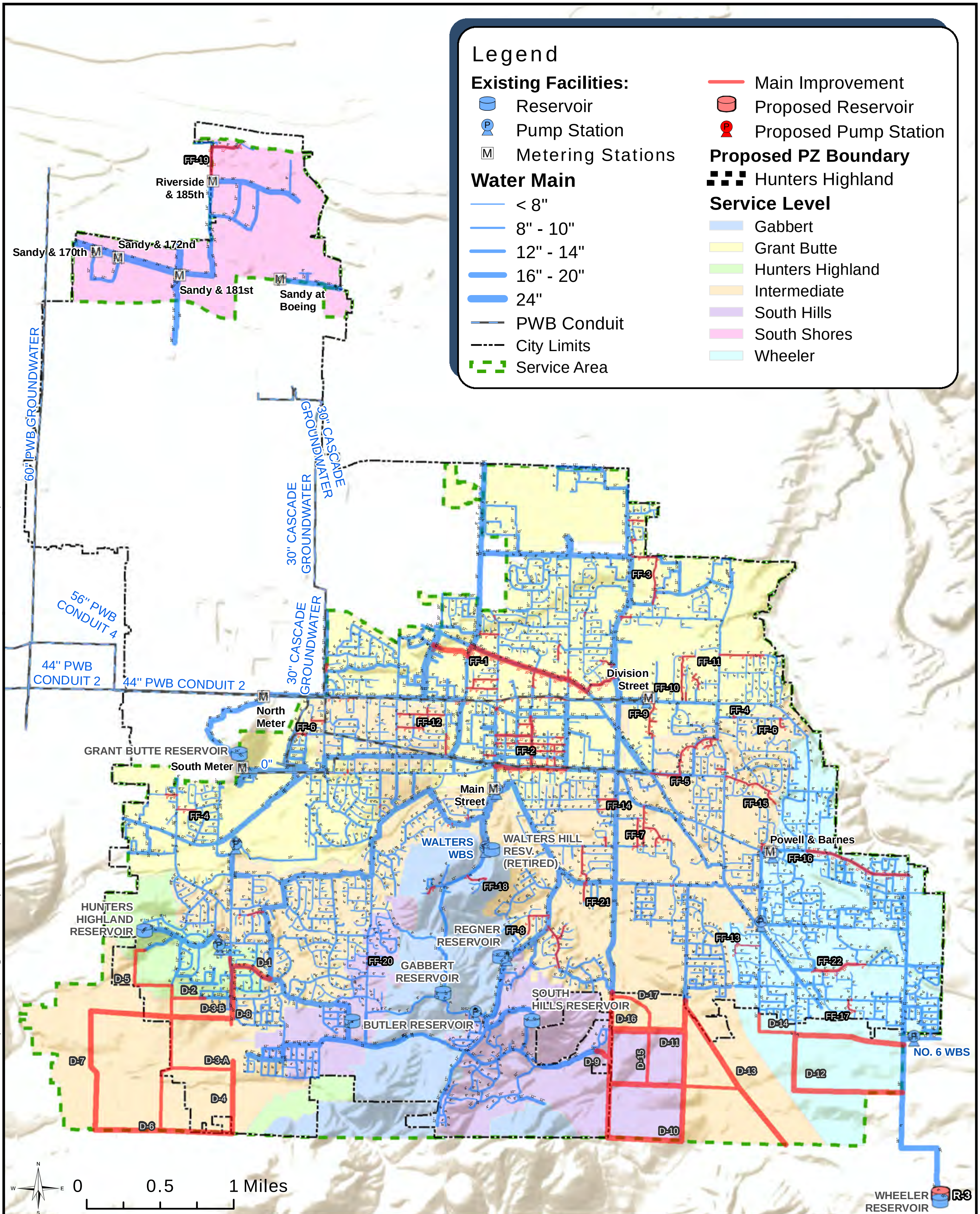


City of Gresham, Oregon
Water System Master Plan

Figure 5-2
Fire Flow Deficiencies



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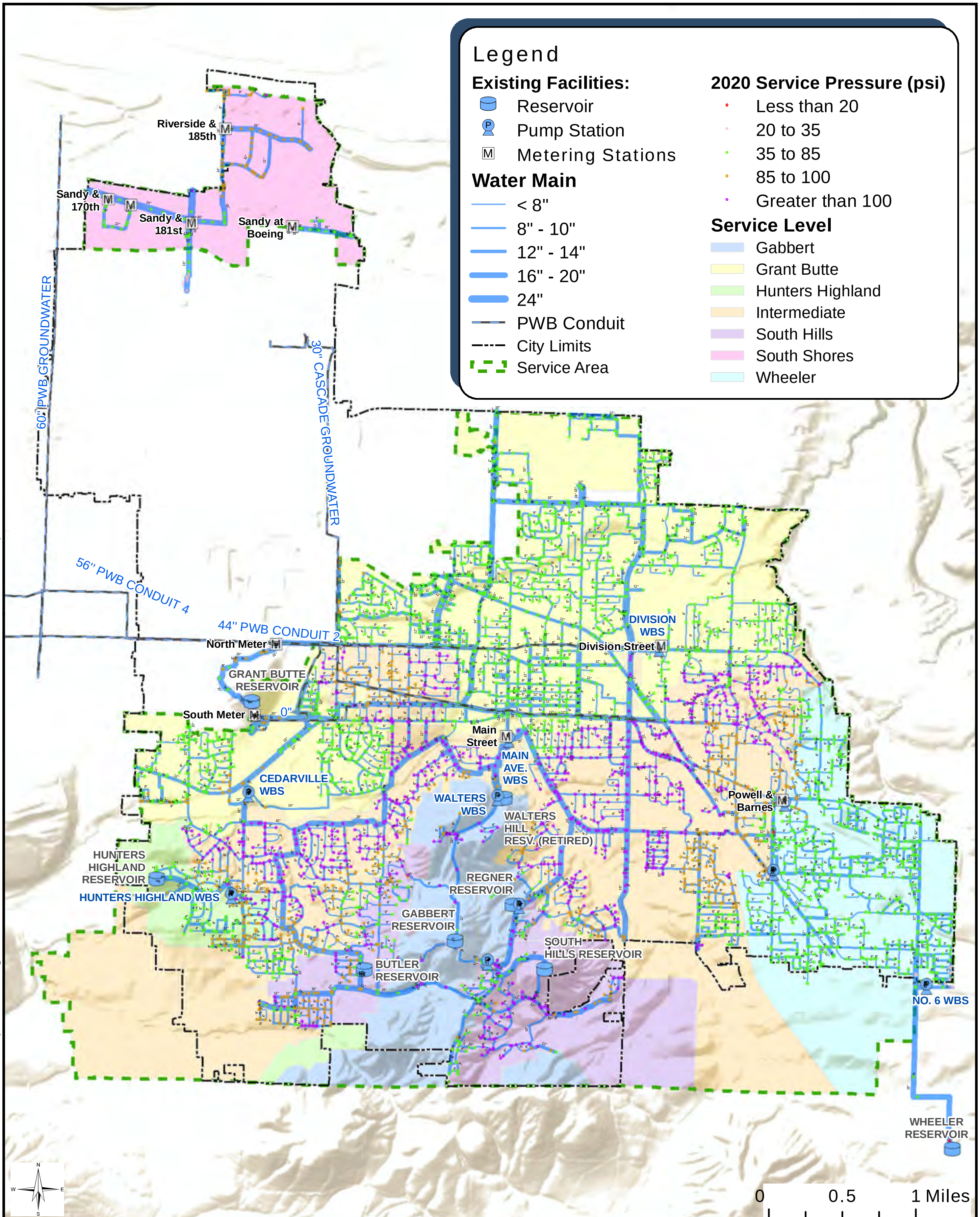
CITY OF GRESHAM 1905

City of Gresham, Oregon
Water System Master Plan

Figure 5-3
Proposed Improvement



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CITY OF GRESHAM 1905

City of Gresham, Oregon
Water System Master Plan

Figure 5-4
2020 Average Day Demand
Service Pressures

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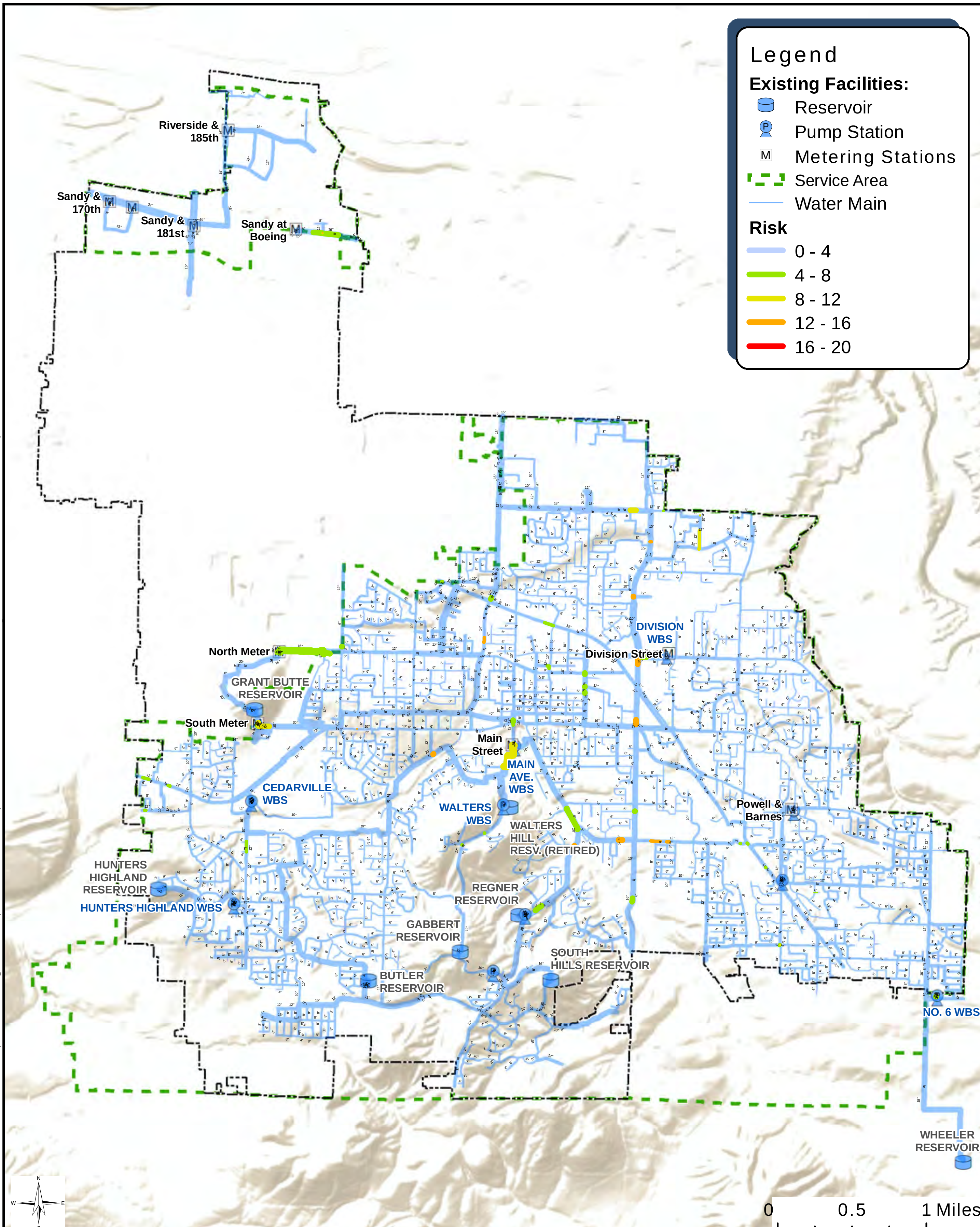

G:\PDX_Projects\20\2749 - Gresham Water Master Plan Update\GIS\Figure 5-5 Pipe Renewal And Replacement - Business Risk.mxd 4/29/2021 1:13:44 PM Amin.Mahdipour

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CITY OF GRESHAM 1905

City of Gresham, Oregon
Water System Master Plan

Figure 5-5
Pipe Renewal & Replacement Program - Replacement Priority

Section **6**

Section 6

Capital Improvement Program (CIP)

This section presents recommended improvements for the City's water system based on the analysis and findings presented in Section 4 and Section 5 and projects identified in the City's current water CIP projects list. These improvements include supply, storage reservoir, water main, and seismic resilience projects. The CIP presented in Table 6-1 at the end of this section summarizes recommended improvements and provides an approximate timeframe for each project. Appendix E contains planning level cost estimate details for each project. Proposed improvements are illustrated on Plate 2 in Appendix A.

6.1 Project Cost Estimates

An estimated project cost has been developed for each recommended improvement consistent with previously identified projects from the City's current CIP and current preliminary design work, as applicable. Cost estimates represent opinions of cost only, acknowledging that final costs of individual projects will vary depending on actual labor and material costs, market conditions for construction, regulatory factors, final project scope, project schedule, and other factors.

6.2 Timeframes

A summary of all improvement projects and estimated project costs is presented in Table 6-1. This CIP table provides for project sequencing by showing prioritized projects for the 5-year, 6 to 10-year and 11 to 20-year timeframes defined as follows.

- 5-year timeframe - recommended completion through 2026
- 6 to 10-year timeframe - recommended completion between 2027 and 2031
- 11 to 20-year timeframe - recommended completion beyond 2031

6.3 Supply

As described in Section 4, the City is currently in the process of expanding the groundwater supply system that it shares with RWPUD, with the intent of ceasing wholesale water purchases from the PWB in 2026. In order to achieve this objective and continue to provide adequate water supply to existing and future customers, a number of major capital improvements were identified in the *Groundwater Development Master Plan.* The City's share of these improvements are included in Table 6-3, with the exception of Supply Package No. 7, which will extend beyond the near-term groundwater development horizon of 2026 and represents the development of "Future Well 1" to meet the City's long-term supply needs. In addition, the cost estimates for Supply Package 7 have been updated to reflect current drilling and development costs.

In addition to the improvements required by 2026, the City will need to develop additional groundwater supply beyond 2026 to meet the needs of continued growth within the City's water service area. As described in **Section 4**, this will include the development of two additional groundwater supply wells and the corresponding infrastructure improvements for treatment and delivery of supply to the water distribution system. It is anticipated the development of the first additional supply well will begin in 2024 (described in more detail below) and the second well development will begin in 2038, approximately 5 years before the capacity is needed.

The timeline for initiating exploratory drilling for the first future well is intended to provide valuable information regarding the potential to site an additional well in close enough proximity to Cascade Well 6 to allow for the development of shared treatment facilities. For the purposes of this Master Plan CIP, it is assumed that separate treatment facilities will be required.

6.4 Storage Reservoirs

As presented in **Table 5-1**, the City currently has a deficit in storage capacity serving the Grant Butte, Intermediate, and Wheeler pressure zones[1]. Much of the existing storage volume was found to be unusable due to dead storage and reduced overflow height for seismic considerations. The existing Grant Butte, Butler, and Wheeler reservoir sites can accommodate construction of more storage facilities to address these deficiencies; however, building new reservoirs at the same level as existing reservoirs would require sizing them to accommodate large volumes of dead storage which is not ideal. The proposed solution is to consider dead storage in one service level as the emergency storage to a lower service level. This integrated solution is explained in detail in **Section 5.4.2**.

Based on demands estimated through 2050 (build-out), two new reservoirs, Pleasant Valley 5 MG Reservoir (Project R-1) and North Wheeler 2 MG Reservoir (Project R-2), are proposed to address the identified buildout storage capacity deficiencies with consideration of an integrated storage sharing solution to minimize the addition of new dead storage to the system and utilize the existing dead storage capacity within the system. A new PRV (Project R-3), at SE Orient Drive and SE Barnes Road, is also recommended to interconnect the Wheeler and Intermediate pressure zones and allow the flow of water from the higher HGL to Intermediate zone in case of emergency.

6.5 Pump Stations

As presented in **Table 5-2**, the City has adequate distribution system pumping capacity through 2050 (buildout) and no additional capacity is recommended.

[1] Storage capacity deficiency in Gabbert pressure zone considered to be minor and operationally manageable, and hence, not included here.

6.6 Distribution Mains

6.6.1 Hydraulic Performance

6.6.1.1 System Pressures

As presented in **Section 5**, hydraulic modeling of the City's water distribution system revealed few areas of low pressure. Modeled low pressures were along transmission mains with no customers served from the low-pressure lines. No improvements are recommended to raise pressures in these transmission mains.

6.6.2 Hunters Highland Pressure Zone Expansion

As described in **Section 5**, the South Hills 3 subzone and the Emerald Heights neighborhood are recommended to be integrated into the future Hunters Highland service level to mitigate the risks associated with the single supply connection at Butler Road and to provide adequate looping between the existing Hunters Highland service level and the South Hills 3 expansion area.

6.6.3 Pipeline Replacement and Renewal Program

Section 5 describes the parameters and scoring system used to prioritize pipe replacements. A systematic, planned replacement program will provide the following benefits.

- Reduced impacts to customers and the environment from unplanned pipe failures
- Reduced repair and replacement costs by performing the work proactively rather than on an emergency basis
- Reduced water loss that results from main breaks and leaks
- Reduction in claims for property damage and loss of revenues from commercial and industrial customers

It is recommended that the City aim to implement an aggressive pipe replacement program to avoid having to replace a disproportionate amount of pipe in the future as the pipes age. For this reason, it is recommended that the City aim to replace 2.4 miles of pipe per year. This is a replacement rate of about one percent of pipe per year. Pipe replacement projects should be coordinated with other City programs such as the Pavement Management Program and other utility projects to save on cost and prevent redundant work and obstruction of roadways.

6.7 Seismic Resilience

Consistent with findings and next steps in the City's water system seismic resilience study (Seismic Resilience Plan Integration TM included as Appendix D), it is recommended that the City develop a 50-year CIP to address seismic vulnerability within the water system.

6.8 Other Projects

6.8.1 Water System Master Plan Update

It is recommended that the City continue to update this WSMP every 10 years. An updated WSMP is required by the State of Oregon for a 20-year planning period. However, as the City grows, it is prudent for the City to continue to regularly evaluate capital investment, prioritize needs for the water system, and document this long-term water service strategy in the WSMP.

6.8.2 Water Management and Conservation Plan

As required by the conditions of G-16917, the City and RWPUD were required to submit a Water Management and Conservation Plan (WMCP) by April 2012, with an update required in 10 years. The next update of the jointly developed WMCP is due to the state of Oregon Water Resources Department in 2023. It is anticipated that a future update within this WSMP's 20-year planning horizon will be required in 2023.

6.8.3 Meter Replacement Program

In order to maintain the accuracy and reliability of the City's customer service meters, including the transmitters that provide the City with real-time usage data, a meter replacement program is recommended. The meter replacement program includes replacement of 16,500 meters over the first 5 years, replacing existing meters that have reached the end of their service life. After this initial replacement program is completed, all meters will be replaced on a 15-year cycle. The budget presented in the CIP reflects this level of replacement.

6.9 Cost Estimating Assumptions

All cost estimates for CIP projects presented in this Plan are planning level costs approximately equivalent to Association for the Advancement of Cost Engineering Class 5 estimates. Cost estimates of this type are classified as order-of-magnitude cost estimates, which assume a 0 to 2 percent level of project definition to reflect the significant number of unknowns in project scope and conditions. Correspondingly, Class 5 cost estimates have a wide accuracy range to reflect these uncertainties at the master planning stage; actual costs may vary from these by minus 50 percent to plus 100 percent.

- **Low End Accuracy Range**: -20 to -50 percent (i.e., the low end of the accuracy range for a $1 million cost estimate is $0.5 to $0.8 million)

- **High End Accuracy Range**: +30- to +100 percent (i.e., the high end of the accuracy range for a $1 million cost estimate is $1.3 to $2.0 million)

All costs are in 2021 dollars, and the Engineering News-Record's (ENR) U.S. 20-City Construction Cost Index for January 2021 was 11627. The estimates are subject to change as the project designs mature. The cost of labor, materials, and equipment may also vary in the future.

6.9.1 Pipeline Unit Cost Assumptions

Table 6-1 presents general assumptions for unit costs of different-sized pipelines that may be used in a CIP project.

Table 6-1 | Pipeline Unit Costs

Pipe Diameter (Inches)	Pipeline Material Cost ($/Linear Foot)	Pipeline Cost, Arterial Road, Including Resurfacing ($/Linear Foot)
8	$148	$222
10	$170	$244
12	$186	$260
16	$228	$308
20	$281	$361

Pipeline costs are for DI pipe and include reconnecting existing services and allowances for valves and fittings. Pipeline construction costs do not include property acquisition, easement, or right-of-way costs. Roadway resurfacing unit costs assume open trench construction with trench patches and do not include full street resurfacing. Where open trench construction may not be possible, individual project cost estimates were modified, as needed, to reflect costs for boring or other construction methods.

6.9.2 Direct Construction Cost Development

Direct construction costs were developed using historical project data, vendor quotes, and general market trends. Direct construction cost estimates focused on major facilities and equipment and include allowances for additional civil, mechanical, electrical, and instrumentation requirements.

6.9.3 Cost Factors

To estimate total project costs for inclusion in the CIP, cost factors were added to the direct construction cost estimates. **Table 6-2** summarizes the cost factors and provides an example of how they were applied to determine a CIP project's cost.

Table 6-2 | Cost Factors

Cost Element	Cost Factor	Cost
Direct Construction Cost		$1.00M
Mobilization, Bonds, Insurance, Shop Drawings	8%	$0.08M
Construction Cost		$1.08M
Project Contingency	30%	$0.32M
Total Construction Cost		$1.40M
Oregon Corporate Activity Tax	1%	$0.02M
Engineering Allowance	20%	$0.28M
Permitting, Inspections, and Administration	5%	$0.07M
City of Gresham Administration Fee	14%	$0.20M
Total CIP Project Cost		**$1.97M**

6.10 CIP Funding

The City may fund the water system CIP from a variety of sources including governmental grant and loan programs, publicly issued debt, and cash resources and revenue. The City's cash resources and revenue available for water system capital projects include water rate funding, cash reserves, and SDCs.

Typically used by utilities to support capital funding needs, SDCs are sources of funding generated through development and system growth. The charge is intended to recover a fair share of the costs of existing and planned facilities that provide capacity to serve new growth. Projects intended to serve new growth, such as the Pleasant Valley and Springwater Service Expansions and Pleasant Valley 5 MG Reservoir, have 100 percent of the cost allocated to growth. Other projects that are intended to improve reliability and efficiency or address asset renewal are assumed to benefit existing and new customers. For these projects, the percent allocated to growth is the percentage of future demand projected to be generated from new customers. The percentage of project costs allocated to growth are shown in **Table 6-3**.

Subsequent to the final review and approval of this WSMP, the City will conduct a financial analysis to review the current water rates and SDC methodology to support the recommended CIP described in this section.

Table 6-3 | Capital Improvement Program

Improvement Category	Project No.	Project Title	CIP Cost Summary[1]									% Allocated to Growth[2]	TOTAL Cost Allocated to Growth
			FY 2021 / 2022	FY 2022 / 2023	FY 2023 / 2024	FY 2024 / 2025	FY 2025 / 2026	5-year 2021 - 2026	6 to 10-year 2027 - 2031	11 to 20-year 2032 - 2041	TOTAL[1]		
Supply	Supply Package No. 1	Cascade Reservoir Improvements	$8,449,000	$3,621,000	-	-	-	$12,070,000	-	-	$12,070,000	27%	$3,258,900
	Supply Package No. 2	Transmission Mains	$520,000	$3,570,000	$4,580,000	-	-	$8,670,000	-	-	$8,670,000	27%	$2,340,900
	Supply Package No. 4	Cascade Site Improvements	-	$1,030,000	$5,520,000	$10,480,000	-	$17,030,000	-	-	$17,030,000	27%	$4,598,100
	Supply Package No. 5	Cascade Well No. 6	-	$720,000	$4,160,000	$3,800,000	-	$8,680,000	-	-	$8,680,000	27%	$2,343,600
	Supply Package No. 6	Cascade Well No. 9	$500,000	$2,410,000			-	$2,910,000	-	-	$2,910,000	27%	$785,700
	Supply Package No. 7	*Future Well 1*	-	-	$500,000	-	-	$500,000	$7,850,000	-	$8,350,000	100%	$8,350,000
	Supply Package No. 8	North Meter Station	-	$500,000	$3,000,000	-	-	$3,500,000	-	-	$3,500,000	27%	$945,000
	Supply Package No. 9	Columbia South	-	-	$430,000	$3,130,000	-	$3,560,000	-	-	$3,560,000	27%	$890,000
	Future GW Supply	*Future Well 2*	-	-	-	-	-	-	-	$8,350,000	$8,350,000	100%	$5,793,000
		Supply Subtotal	**$9,469,000**	**$11,851,000**	**$18,190,000**	**$17,410,000**	**-**	**$56,920,000**	**$7,850,000**	**-**	**$64,770,000**		**$23,512,200**
Storage	R-1	Pleasant Valley 5MG Reservoir	-	-	$660,000	$1,981,000	$1,320,000	$3,961,000	$9,241,000	-	$13,202,000	100%	$13,202,000
	R-2	Wheeler North 2MG Reservoir	-	-	-	-	-	-	-	$5,173,000	$5,173,000	100%	$5,173,000
	R-3	Install a PRV station between Wheeler and Intermediate PZs, at SE Orient Dr and SE Barnes Rd	-	-	-	-	-	-	$412,000	-	$412,000	100%	$412,000
		Storage Improvements Subtotal	**-**	**-**	**$660,000**	**$1,981,000**	**$1,320,000**	**$3,961,000**	**$9,653,000**	**$5,173,000**	**$18,787,000**		**$18,787,000**
Fire Flow	FF-1	Install 15,820 LF of pipe to improve fire flow in Grant Butte	$1,703,000	$1,703,000	$1,703,000	$1,703,000	$1,703,000	$8,515,000	-	-	$8,515,000	27%	$2,299,050
	FF-2 through FF-22	Install 58,810 LF of pipe to improve fire flow	-	-	-	-	-	-	$9,020,000	$18,040,000	$27,060,000	27%	$7,306,200
		Fire Flow Improvements Subtotal	**$1,703,000**	**$1,703,000**	**$1,703,000**	**$1,703,000**	**$1,703,000**	**$8,515,000**	**$9,020,000**	**$18,040,000**	**$35,575,000**		**$9,605,250**
Distribution Mains[3]	D-1	Pleasant Valley Service Extension (PV2, partial) Install 3,360 LF of 16-inch diameter pipe	$2,204,000	-	-	-	-	$2,204,000	-	-	$2,204,000	100%	$2,204,000
	D-2	Pleasant Valley Service Extension (PV3) Install 2,710 LF of 12-inch diameter pipe	-	-	-	-	-	-	$1,358,000	-	$1,358,000	100%	$1,358,000
	D-3A	Pleasant Valley Service Extension (PV4 South) Install 2,360 LF of 12-in and 300 LF of 16-inch diameter pipe	$193,000	$193,000	$193,000	$193,000	$193,000	$965,000	-	-	$965,000	100%	$965,000
	D-3B	Pleasant Valley Service Extension (PV4 North) Install 2,540 LF of 12-in and 2,190 LF of 16-inch diameter pipe	-	-	-	-	-	-	$1,913,000	-	$1,913,000	100%	$1,913,000
	D-4	Pleasant Valley Service Extension (PV5) Install 2,310 LF of 16-inch diameter pipe	-	-	-	-	-	-	$1,040,000	-	$1,040,000	100%	$1,040,000
	D-5	Pleasant Valley Service Extension (PV6) Install 2,920 LF of 12-inch diameter pipe	-	-	-	-	-	-	-	$1,069,000	$1,069,000	100%	$1,069,000
	D-6	Pleasant Valley Service Extension (PV7) Install 2,480 LF of 12-in and 2,600 LF of 16-inch diameter pipe	-	-	-	-	-	-	-	$2,076,000	$2,076,000	100%	$2,076,000

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Improvement Category	Project No.	Project Title	CIP Cost Summary[1]									% Allocated to Growth[2]	TOTAL Cost Allocated to Growth
			FY 2021 / 2022	FY 2022 / 2023	FY 2023 / 2024	FY 2024 / 2025	FY 2025 / 2026	5-year 2021 - 2026	6 to 10-year 2027 - 2031	11 to 20-year 2032 - 2041	TOTAL[1]		
Distribution Mains[3]	D-7	Pleasant Valley Service Extension (PV8) Install 9,630 LF of 16-inch diameter pipe	-	-	-	-	-	-	-	$4,319,000	$4,319,000	100%	$4,319,000
	D-8	Hunters Highland Pressure Zone Expansion (HH1) Install 550 LF of 12-inch diameter pipe	-	-	-	-	$207,000	$207,000	-	-	$207,000	100%	$207,000
	D-9	Springwater Service expansion (SW1) Install 530 LF of 16-inch diameter pipe	-	-	-	-	-	-	-	$241,000	$241,000	100%	$241,000
	D-10	Springwater Service expansion (SW2) Install 10,270 LF of 16-inch diameter pipe	-	-	-	-	-	-	-	$4,606,000	$4,606,000	100%	$4,606,000
	D-11	Springwater Service expansion (SW3) Install 5,520 LF of 16-inch diameter pipe	-	-	-	-	-	-	-	$2,477,000	$2,477,000	100%	$2,477,000
	D-12	Springwater Service expansion (SW4) Install 9,840 LF of 16-inch diameter pipe	-	-	-	-	-	-	-	$4,415,000	$4,415,000	100%	$4,415,000
	D-13	Springwater Service expansion (SW5) Install 2,030 LF of 12-in and 6,180 LF of 16-inch diameter pipe	-	-	-	-	-	-	-	$3,514,000	$3,514,000	100%	$3,514,000
	D-14	Springwater Service expansion (SW6) Install 2,030 LF of 12-inch diameter pipe	-	-	-	-	-	-	-	$746,000	$746,000	100%	$746,000
	D-15	Springwater Service expansion (SW7) Install 1,930 LF of 12-inch diameter pipe	-	-	-	-	-	-	-	$709,000	$709,000	100%	$709,000
	D-16	Springwater Service expansion (SW8) Install 5,060 LF of 16-inch diameter pipe	-	-	-	-	-	-	-	$2,274,000	$2,274,000	100%	$2,274,000
	D-17	Springwater Service expansion (SW9) Install 2,140 LF of 12-inch diameter pipe	-	-	-	-	-	-	-	$784,000	$784,000	100%	$784,000
		Distribution System Improvements Subtotal	**$2,397,000**	**$193,000**	**$193,000**	**$193,000**	**$400,000**	**$2,682,000**	**$3,947,000**	**$27,230,000**	**$33,859,000**		**$33,859,000**
Pipeline Renewal and Replacement Program Subtotal	PRR-1	Pipeline Renewal and Replacement Program	-	-	-	-	$4,338,000	$4,338,000	$21,690,000	$43,380,000	$69,408,000	0%	$0
		Pipeline Renewal and Replacement Program Subtotal	**-**	**-**	**-**	**-**	**$4,338,000**	**$4,338,000**	**$21,690,000**	**$43,380,000**	**$69,408,000**		**$0**
Seismic Resilience	E-1	Seismic Improvements - Gabbert Inlet/Outlet Piping (P-2, partial)	$575,000	-	-	-	-	$575,000	-	-	$575,000	27%	$144,000
	E-2	Seismic Improvements - Division PS (PS-2)	-	$380,000	-	-	-	$380,000	-	-	$380,000	27%	$95,000
	E-3	Seismic Improvements - South Hills Inlet/Outlet Piping (P-2, partial)	-	-	$1,140,000	-	-	$1,140,000	-	-	$1,140,000	27%	$285,000
	E-4	Seismic Improvements - Regner Reservoir (R-4)	-	-	-	-	$1,011,000	$1,011,000	-	-	$1,011,000	27%	$253,000
	E-5	Seismic Improvement - Mid-term Projects	-	-	-	-	-	-	$1,877,000	$3,754,000	$5,631,000	27%	$1,408,000
		Seismic Resilience Improvements Subtotal[4]	**$575,000**	**$380,000**	**$1,140,000**	**$0**	**$1,011,000**	**$3,106,000**	**$1,877,000**	**$3,754,000**	**$8,737,000**		**$2,359,000**
Other Projects	M-1	Meter Replacement Program	$1,337,000	$1,337,000	$1,337,000	$1,337,000	$1,337,000	$6,685,000	$2,228,000	$4,455,000	$13,368,000	0%	$0
	W-1	Water Management and Conservation Plan	-	-	$50,000	-	-	$50,000	-	$50,000	$100,000	27%	$27,000
	W-2	Water System Master Plan Update	-	-	-	-	-	-	-	$400,000	$400,000	27%	$108,000
	D-18	Miscellaneous Distribution System Improvements[3]	$138,000	$138,000	$138,000	$138,000	$138,000	$690,000	-	-	$690,000	27%	$186,300
		Other Projects Subtotal	**$1,475,000**	**$1,475,000**	**$1,525,000**	**$1,475,000**	**$1,475,000**	**$7,375,000**	**$2,228,000**	**$4,905,000**	**$14,558,000**		**$321,300**
Total			**$15,619,000**	**$15,602,000**	**$23,411,000**	**$22,762,000**	**$10,247,000**	**$86,897,000**	**$56,265,000**	**$102,482,000**	**$245,694,000**		**$788,443,750**

Notes:
1. All costs in 2021 dollars and include all soft costs including 14% City administration fee
2. Percentage based on MDD from 2020 compared to MDD in 2040
3. Includes Butler remote operated PRV, generator and ATS at Gabbert PS and Salquist PS, MCC and VFD at Hunters Highland PS
4. Includes projects identified in Seismic Resilience Plan Integration.

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Appendix