Clackamas River Water

South System

PWSID: 4100594

Water System Master Plan

FINAL | APRIL 2019

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Clackamas River Water

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Water System Master Plan

SOUTH SYSTEM

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Abbreviations

%	Percent
CRW	Clackamas River Water
AC	Asbestos Cement
ADD	Average Day Demand
ALA	American Lifelines Association
ASR	Aquifer Storage and Recovery
BPS	Booster Pump Station
Carollo	Carollo Engineers, Inc.
CIP	Capital Improvement Program
City	City of Oregon City
County	Clackamas County
CRW	Clackamas River Water District
CRWSC	Clackamas Regional Water Supply Commission
CSZ	Cascadia Subduction Zone
CT	(Chlorine) Contact Time
DIP	Ductile Iron Pipe
DOGAMI	Department of Geology and Mineral Industries
DSL	Distribution System Leakage
EHU	Equivalent Household Unit
ENR	Engineering News Report
EPA	Environmental Protection Agency
ERU	Equivalent Residential Unit
Filter Plant	Clackamas River Filter Plant
fps	feet per second
ft	feet
gal	gallons
gpm	Gallons Per Minute
HGL	Hydraulic Grade Line
HOPP Area	Holcomb-Outlook-Park Place Health Hazard Area
hp	horsepower
IBC	International Building Code
ISO	Insurance Services Office
LF	linear foot
LOS	Level of Service
MDD	Maximum Day Demand
Metro	Oregon Metro Research Center

MFR	Multi-Family Residential
MG	million gallons
mgd	million gallons per day
MJA	McMillan Jacobs Associates
MMD	Maximum Monthly Demand
Mt. Scott	Mt. Scott Water District
MWD	Maximum Week Demand
NCCWC	North Clackamas County Water Commission
O&M	Operations and Maintenance
Oak Lodge	Oak Lodge Water District
OAR	Oregon Administrative Rules
OHA	Oregon Health Authority
OLWD	Oak Lodge Water District
ORP	Oregon Resilience Plan
OSSC	Oregon Structural Specialty Code
OSSPAC	Oregon Seismic Safety Advisory Committee
Otty North	Otty Reservoir North
OWRD	Oregon Water Resources Department
PF	Peaking Factor
PGA	Peak Ground Acceleration
PGD	Permanent Ground Deformation
PGV	Peak Ground Velocity
PHD	Peak Hour Demand
Plan	Water System Master Plan
PLC	Programmable Logic Controller
PRV	Pressure Reducing Valves
PS	Pump Station
psi	pounds per square inch
psig	pounds per square inch gauge
RUL	Remaining Useful Life
RWSA	Retail Water Service Area
SCADA	Supervisory Control and Data Acquisition
SDWA	Safe Drinking Water Act
SFR	Single-Family Residential
SFWB	South Fork Water Board
SWA	Sunrise Water Authority
TM	Technical Memorandum

VFD	Variable Frequency Drive
West Yost	West Yost and Associates
WMCP	Water Management and Conservation Plan
WTP	Water treatment plant
WSMP	Water System Master Plan

EXECUTIVE SUMMARY – SOUTH SYSTEM

ES.1 Introduction

This Water System Master Plan (Plan) updates Clackamas River Water's (CRW) former Water System Plan, and was developed as a joint effort between CRW staff and Carollo Engineers, Inc. This Plan is associated with the following Public Works System Identification (PWSID) number: CRW South (Clairmont) – 4100594.

This Plan encompasses a 20-year planning horizon from 2019 through 2038. Analysis in this Plan is divided up into a ten (10) year short-term planning period from 2019 through 2028, and a ten (10) year long-term planning period from 2029 through 2038. These timeframes are estimates. Depending on the application process, project work, and available funding, the timing may change.

In accordance with Chapter 333-061 of the Oregon Administrative Rules, Oregon Health Authority (OHA) requirements and considering all other jurisdictions within CRW, this Plan:

- Considers past studies, reports, agreements, and other data concerning the water system.
- Develops an inventory of CRW's existing water system and infrastructure.
- Develops demographic and demand analysis to project future demands within CRW's service area.
- Verifies that CRW's policies and criteria, which the system will be evaluated with, comply with OHA standards.
- Evaluates current and future water resources to identify water supply improvements and potential deficiencies.
- Evaluates the existing distribution system using CRW's updated hydraulic model and develop improvements for identified deficiencies.
- Develops a Seismic Resilience Plan outlining recommended improvements for supply, pumping, storage, and the distribution systems.
- Develops a CIP outlining recommended system improvements to deliver the Level of Service (LOE) required, and programs with planning level cost estimates and schedules within the twenty year planning period.

As shown in Figure ES.1, CRW's South System is surrounded in the north by the Clackamas River and the City of Happy Valley, in the northwest by the City of Gladstone, and in the west by the City of Oregon City. The majority of CRW's south service area including the southerly and easterly boundaries is within unincorporated Clackamas County.

CRW's South System encompasses approximately 29.4 square miles and is located southeast of Portland, as shown in Figure 1.1. Its service area is more sparsely populated, rural, and residential than the North System's service area. Per the Metro Published Projections, the South System provided about 1.6 million gallons of water per day to approximately 5,000 accounts and approximately 2,100 employees in 2015.

The South System purchases water at a wholesale rate from the South Fork Water Board (SFWB).

Figure ES.1 shows the following boundaries with the neighboring water agencies:

- Planning Area: the area CRW expects to serve by the end of this Plan's planning horizon (2038).
- Service Area: future, long-term area that CRW may serve beyond 2039.

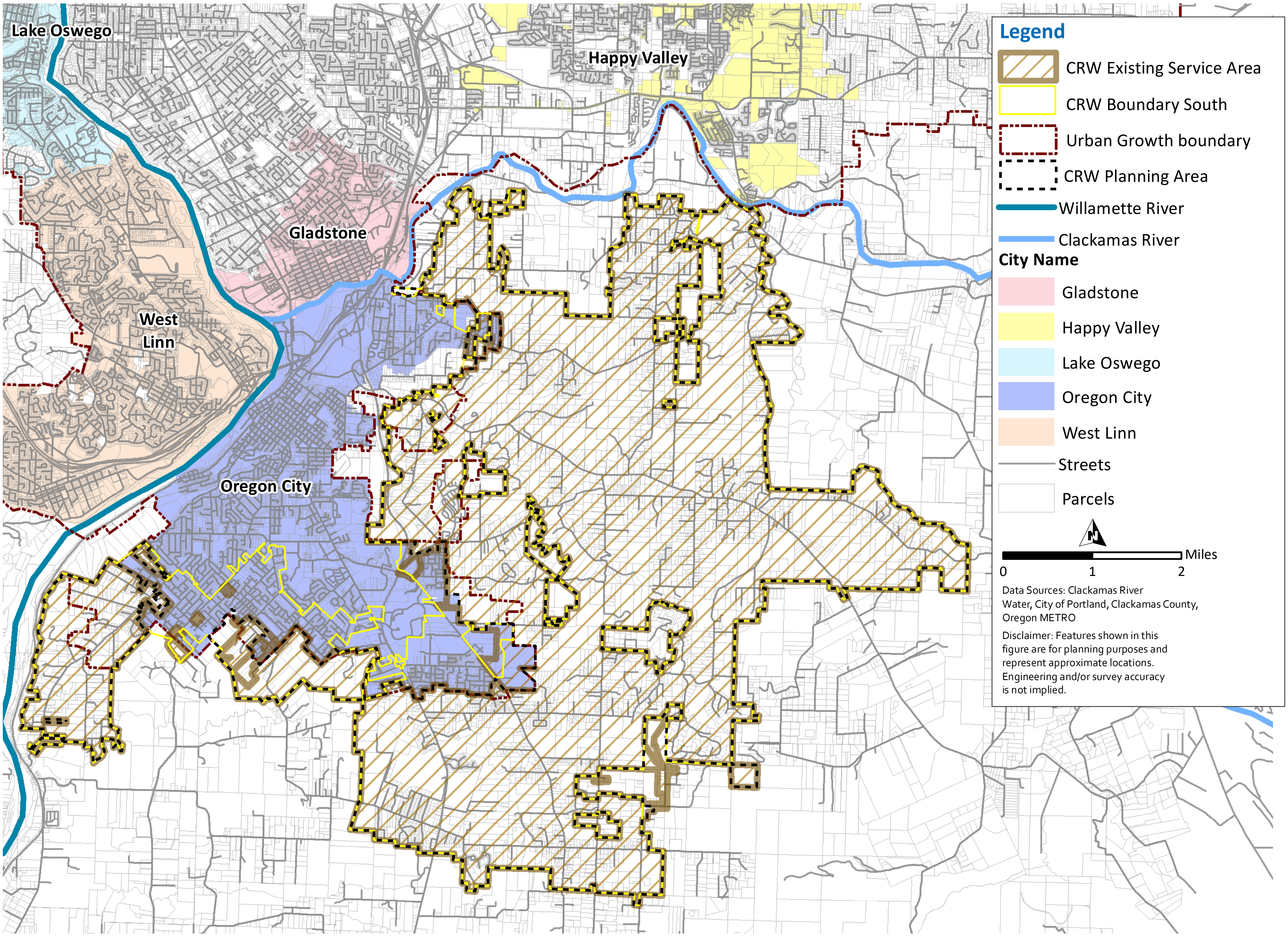

Figure ES.1 CRW Existing Service Area and Neighboring Cities - South System

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ES.2 Existing Water System

This Plan describes each of CRW's water system infrastructure assessed during the site visit and presents a remaining useful life analysis of its water mains.

To account for the topography of Clackamas River Water's (CRW) South System, the water system consists of six individual pressure zones, nine storage facilities, and seven booster pump stations (PS) within the 29.4 square miles of CRW's South System service area. CRW's pressure zones and water system facilities in the South System are shown on Figure ES.2.

CRW's water treatment plant provides water supply to only the North System. Water to the South System is provided from South Fork Water Board (SFWB). CRW is in the process of constructing a backbone with the intent to hydraulically connect the North System with the South System. After completion of both phases of the backbone, CRW's water treatment plant will serve most of CRW customers. There are also some customers who are served through the Oregon City System which will require CRW to continue to purchase some amount of water from both OC and SFWB even after the Backbone project is complete. The hydraulic profile shown in Figure ES.3 shows how the various components of the water system work together to provide water service to every customer.

The South System consists of one (Hunter Heights) hydraulically disconnected system. This Plan focuses on the Holcomb/Barlow Crest/Hunter Heights, and Redland/Beavercreek/Henrici systems during the analysis.

- The Holcomb/Barlow Crest/Hunter Heights system is in the northern portion of the system, close to the Clackamas River, and is served by the South Fork Water Board (SFWB) by wheeling water through the Oregon City distribution system to the Forsythe Master Meter and Hunter Avenue Pump Station. To serve the Barlow Crest connections, water is wheeled through a combination of CRW and Oregon City facilities consisting of the Hunter Avenue Pump Station, Holcomb Blvd. 16-inch transmission main and the Barlow Crest Reservoir. From the Barlow Crest Reservoir, CRW serves the Holcomb and Hunter Heights pressure zones.
- The Redland/Beavercreek/Henrici system contains most of the South System and is served by SFWB at the Anchor Way connection.
- The South End and Meyers connections are two small service areas located south of Oregon City and are served from water wheeled through Oregon City's system.
- There are some CRW customers considered "joint users" who are served from water purchased from Oregon City and served through Oregon City's distribution system.

Booster pump stations deliver water from areas of lower elevation to areas of higher elevation, typically from one pressure zone to another. CRW owns, operates, and maintains six pump stations in the South Service Area.

Water distribution systems rely on stored water to help equalize daily fluctuations between supply and demand to supply sufficient water for firefighting and meet demands during an emergency or an unplanned outage of a major supply source.

The South service area of CRW's water system has nine reservoirs at six different sites with a combined total capacity of 8.5 million gallons (MG), include volume at Barlow Crest Reservoir.

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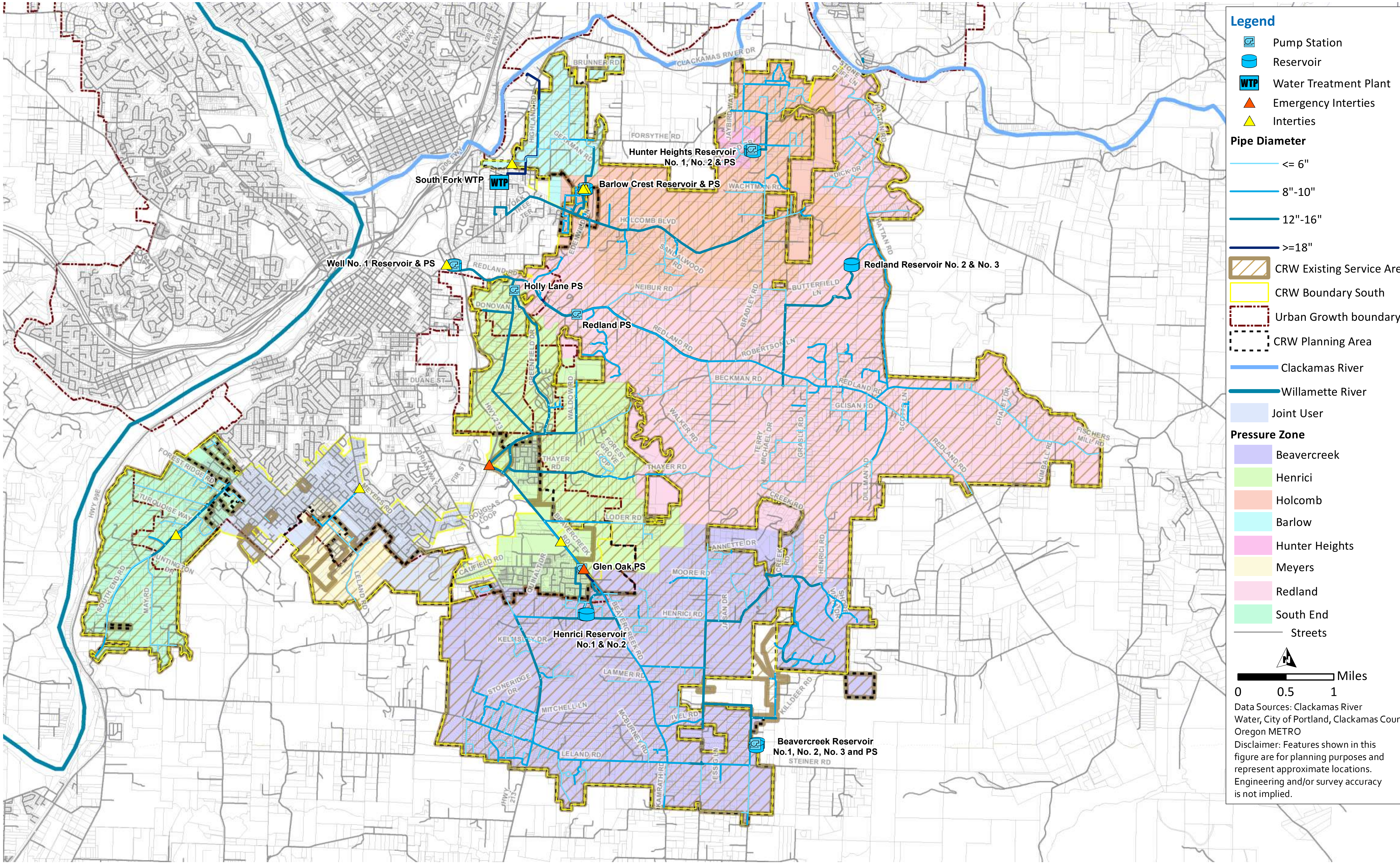

Figure ES.2 CRW Existing System and Facilities - South System

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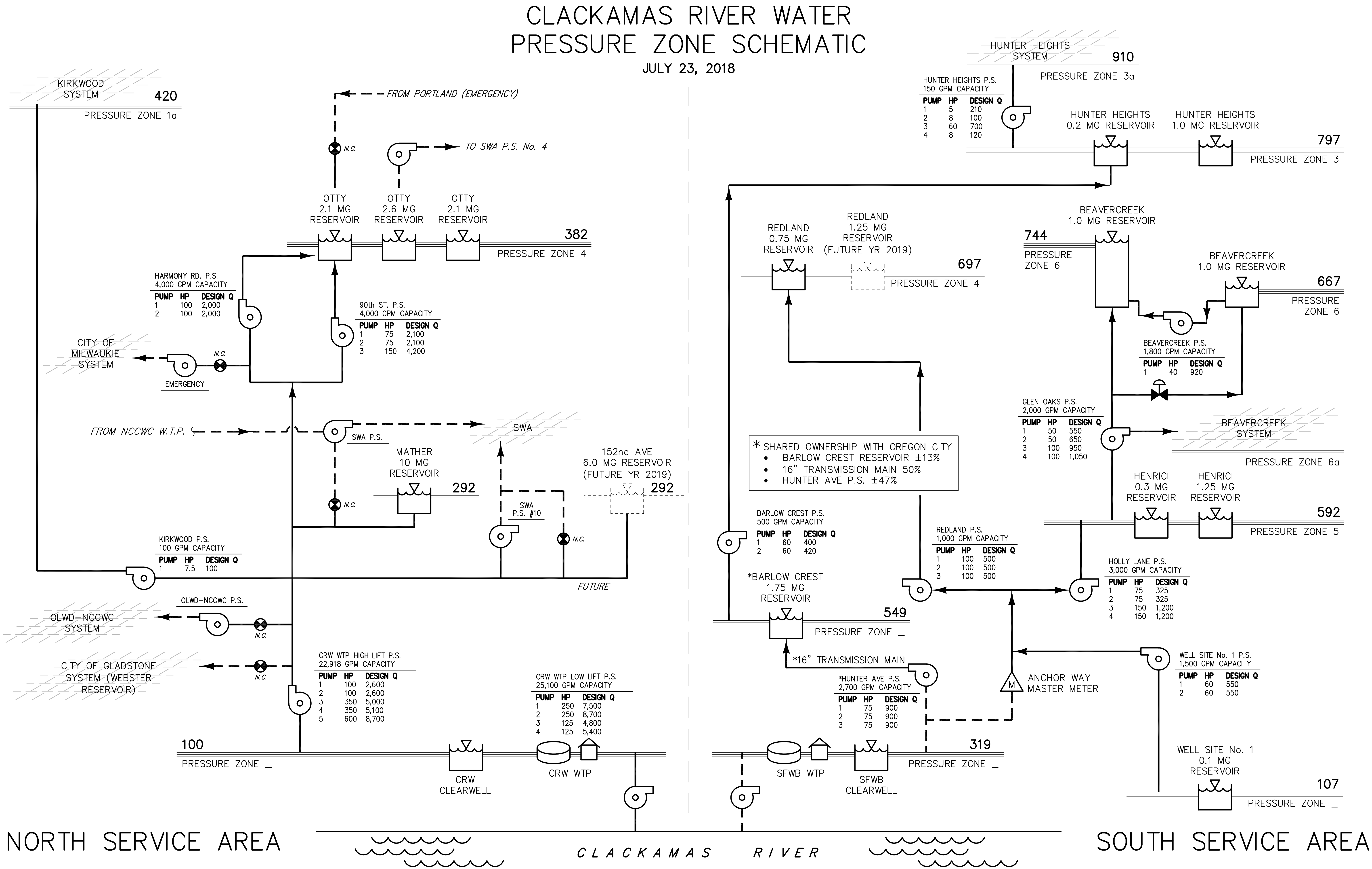

Figure ES.3 Hydraulic Profile (South System)

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CRW maintains thorough asset records of pipe material, length, and installation year for over 99 percent of the water mains in its distribution system. During this Plan, a remaining useful life (RUL) analysis was performed. The length of time a pipe is anticipated to remain functional after installation is called the useful life. Useful life depends largely on the pipe material, but can also depend on soil conditions, water constituents, and installation. Theoretically, when a pipe is in service beyond its useful life, the increasing costs of maintenance associated with a failing pipe are too high to justify continued maintenance, and thus justify replacement instead. Although pipe age and material were the only factors used for this remaining useful life analysis, it provides a foundation for long-range planning.

According to Table ES.1, within the 20-year planning period, CRW should prepare to replace approximately 103,700 feet of pipe that will reach the end of its useful life. To accomplish this, CRW will need to replace approximately 9,110 feet of pipe between 2019 and 2028 and approximately 1,260 feet of pipe per year between 2029 and 2038.

Figure ES.4 shows the number of feet of water main that will reach the end of its useful life during each year replacement period for the next 100 years. As the chart shows, a small portion of the system's water main (16 percent) will reach the end of its useful life by 2039. A majority of the mains in the system will not need to be replaced until after 2075. Nearly 350,900 LF of water main, on average, will reach the end of its useful life annually between 2075 through 2120. The leakage records were updated by CRW and used to prioritize pipelines to include in the program under both short- and long-terms, and the results from the remaining useful life are illustrated in Figure ES.5.

Table ES.1 Linear Feet of Pipe by Material and Installation Decade – South System

	Total Length (ft) by Decade Installed								
Material Type	Unknown	1959-1963	1964-1968	1969-1978	1979-1988	1989-1998	1999-2008	2009-2018	Total (ft)
Ductile Iron	132			21,313	46,495	110,079	147,019	27,452	352,491
Cast Iron	22	5,804	1,884	172,087	22,133	11			201,942
Copper	324				41	2,104	1,112	16	3,597
Galvanized Pipe		836		1,164	529				2,529
Steel		77,522		4,230	346	22			82,120
PVC					1,378	1,202		682	3,262
Asbestos-Cement		12,753		1,384					14,137
Unknown	1,361	33							1,394
Total Length (ft)	**1,838**	**96,949**	**1,884**	**200,179**	**70,922**	**113,418**	**148,132**	**28,150**	**661,472**
Percent of Total System (%)	**0.3%**	**14.7%**	**0.3%**	**30.3%**	**10.7%**	**17.1%**	**22.4%**	**4.3%**	**100.0%**

Notes on Color coding:

1. Red: Pipeline is past its remaining useful life.
2. Orange: Pipeline will reach its remaining useful life between 2019 and 2028.
3. Yellow: Pipeline will reach its remaining useful life between 2029 and 2038.
4. Purple: Pipeline will reach its remaining useful life between 2039 and 2048.
5. Light Gray: Pipeline will reach its remaining useful life after 2048.

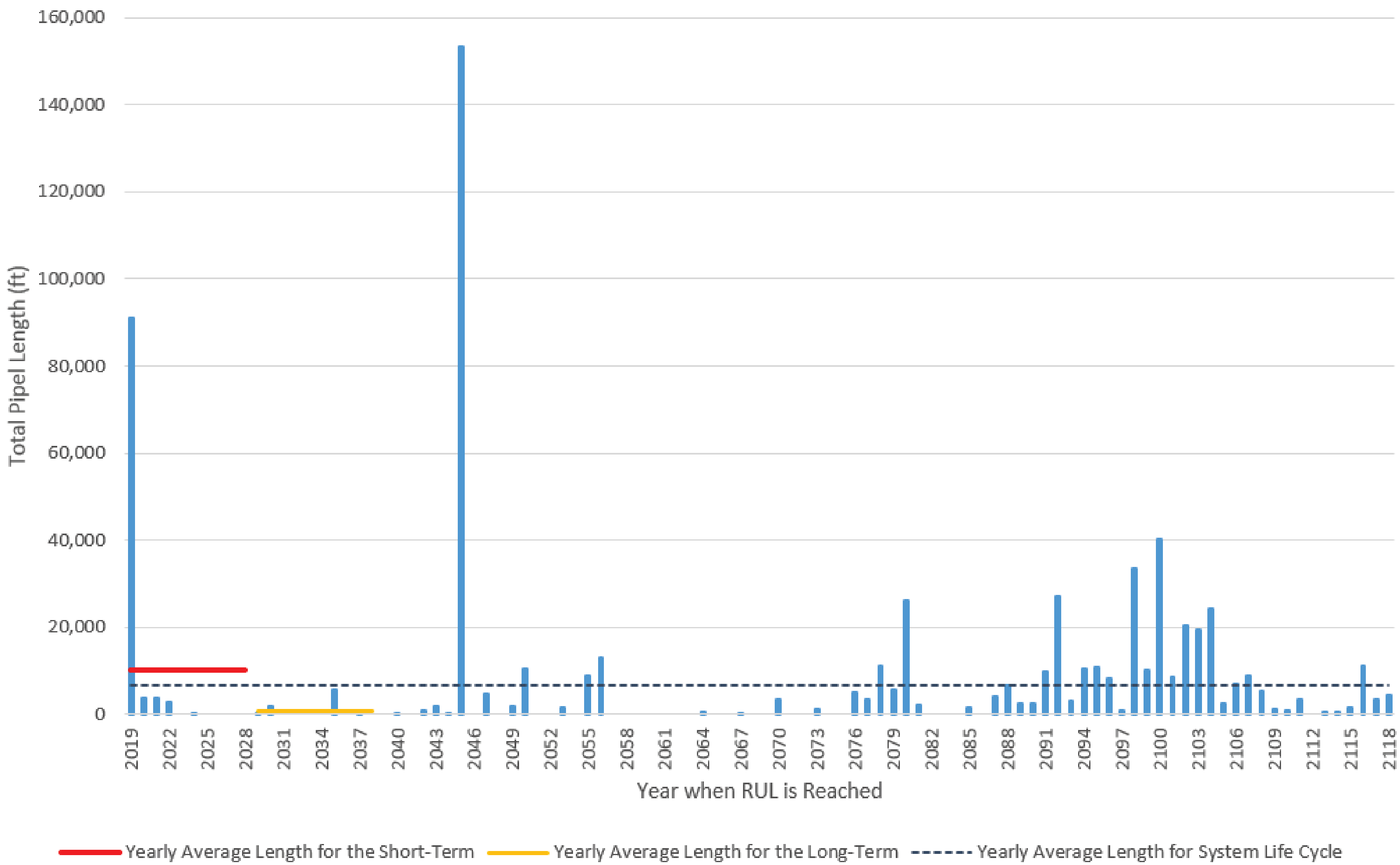

Figure ES.4 Water Main Replacement Schedule Chart

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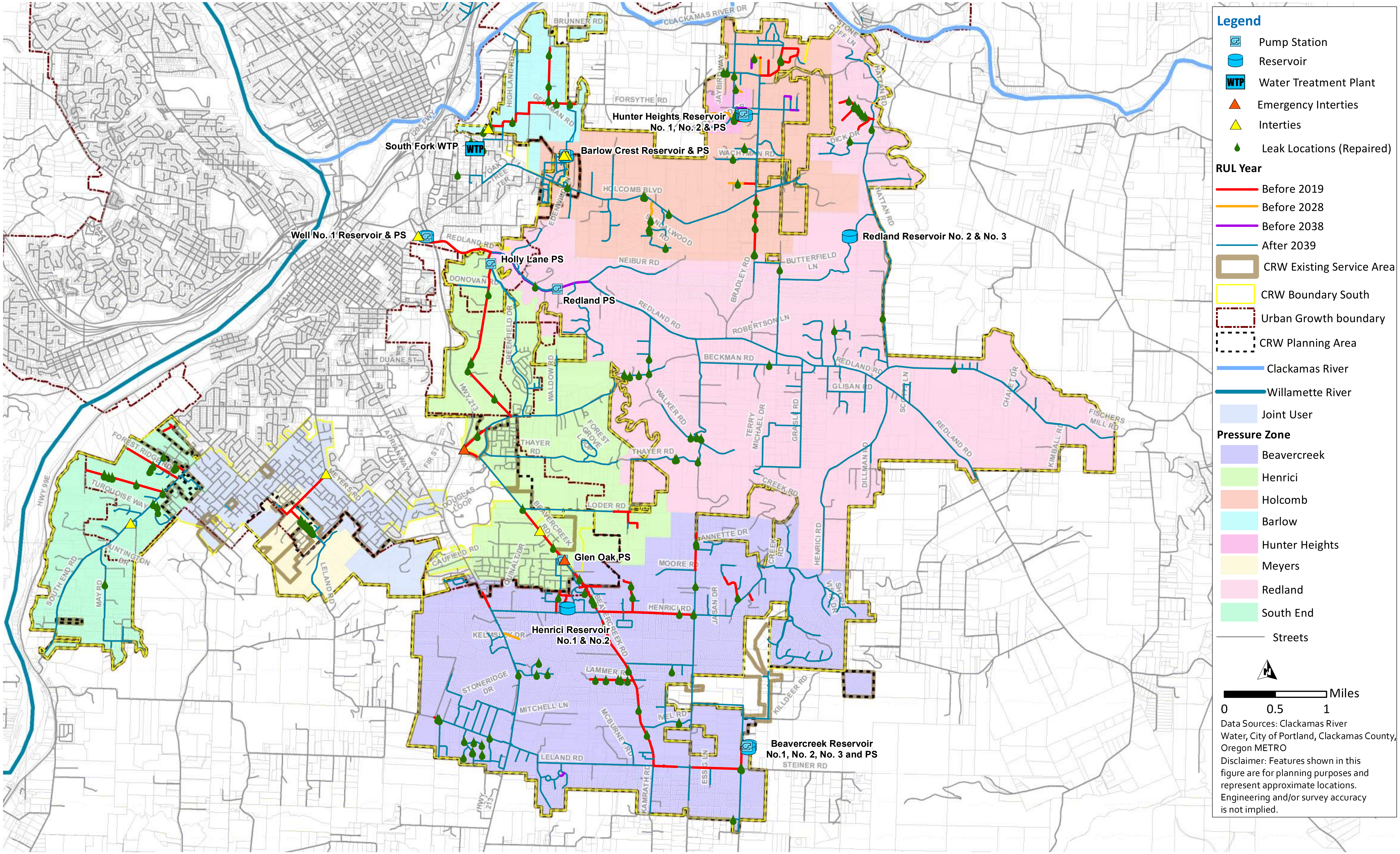
Legend
Pump Station
Reservoir
Water Treatment Plant
Emergency Interties
Interties
Leak Locations (Repaired)
RUL Year
Before 2019
Before 2028
Before 2038
After 2039
CRW Existing Service Area
CRW Boundary South
Urban Growth boundary
CRW Planning Area
Clackamas River
Willamette River
Joint User
Pressure Zone
Beavercreek
Henrici
Holcomb
Barlow
Hunter Heights
Meyers
Redland
South End
Streets
Miles
0 0.5 1
Data Sources: Clackamas River Water, City of Portland, Clackamas County, Oregon METRO
Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.
South Fork WTP
Hunter Heights Reservoir No. 1, No. 2 & PS
Barlow Crest Reservoir & PS
Well No. 1 Reservoir & PS
Holly Lane PS
Redland PS
Redland Reservoir No. 2 & No. 3
Glen Oak PS
Henrici Reservoir No.1 & No.2
Beavercreek Reservoir No.1, No. 2, No. 3 and PS
CLACKAMAS RIVER DR
BRUNNER RD
FORSYTHE RD
HOLCOMB BLVD
REDLAND RD
NEIBUR RD
BUTTERFIELD LN
BECKMAN RD
ROBERTSON LN
GLISAN RD
THAYER RD
LODER RD
CAUFIELD RD
MOORE RD
HENRICI RD
LAMMER RD
MITCHELL LN
STONERIDGE DR
LELAND RD
STEINER RD
KAMRATH RD
MCBURNEY RD
FOREST RIDGE RD
TURQUOISE WAY
SOUTH END RD
MAY RD
HWY 213
HWY 99E
FISCHERS MILL RD
KIMBALL RD
DILLMAN RD
WALKER RD
TERRY MICHAEL DR
DONOVAN RD
DUANE ST
BRADLEY RD
HATTAN RD
DICK DR

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ES.3 Planning Data and Water Demands

Chapter 3 presents a demographic analysis, historical water production and consumption trends, as well as water demand forecasts for the ten- (2028), and twenty-year (2038) planning periods for CRW's Service Area. Projecting realistic future water demands is necessary for evaluating the capability of the water system to meet future water service requirements, planning for infrastructure projects, and securing adequate water supply. Future water demands are used as input conditions for the analyses of the water system that are used to develop the capital improvement program (CIP). Along with the growth rates developed in the demographic analysis, the water use parameters found in the historical production and consumption data were used to predict a range of future water demand. Although low, medium, and high demand projections scenarios were developed, this chapter evaluates the capacity deficiencies in the water system analysis based on medium demand projections.

The Oregon Metro Research Center (Metro) publishes household, employee, and population growth forecasts for jurisdictions within its regional boundary, which includes all of CRW's jurisdictions.

A demographic analysis of CRW's retail water service area was performed using data from Metro's 2015-2040 Distributed Forecast (Scenario #1610), adopted in 2016 by Metro Ordinance 16-1371. The 2015 dataset contained the most recent forecasts when the demographic analysis was performed.

The unique consumption trends of CRW's various customer classes were pulled from customer billing data. The historical average water use for single-family residential (SFR) customers establishes the District's current Equivalent Household Unit (EHU) water use. Multi-family residential (MFR) and non-residential customers' water use was compared to the EHU value, which expresses their consumption in terms of EHUs.

To calculate Average Day Demand (ADD) projections for each customer class, EHU projections were multiplied by EHU values unique to each demand projection scenario. To establish total ADD projections, non-revenue water consumption, including Other Authorized Use and Distribution System Leakage (DSL), was then added given the low, medium, and high assumptions. Finally, Maximum Day Demand (MDD) projections were established by multiplying ADD projections with the appropriate MDD to ADD peaking factor for each demand projection scenario.

Figure ES.6 shows a graph of the South System's historical ADD and MDD demands and the projected demands of the medium scenario, with low-to-high ranges for both ADD and MDD. The ADD was approximately 1.4 mgd in 2017. In 2038, it is estimated to be between 1.9 and 2.2 mgd, while the medium demand scenario predicts 2.1 mgd. In 2038, MDD is estimated to be between 4.6 and 6.9 mgd, while the medium demand scenario predicts 5.7 mgd.

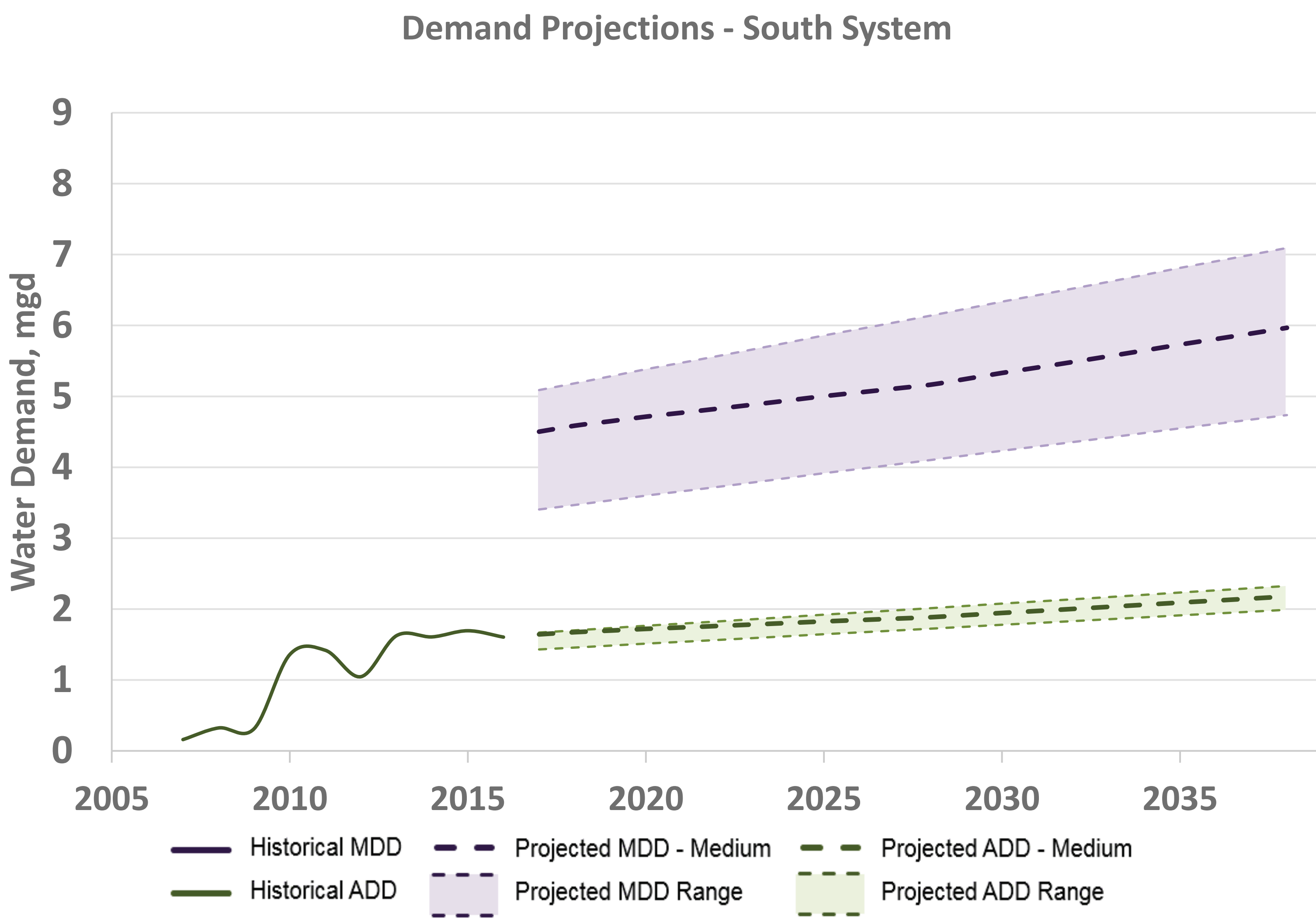

Figure ES.6 Demand Projections, South System

ES.4 Policies and Criteria

Clackamas River Water (CRW) manages its water utility under established water system policies and criteria that govern various aspects of operations, maintenance, and expansion. The policies and criteria detailed in this chapter help CRW develop new water infrastructure and maintain its desired level of service (LOS) while working within a geographically and environmentally challenging area. These policies and criteria also help CRW provide uniform treatment to all utility customers and information to current and potential District customers.

CRW's water system criteria include design parameters and performance criteria to ensure that policies governing the water system are followed. Although not precise rules, they are standards CRW can use to evaluate its water system with when planning capital improvement and capital maintenance projects.

The Water System Master Plan (Plan) established the following vision and mission for the utility and public services:

- **Our Vision:** We believe that an ample supply of high quality water is essential to our region's vitality.
- **Our Mission:** We will provide high-quality, safe drinking water to our customers at rates consistent with responsible planning for our district's long-term health.

CRW will fulfill its "duty to serve" by meeting or exceeding water quality regulations and following the LOS guidelines for its water systems as established in the Oregon Resilience Plan (ORP).

CRW developed and adopted system analysis criteria it uses to identify deficiencies in and design water system improvements for the existing distribution system.

Table ES.2 summarizes the system analysis criteria and its content is detailed in the sections below.

Table ES.2 System Analysis Criteria Summary

Pipeline Velocities and Head loss Criteria		
Pipeline Type	Maximum Velocity	Maximum Head Loss
Maximum Distribution Velocity		
Pipeline Diameter <12 inches @ PHD(1) (distribution)	10 fps(6)	10 ft(2)/1,000 ft(2)
Pipeline Diameter ≥12 inches @ PHD(1) (transmission)	5 fps(6)	5 ft(2)/1,000 ft(2)
Service Pressure Criteria		
Type	Criteria	
Minimum pressure		
PHD(1)	40 psi(3)	
MDD(7) plus Fire Flow	20 psi(3)	
Pressure Reducing Valves (PRVs)	Supply PHD(1)	
Water Storage Evaluation Criteria		
Water Storage Type	Criteria	
Operational Storage	25 percent of MDD(7) of the area	
Emergency Storage	2 x ADD(4) for emergencies	
Fire Storage	Largest fire flow demand	

Table ES.2 System Analysis Criteria Summary (Continued)

Fire Flow Criteria		
Customer Type	Fire Flow Rate	Duration
Single-Family Residential (South)	1000 gpm(5)	2 hours
Multi-Family Residential (South)	1500 gpm(5)	2 hours
Commercial/Industrial (South)	1500 gpm(5)	2 hours
Beavercreek Elementary School	2500 gpm(5)	2 hours
Ogden Middle School	3000 gpm(5)	3 hours
Redland Elementary School	2750 gpm(5)	2 hours
Minimum Line Size		
Customer	Pipe Diameter	
Residential	8-inch diameter	
Commercial/Industrial	12-inch diameter	

Notes:
(1) Peak hour demand (PHD).
(2) Feet (ft).
(3) Pounds per square inch (psi).
(4) Average Day Demand (ADD).
(5) Gallons per minute (gpm).
(6) Feet per second (fps).
(7) Maximum Day Demand (MDD).

ES.5 Supply Analysis

Currently, the entire water supply for CRW's South System comes from water produced at South Fork Water Board's (SFWB) 25 mgd water treatment plant. This treatment plant is located on Hunter Avenue in Oregon City, south of the Clackamas River. SFWB serves most of the water directly to CRW, while some locations are provided through Oregon City's distribution system (purchased from SFWB).

CRW also owns one groundwater well, known as Well No. 1, located near Abernathy Creek close to Oregon City. Although water from this well is available for the South System, it is used only for backup in emergencies.

CRW has a permit allowing it to test Well No. 1 as an aquifer storage and recovery (ASR) system.

As discussed in Chapter 5 – Water Supply (North), the North System has sufficient water rights to meet projected demand through 2038. The existing water rights are also sufficient to meet existing and future demands from the South System through 2038. As a result, CRW is currently developing connectivity from the North System to the South System through the backbone system as illustrated in Figure ES.7.

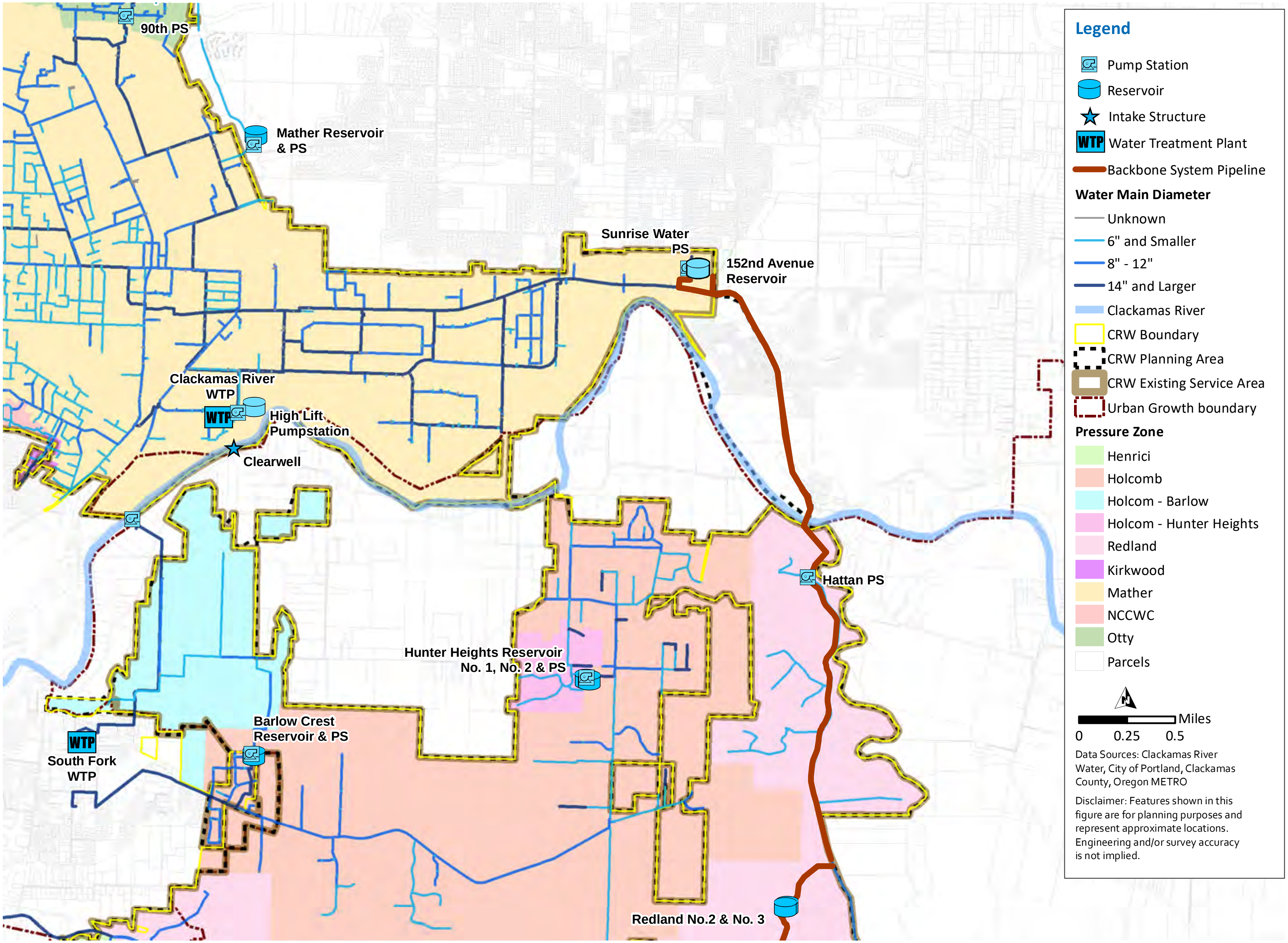

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Figure ES.7 Backbone System Connectivity

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ES.6 System Analysis

CRW's South water distribution system was evaluated for its ability to meet CRW's performance criteria under 2018, 2028, and 2038 future demand conditions using the medium demand projection scenario. The distribution system was evaluated for its supply and pumping capacity and reliability, the capacity of its storage facilities, and for adequate pressures and fire flow capacity using the updated hydraulic model. The analysis assumed that the backbone projects Phase 1 are completed by 2020 and Phase 2 will be in the next few years (2024), as illustrated in Figure ES.8.

The analysis of CRW's South water system identified several system deficiencies and recommends the following improvements to eliminate these deficiencies. These recommendations form the basis of CRW's South CIP outlined in Chapter 8:

1. The pumping analysis identified that the Bradley Rd Pump Station should be designed to provide sufficient capacity to service the Holcomb, Hunter Heights, and Barlow pressure zones. Additionally, the Hunter Heights Pump Station does not have sufficient firm pumping capacity. To provide sufficient firm capacity, it is recommended that a redundant fire flow pump be installed at the pump station.
2. The storage analysis identified that when the Backbone Phase 2 Projects are implemented, the South System has sufficient storage through the planning horizon. No additional improvements are recommended.
3. The distribution system analysis used the updated hydraulic model of CRW's existing system along with the fire flow requirements throughout the system to identify areas experiencing low pressures, areas experiencing high velocities and head losses, and areas that do not provide adequate fire flow. Results from the 2038 conditions are shown in Figures ES.9 through ES.11.

Fifty pipeline projects, including upsize and new pipe installation, are recommended to ensure required fire flows, pressures, velocities, and head losses are available to all water mains in the South system.

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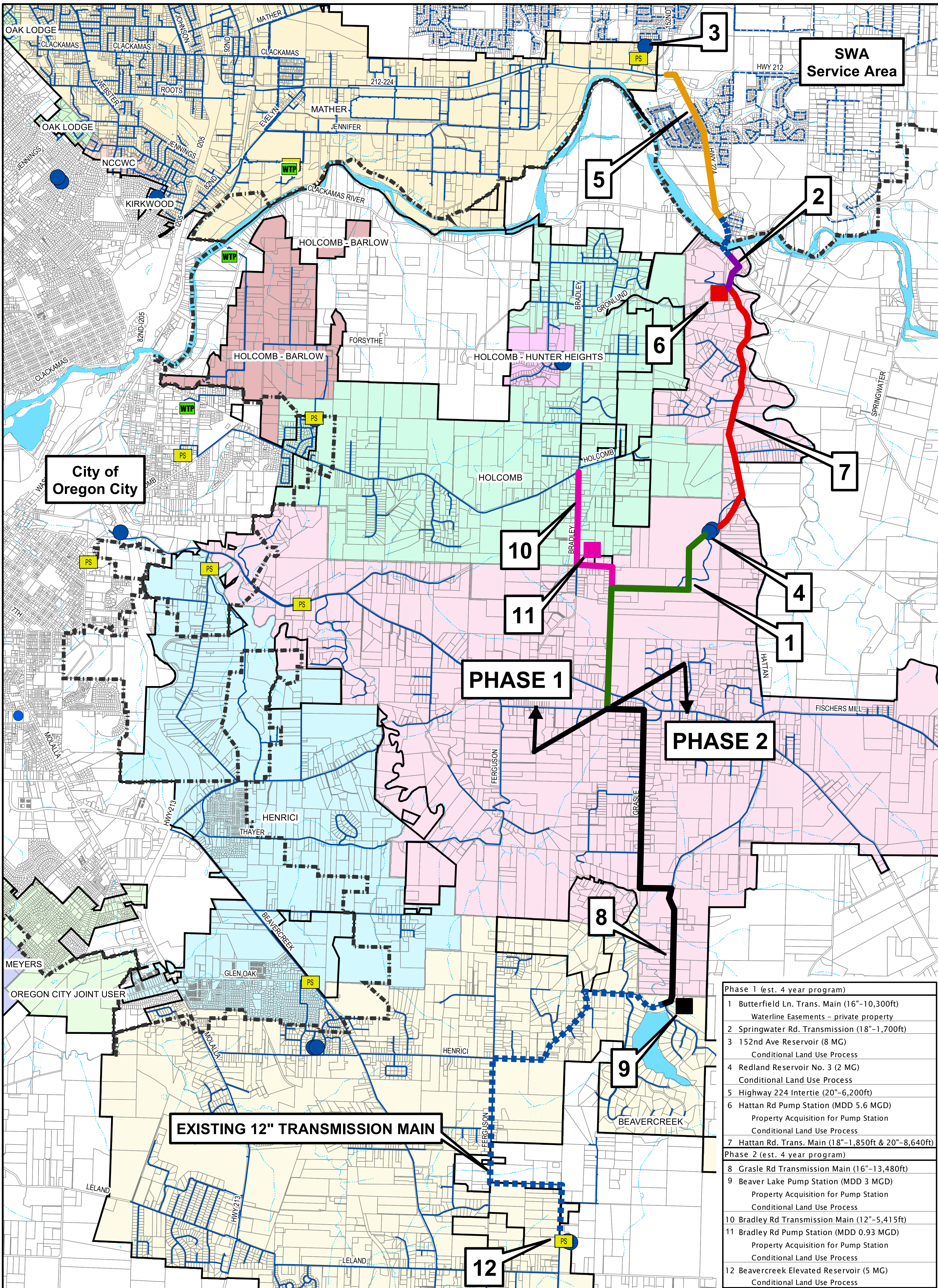
BACKBONE PROJECTS - CRW PRESSURE ZONES



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Drawing Location: F:\GIS\ArcMap MXD Project Files
Drawing By: M. Grose

Clackamas River Water

CLACKAMAS RIVER WATER
GEOGRAPHIC INFORMATION SYSTEM
16770 SE 82nd Drive - Clackamas, Oregon
503-722-9220 - www.crwater.com

Figure ES.8 CRW Backbone Projects

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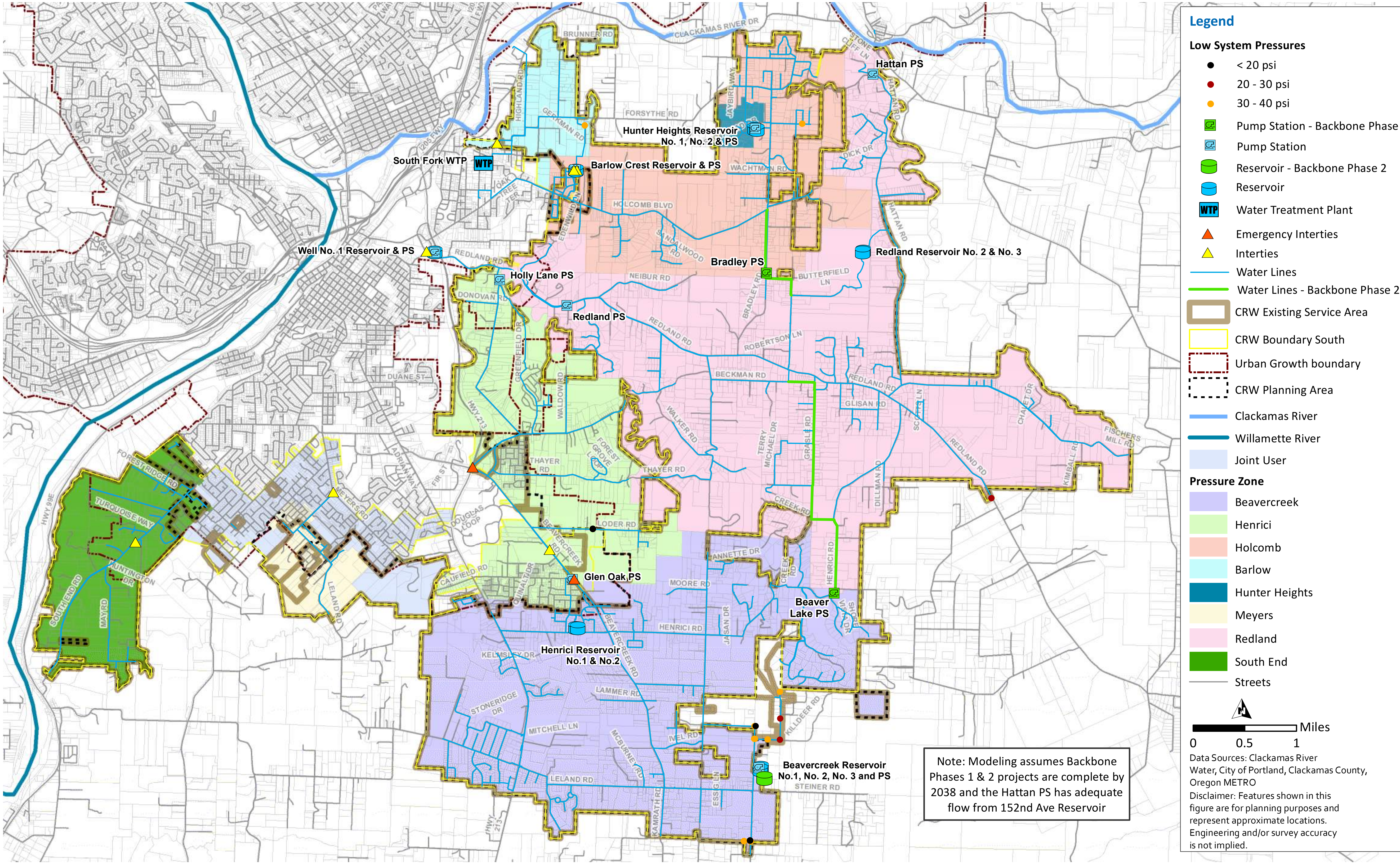

ES.9 Low System Pressures Under 2038 PHD Conditions - South System

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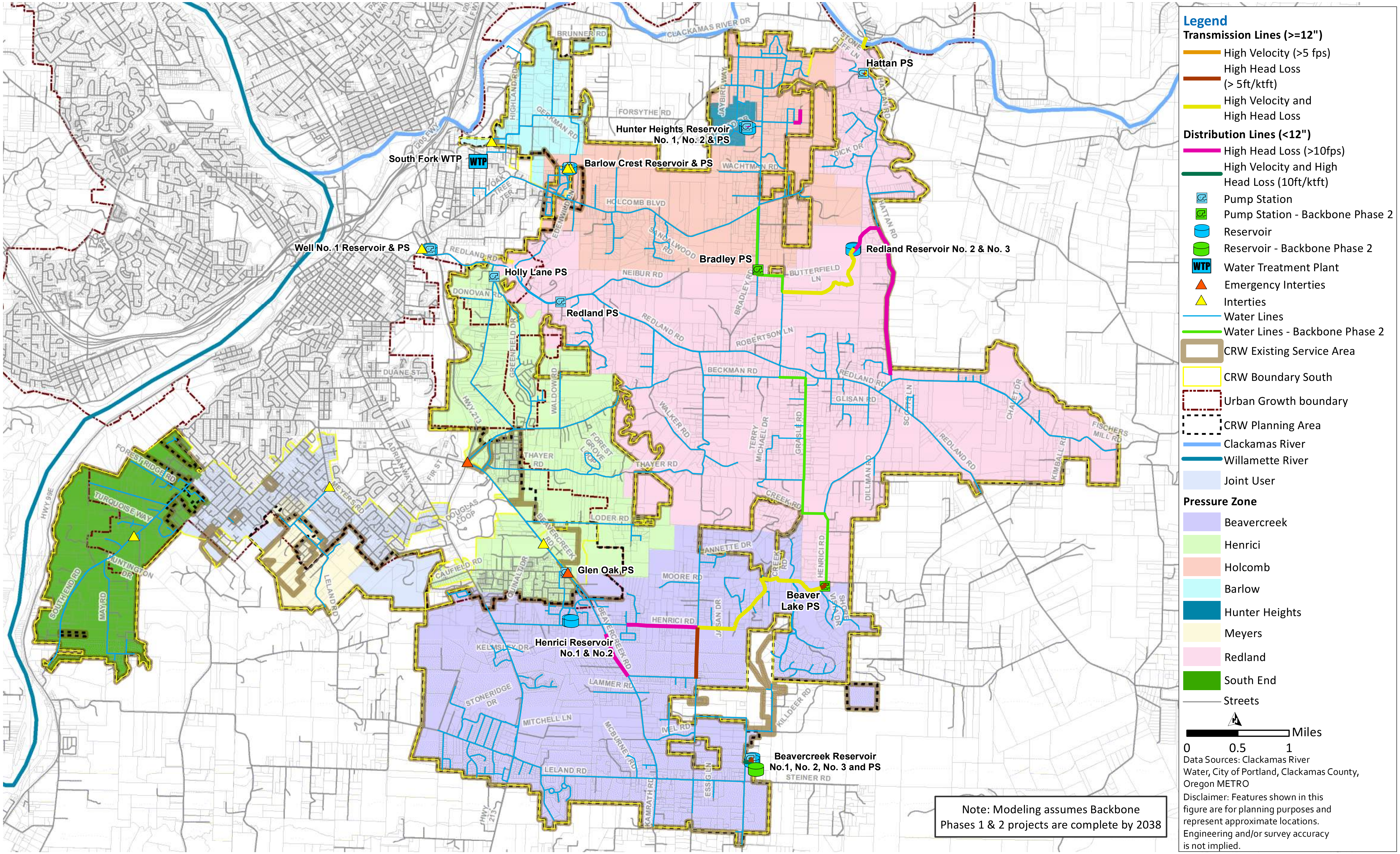

Figure ES.10 Pipeline Velocities and Head Loss under 2038 PHD Conditions - South System

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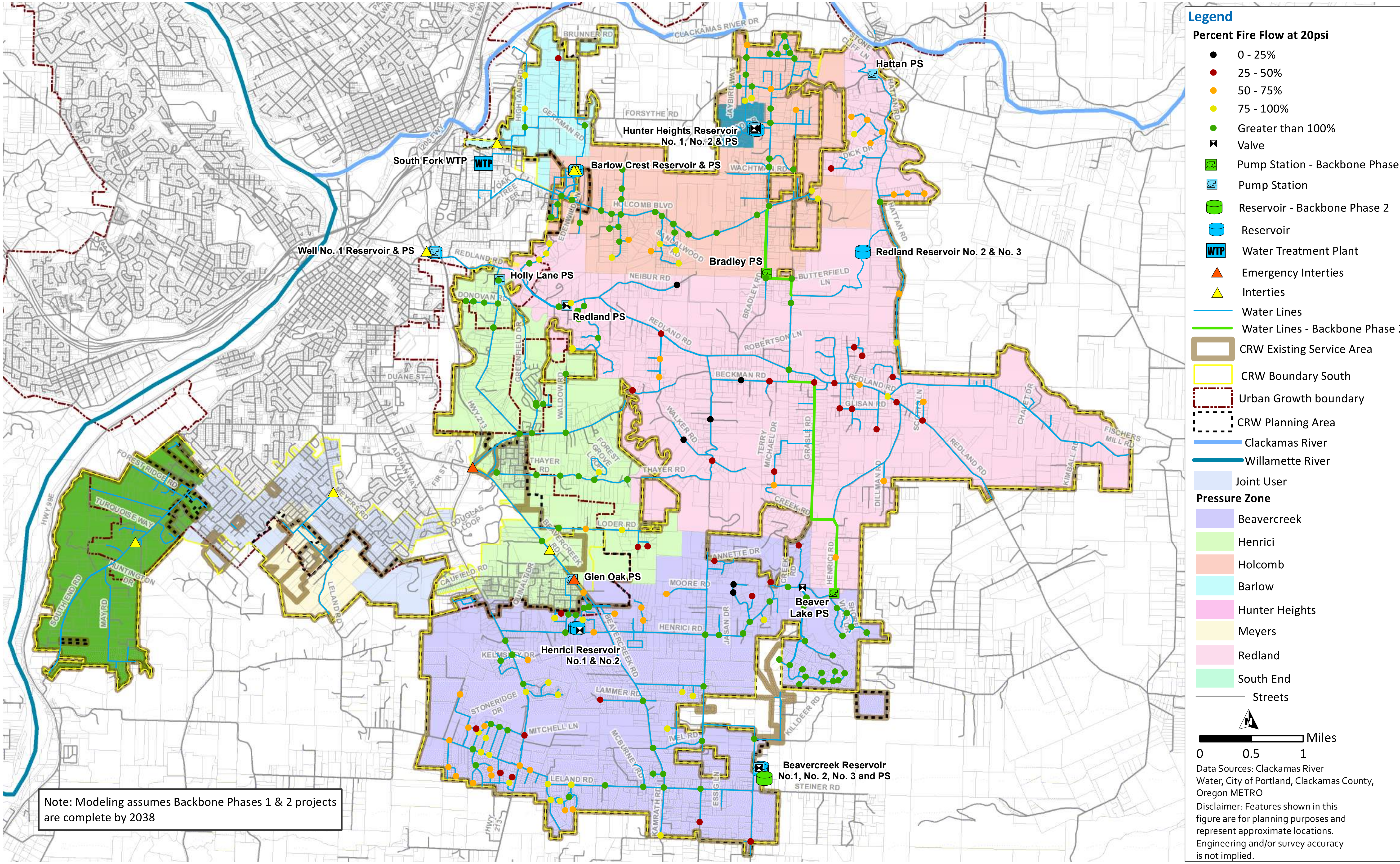

Figure ES.11 Fire Flow Deficiencies under 2038 MDD + Fire Flow Conditions - South System

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ES.7 Seismic Assessment Results

In compliance with OAR 333-061-0060, the seismic risk assessment must identify critical facilities needed to supply water to key community needs during a seismic event (fire suppression, health care, first aid emergency, drinking water). With input from the CRW staff, the assessment identified the seismic system and its infrastructure, which include key supply, treatment, distribution, and storage elements required to continue supplying water to the community after a Cascadia subduction zone earthquake.

CRW is following recommendations outlined in the 2013 Oregon Resilience Plan (ORP), which defines the seismic backbone system's function as follows: "The backbone water system would be capable of supplying key community needs, including fire suppression, health and emergency response, and community drinking water distribution points, while damage to the larger (non-backbone) system is being addressed." Chapter 7 also presents the results of the performance evaluation of the system's pipes and makes recommendations for seismic resilience, which will be integrated into a 50-year Mitigation Plan.

CRW identified a critical seismic system for the South System that connects the following critical facilities that are highlighted in Figure ES.12 to the 152nd Ave Reservoir and Sunrise Water pump station in the South System.

Figure ES.13 shows a map of the repair rates for all the pipes in the South System that will result from the Magnitude 9 (M9) Cascadia Subduction Zone (CSZ) earthquake.

To adequately prepare for the M9 CSZ earthquake, every major component of CRW's water distribution system must be evaluated and improved as necessary. The following seismic improvements are recommended:

- Backbone Seismic System Pipes
- Low-risk Seismic System Pipes (seismic system pipelines with a repair rate less than 0.15 repairs per 1,000 feet are considered "low-risk")
- High-risk Seismic System Pipes (seismic system pipelines with a repair rate greater than or equal to 0.15 repairs per 1,000 feet are considered "high-risk")
- Seismically actuated isolation valves on storage reservoirs.

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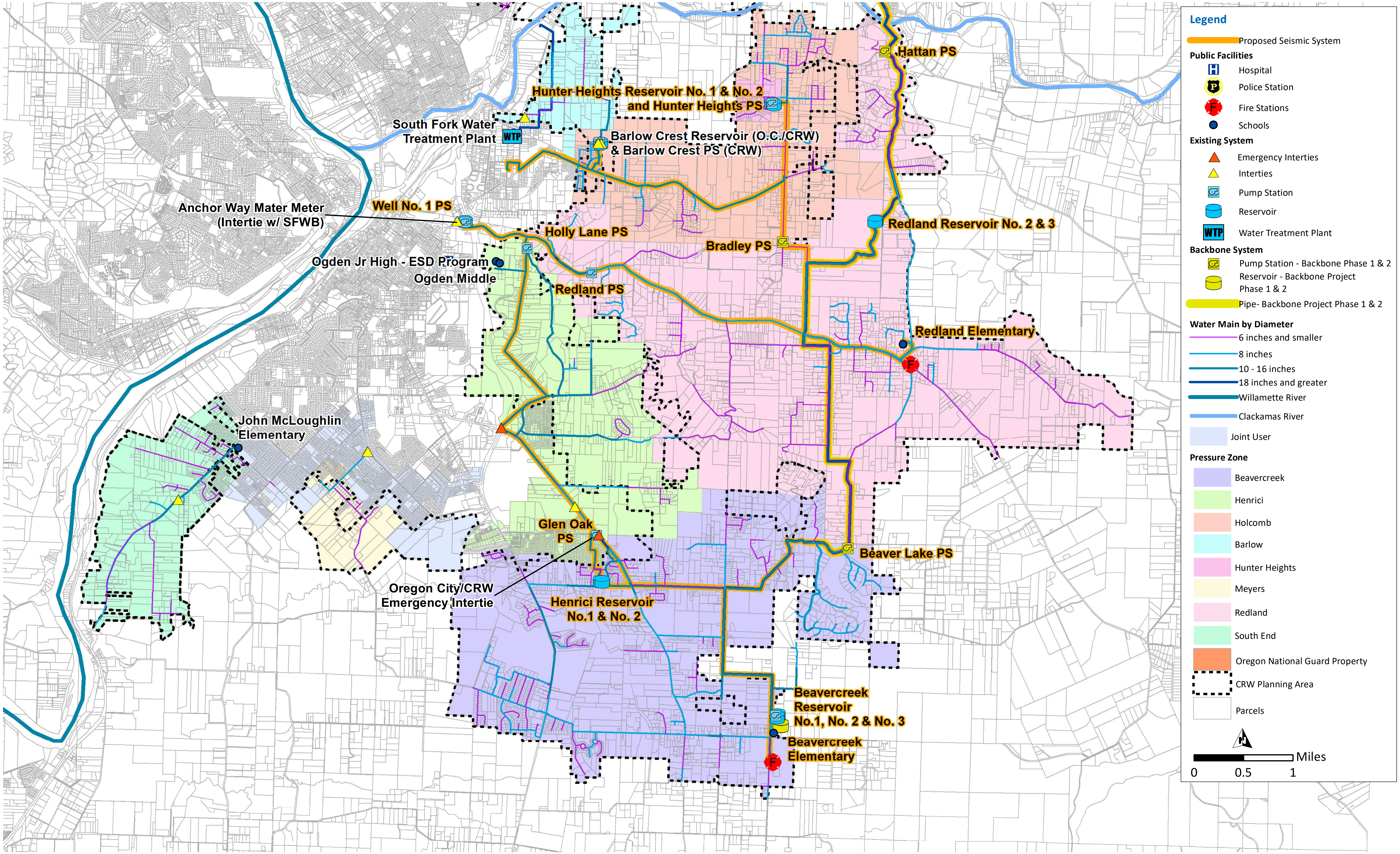

Figure ES.12 CRW South Seismic System

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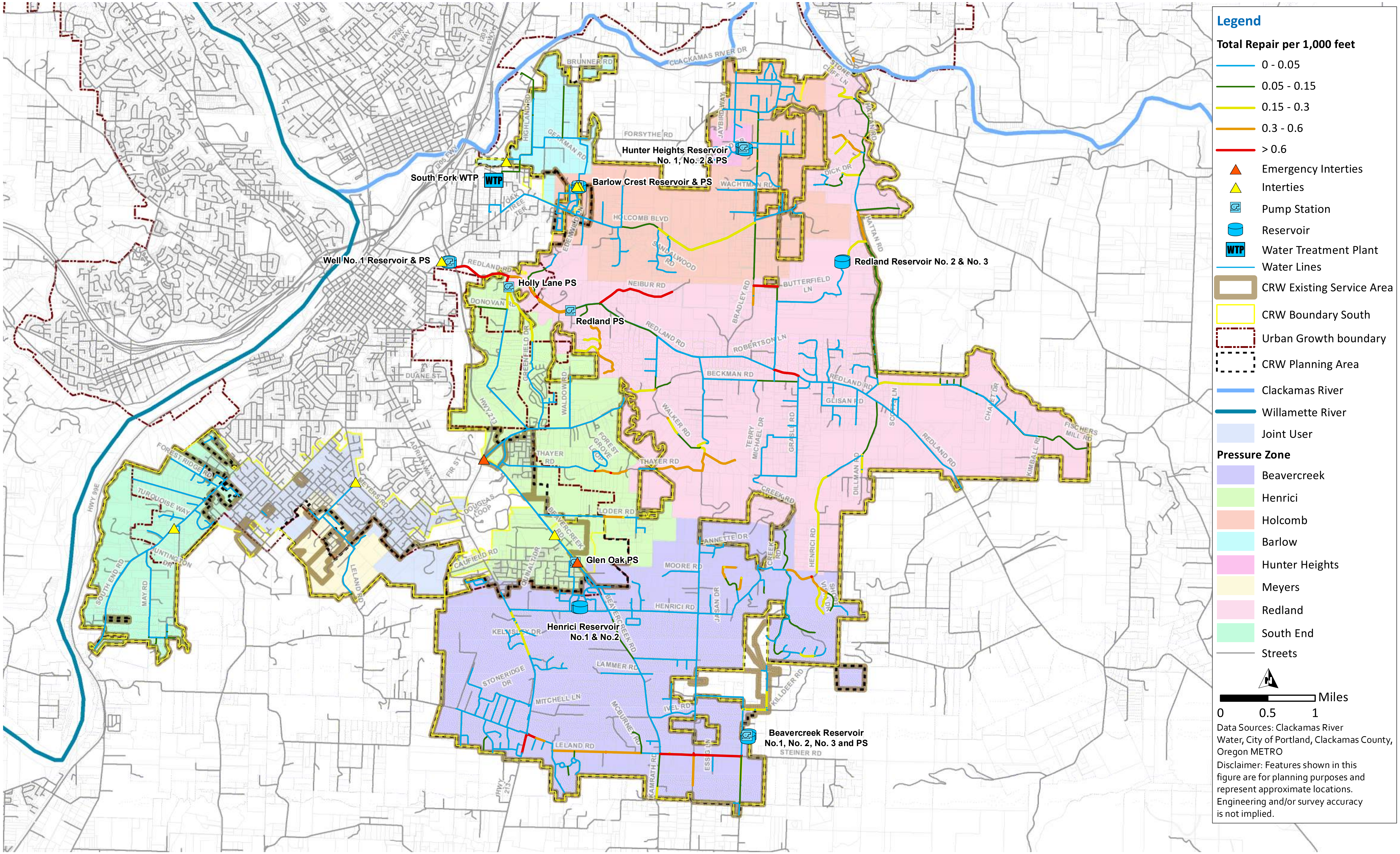

Figure ES.13 Potential Repair Rates per 1,000 LF - South System

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ES.8 Capital Improvements Plan

The recommended supply, storage, pipeline, and other ongoing projects are compiled into a comprehensive CIP for CRW to provide a guideline for planning and budgeting. Chapter 8 presents the cost estimate and schedule for each project and describes the assumptions used to develop cost estimated and to prioritize projects.

The Plan's capital projects are categorized by the infrastructure involved, which are as follows:

- General (G).
- Programmatic (P).
- Pressure Zone (PZ).
- Storage (ST).
- Pump Station (PS).
- Distribution Pipeline (D).
- Backbone (BB).

Note, Programmatic projects (P) represent the repair and replacement program and the seismic system program. The programmatic projects include capital pipelines replacement programs that do not specify individual projects by location but rather a length of pipe replacement each year.

The total South System CIP cost over the next 20 years is approximately $174 million, which equated to $8.7 million annually, as presented in Table ES.3. Project phasing is described as either short-term (2019-2028) or long-term (2029-2038). Of the total cost, $70 million is budgeted for the short-term phase and $104 million is budgeted for the long-term phase.

The South System CIP is split into seven (7) categories: general, programmatic, pressure zone, storage, pump station, distribution pipeline, and backbone. As outlined in Table ES.4, throughout the 20-year planning period, $650,000 (0.5%) is budgeted for general projects, $69.5 million (20.6%) is budgeted for programmatic projects, $1.9 million (1.4%) is budgeted for pressure zone projects, $6 million (4.7%) is budgeted for storage projects, $600,000 (0.4%) is budgeted for pump station projects, $67 million (50.5%) is budgeted for distribution pipeline projects, and $29 million (21.8%) is budgeted for the backbone phase 2 projects..

Table ES.3 South CIP Summary by Project Type

Project Type	Short-Term (2019-2028)	Long-Term (2029-2038)	Total CIP
Improvement	$40,629,000	$47,964,000	$88,593,000
Capacity	$1,033,000	--	$1,033,000
Repair and Replacement	$28,348,000	$56,465,000	$84,813,000
Total Cost	**$70,010,000**	**$104,429,000**	**$174,439,000**
Annual Cost	**$7,001,000**	**$10,443,000**	**$8,722,000**

Table ES.4 South CIP Summary by Project Category

Project Category	Short-Term (2019-2028)	Long-Term (2029-2038)	Total CIP	Percentage
General	$450,000	$200,000	$650,000	0.4%
Programmatic	$22,830,000	$46,665,000	$69,495,000	39.8%
Pressure Zone	--	$1,879,000	$1,879,000	1.1%
Storage	$700,000	$5,250,000	$5,950,000	3.4%
Pump Station	--	$600,000	$600,000	0.3%
Distribution Pipeline	$16,972,000	$49,835,000	$66,807,000	38.3%
Backbone	$29,058,000	--	$29,058,000	16.7%
Total Cost	**$70,010,000**	**$104,429,000**	**$174,439,000**	
Annual Cost	**$7,001,000**	**$10,443,000**	**$8,722,000**	

The specific South System capital improvement projects are shown on Figure ES.14. Projects were prioritized according to their urgency in mitigating projected deficiencies, fixing pipelines with condition and leakage records, and servicing anticipated growth. The programmatic capital improvement projects, including the Repair and Replacement Pipeline Program and the Seismic System Pipeline Program, are shown in Figure ES.15. Each project also has a project sheet in Appendix N describing it in detail.

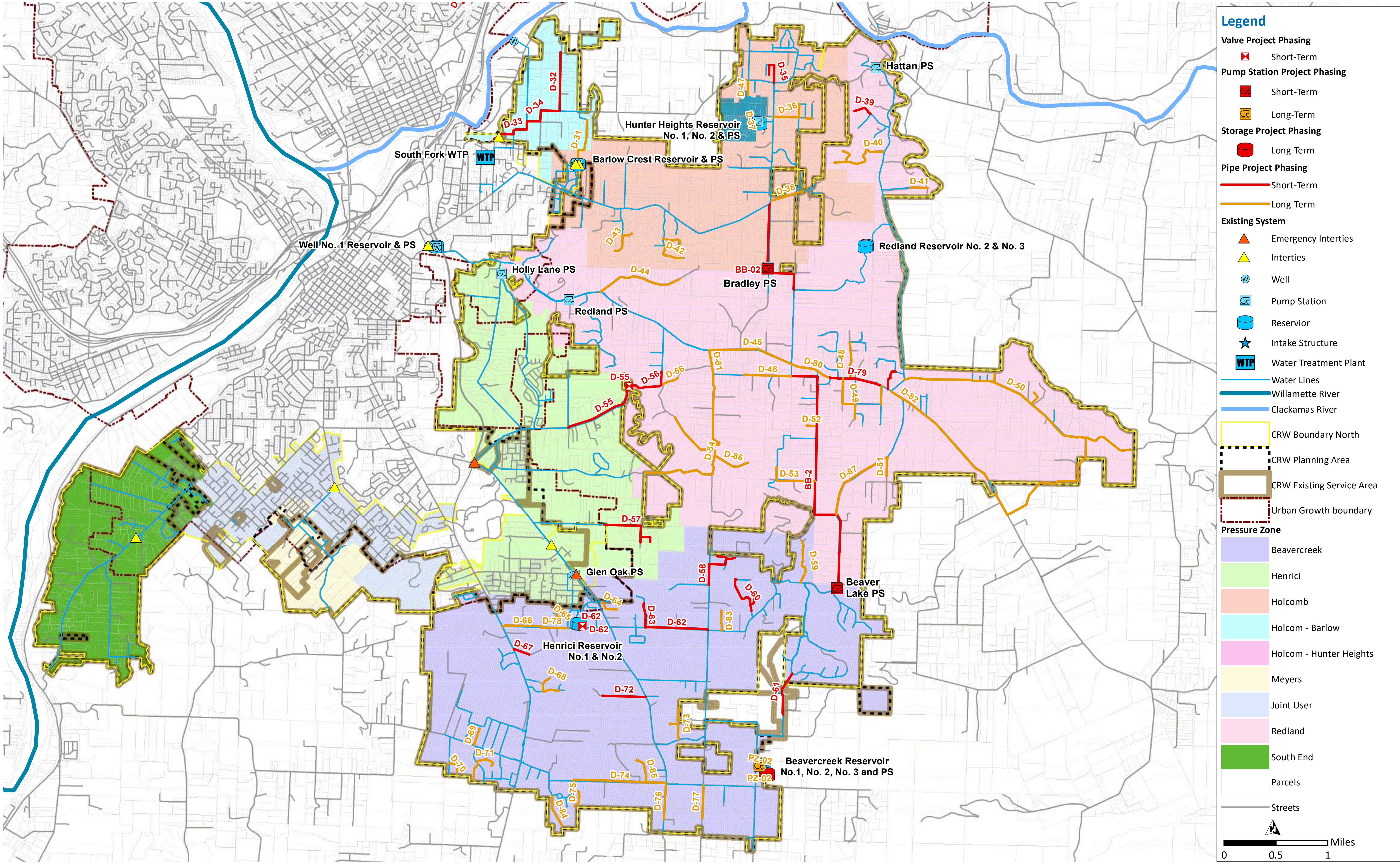

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Figure ES.14 CIP Specific Project Phasing - South System

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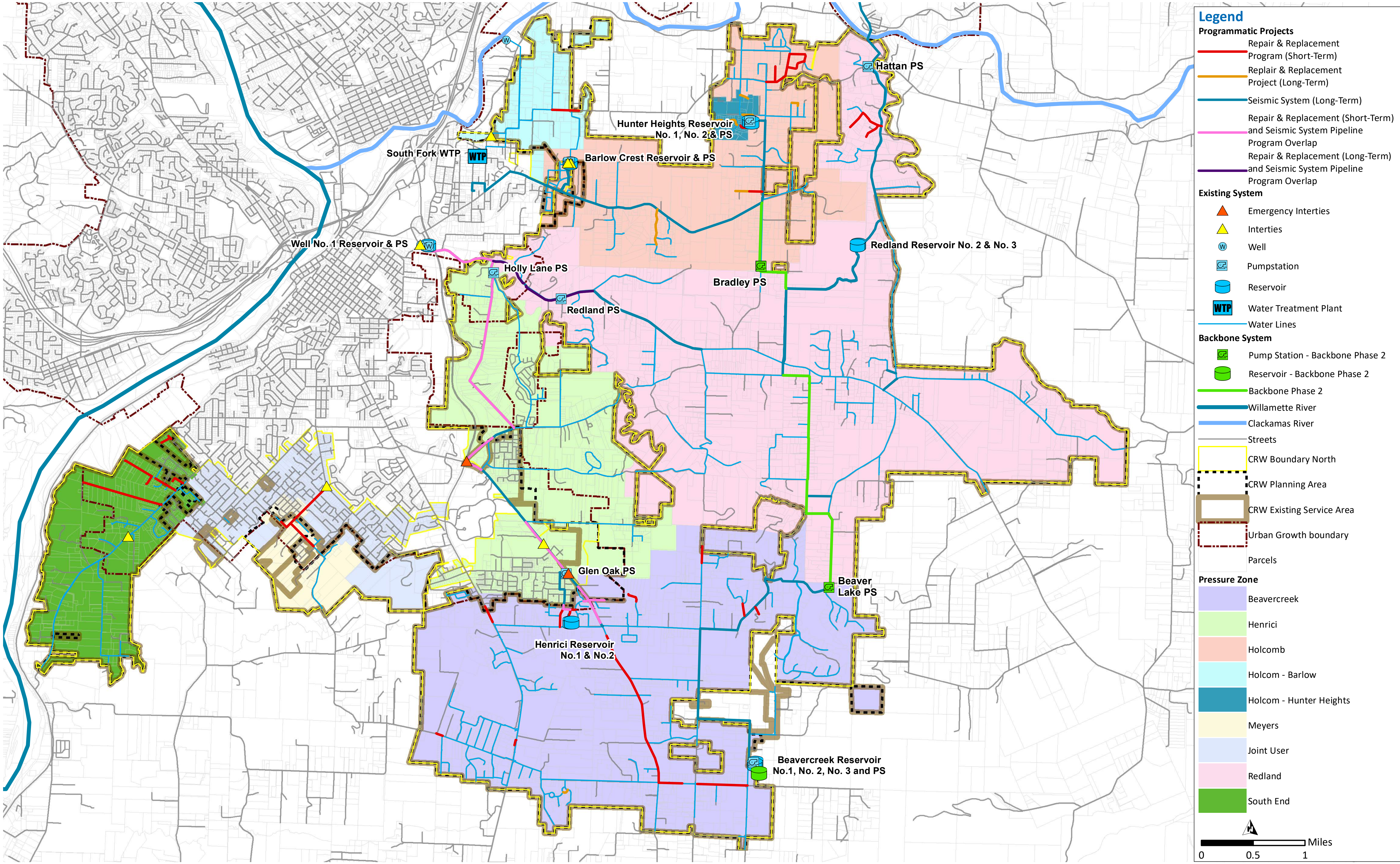

Figure ES.15 CIP Programmatic Projects - South System

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Chapter 1

INTRODUCTION – SOUTH SYSTEM

1.1 Introduction

This Water System Master Plan (Plan) updates Clackamas River Water's (CRW) former Water System Plan, and was developed as a joint effort between CRW staff and Carollo Engineers, Inc. This Plan is associated with the following Public Works System Identification (PWSID) number: CRW South (Clairmont) – 4100594.

This Plan encompasses a 20-year planning horizon from 2019 through 2038. Analysis in this Plan is divided up into a ten (10) year short-term planning period from 2019 through 2028, and a ten (10) year long-term planning period from 2029 through 2038. These timeframes are estimates. Depending on the application process, project work, and available funding, the timing may change.

In accordance with Chapter 333-061 of the Oregon Administrative Rules, Oregon Health Authority (OHA) requirements and considering all other jurisdictions within CRW, this Plan:

- Considers past studies, reports, agreements, and other data concerning the water system.
- Develops an inventory of CRW's existing water system and infrastructure.
- Develops demographic and demand analysis to project future demands within CRW's service area.
- Verifies that CRW's policies and criteria, which the system will be evaluated with, comply with OHA standards.
- Evaluates current and future water resources to identify water supply improvements and potential deficiencies.
- Evaluates the existing distribution system using CRW's updated hydraulic model and develop improvements for identified deficiencies.
- Develops a Seismic Resilience Plan outlining recommended improvements for supply, pumping, storage, and the distribution system.
- Develops a CIP outlining recommended system improvements to deliver the Level of Service (LOS) required, and programs with planning level cost estimates and schedules within the twenty year planning period.

1.2 Approval Process

In 2017, CRW's Board of Commissioners (Board) authorized Carollo to prepare this document in accordance with CRW policies and procedures and all applicable federal and Oregon Health Authority (OHA) regulations set forth in the Oregon Administrative Rules (OAR) 333-061-0060. CRW will submit this Plan to OHA as part of the agency review process.

To document the Plan's approval process, Carollo included the Board's comment letters and the adoption resolution in Appendix A.

1.3 Overview of CRW

1.3.1 Location

CRW's South System is surrounded in the north by the Clackamas River and the City of Happy Valley, in the northwest by the City of Gladstone, and in the west by the City of Oregon City. The majority of CRW's south service area including the southerly and easterly boundaries is within unincorporated Clackamas County.

CRW's South System encompasses approximately 29.4 square miles and is located southeast of Portland, as shown in Figure 1.1. Its service area is more sparsely populated, rural, and residential than the North System's service area. Per the Metro Published Projections, the South System provided about 1.6 million gallons of water per day to approximately 5,000 accounts and approximately 2,100 employees in 2015.

The South System purchases water at a wholesale rate from the South Fork Water Board (SFWB).

Figure 1.2 shows the following boundaries, along with neighboring water agencies:

- Planning Area: the area CRW expects to serve by the end of this Plan's planning horizon (2038).
- Service Area: The future, long-term area CRW may serve beyond 2038.

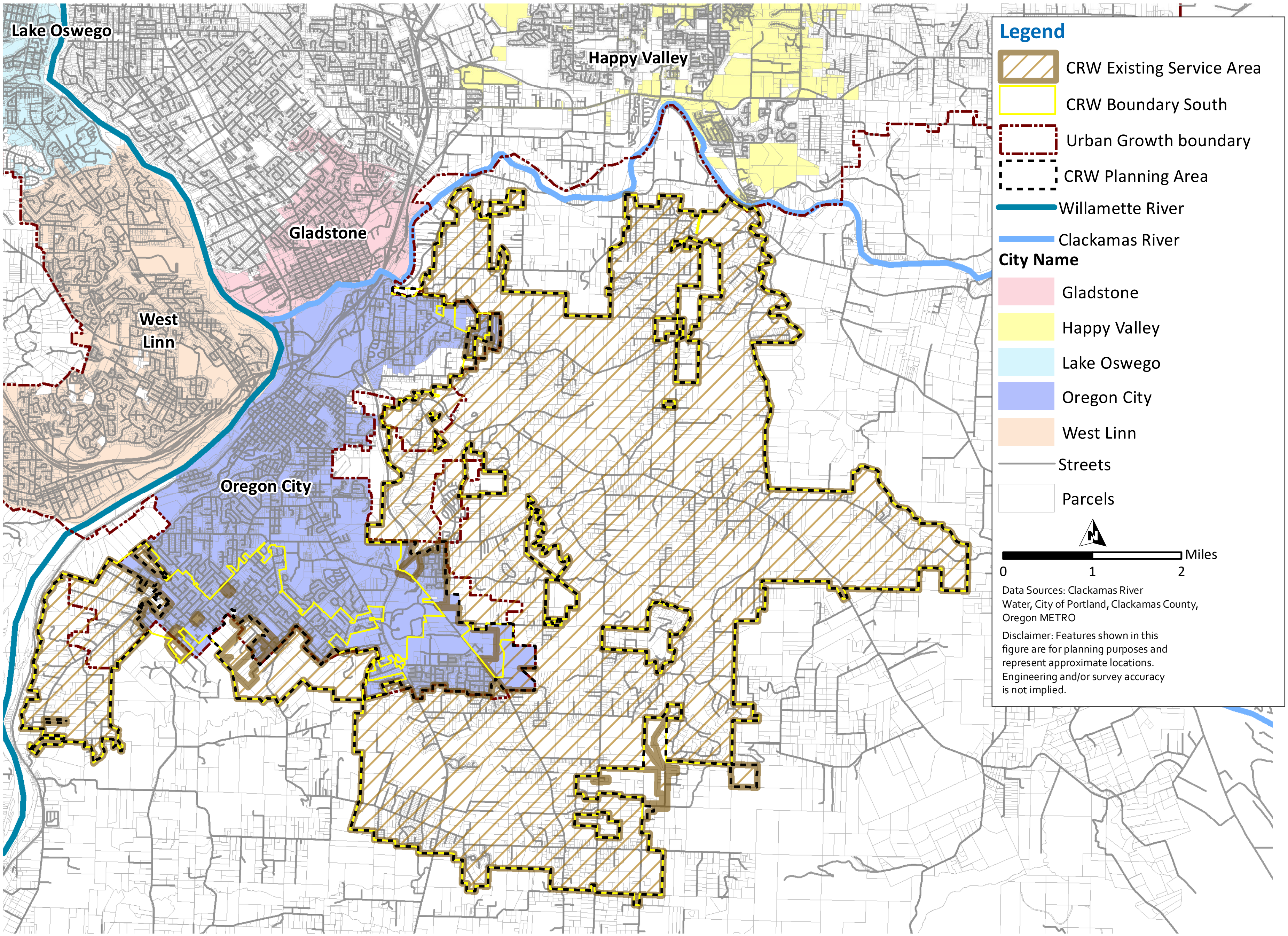

Figure 1.1 CRW Existing Service Area and Neighboring Cities - South System

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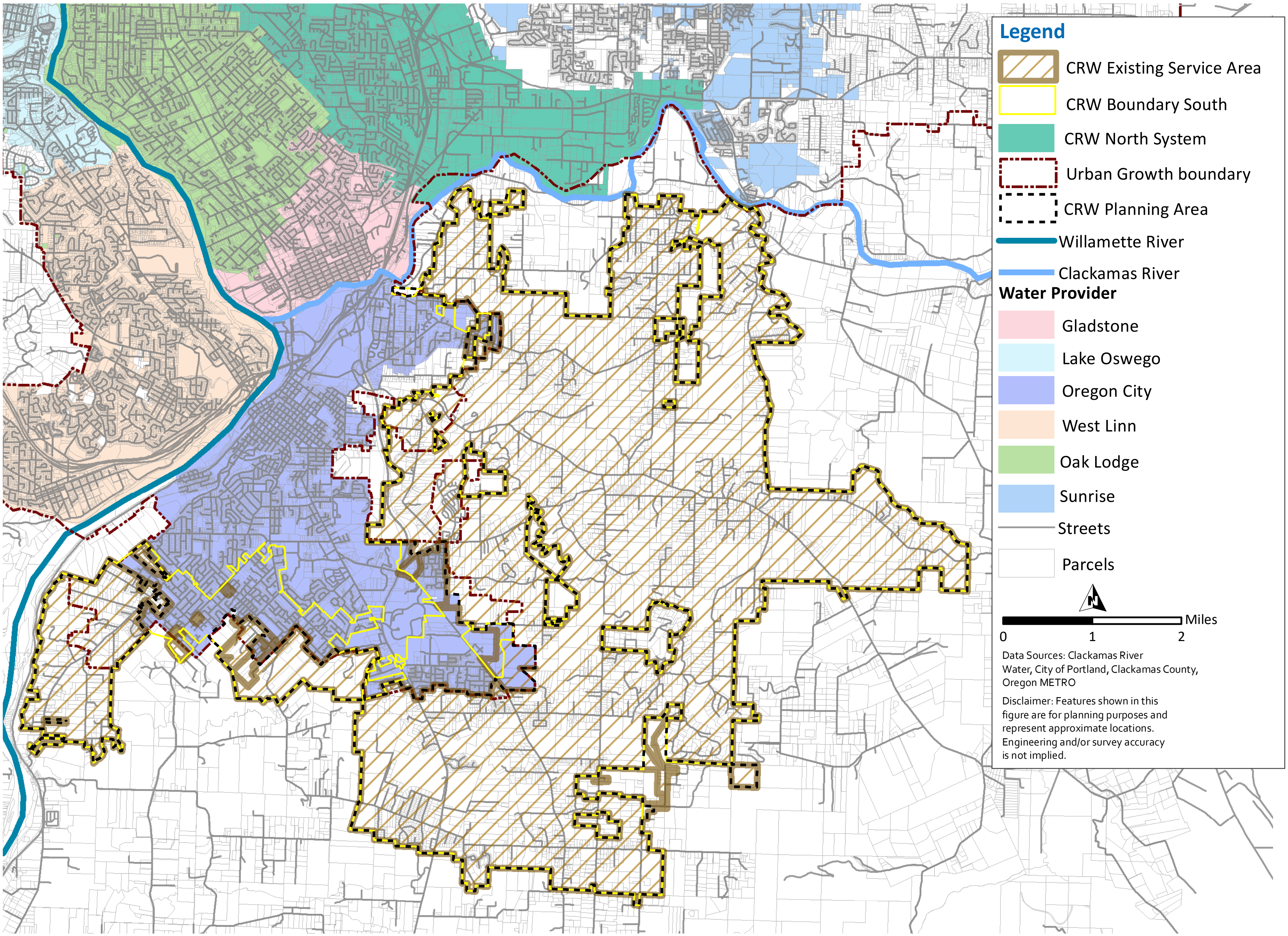

Figure 1.2 CRW Existing Service Area and Neighboring Water Providers - South System

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1.3.2 Vision Statement

CRW operates with the following vision statement: "Our vision is that we believe that an ample supply of high quality water is essential to the vitality of our region."

1.3.3 Mission Statement

CRW has the following mission statement: "We will provide high-quality, safe drinking water to our customers at rates consistent with responsible planning for our district's long-term health."

1.3.4 History of Clackamas River Water

The Clackamas Water was initially formed in 1926. Nearly 70 years later in 1995, Clackamas River Water was established when the Clackamas Water District and the Clairmont Water District were consolidated into one. Thus, CRW currently serves two distinct areas formerly served by two separate districts.

This report refers to the former Clackamas Water District water system as "the North System" and the former Clairmont Water District system "the South System." For this Plan, both North and South systems were evaluated and are discussed separately in the report.

1.3.5 Authority, Management, and Conduct of Business

CRW is a domestic water supply district organized under ORS Chapter 264. CRW is governed by a five-member board of commissioners, elected by the citizens residing within its service area. The Board establishes policies by resolution, which governs CRW operations. The general manager oversees the water system's daily operations and maintenance (O&M) in accordance with policies established by the commissioners and in coordination with neighboring jurisdictions, other water purveyors, and regional water supply groups and agencies. The general manager reports directly to the Board and supervises engineering, maintenance, water resource, and administrative staff.

1.4 Regulations

CRW operates under regulations and requirements that pertain to the supply of safe drinking water and the provision of adequate domestic water and fire protection services. This section briefly summarizes key regulations that affect CRW's everyday operations. CRW's intergovernmental agreements regarding delivery of water to its customers are listed in Section 1.6.

1.4.1 Federal Regulations

Public Law 93-523, known as the Safe Drinking Water Act (SDWA), directs the US Environmental Protection Agency (EPA) to establish national minimum standards for drinking water that limit the amount of certain substances in drinking water sources. These limits are regulated by the Oregon Health Authority (OHA) and are adhered to by CRW.

1.4.2 State of Oregon Requirements

This Plan is required to meet state requirements set forth in the OHA's Oregon Administrative Rules (OAR) 333 Water System Master Plan Requirements. As such, CRW will submit this document to OHA as part of the agency review process.

1.4.3 Clackamas County Requirements

Because CRW operates in Clackamas County (County), it must operate within the County's rules and regulations and must use its planning data to develop growth projections for portions served by CRW. This Plan was thus developed to meet the requirements stated in Clackamas County Code Titles 1006.03 (Clackamas County Zoning and Development Ordinance Plan).

CRW must also operate within the terms of its current right-of-way franchise with Clackamas County and Oregon City.

1.5 Previous Studies

Water system plans were developed for CRW systems in 1998, 2005, and 2011. In addition to reviewing these plans, Carollo reviewed a variety of studies completed by and for CRW (referenced throughout this document). Carollo also considered a variety of documents produced by other jurisdictions. The key document reviewed for this Plan is summarized below.

1.5.1 Clackamas River Water Modeling Technical Memorandum, West Yost Associates, 2011

This technical memorandum (TM) defines water distribution service standards and makes recommendations for analyzing the performance of CRW's existing potable water distribution system. The recommendations in this TM guide the planning and design of improvements needed to meet future demands.

1.5.2 Clackamas River Water Water Management and Conservation Plan, 2011

This plan guides the effective use and stewardship of CRW's water supply. According to the plan, proper use and guidance are achieved with water management, water conservation, and curtailment programs that fulfill OAR requirements adopted by the Water Resources Commission in November 2002 (OAR Chapter 690, Division 86).

1.5.3 Clackamas Regional Water Supply Commission Planning Document, 2017

This planning document outlines present and future water demands for the principal parties of the Clackamas Regional Water Supply Commission (CRWSC). It also summarizes relevant source capacity and water availability.

1.5.4 Clackamas River Water Hydraulic Flow Test, West Yost Associates, 2011

This document develops a reliable, fairly accurate, representative hydraulic model of CRW's water supply and distribution system that can be used to conduct detailed hydraulic analyses of existing and proposed pump stations, storage facilities, pipeline sizes, and alignments. West Yost and Associates (West Yost) provided the engineering services to help update, enhance, and calibrate CRW's water system hydraulic model.

1.5.5 Clackamas River Water ISO Pre-Survey Report, 2016

This report helps determine the fire flows needed for CRW's South Service Area using up-to-date information about fire protection services in communities served by CRW. The goal of the Insurance Services Office (ISO) is to provide a standard for fire departments to budget and plan for facilities, equipment, and training.

1.6 Intergovernmental Agreements

This section summarizes each of CRW's intergovernmental agreements for the South System, which include water supply agreements (both sales and purchase), emergency water supply, and collaborative agreements. Appendix B through D contains additional detail about CRW's intergovernmental agreements.

1.6.1 South Fork Water Board

1.6.1.1 South Fork Water Board Settlement Agreement (Rates)

South Fork Water Board (SFWB) and CRW entered into a settlement agreement that allows SFWB to serve CRW with "wholesale water" at a rate starting at $0.7400/ccf. This rate was established from the last formal agreement between CRW and SFWB, which formally expired in July, 1998. SFWB and CRW have continued to operate under the settlement agreement terms and have not developed a new agreement. The settlement agreement and mutual release was established in May of 2010. A copy of the settlement agreement is included in Appendix B.

1.6.1.2 Oregon City and SFWB Land Use Appeals Settlement Agreement

The City of Oregon City, the SFWB, CRW, the Sunrise Water Authority, and the Clackamas Regional Water Supply Commission (CRWSC) entered a settlement agreement in 2014 in which the City of Oregon City and SFWB dismissed the appeals filed with the Land Use Board of Appeals, specifically those pertaining to the formation of the CRWSC under ORS chapter 190 ("the 190 Agreement").

The settlement agreement was established in May of 2014. A copy of the agreement is included in Appendix B.

1.6.2 Oregon City Supply Agreement

1.6.2.1 Clackamas River Water Cooperative Intergovernmental Agreement, 1998

The City of Oregon City and CRW entered into a new agreement to terminate the Renewal and Modification of Cooperative Intergovernmental Agreement ("the 1992 Renewal") and allocate the respective rights and responsibilities of all parties involved in domestic water services to the territory known as Holcomb-Outlook-Park Place Health Hazard Area (HOPP Area). This agreement consists of amended agreements from the Clairmont Water District Intergovernmental Cooperative Agreement ("the 1989 Agreement"), Clackamas River Water Cooperative Intergovernmental Agreement ("the 1990 Agreement"), and the 1992 Renewal.

According to the new agreement, the City of Oregon City and CRW shall cooperate in planning and constructing six basic facilities in the HOPP Area. Table 1.1 lists these facilities and their respective funding sources.

This agreement was established in April of 1998 and remains in effect through 2028. Appendix C shows CRW's agreement with the City of Oregon City.

Table 1.1 Basic Facilities

Basic Facility	Funding
1. Hunter Avenue Pump Station (1,800 gpm expandable to 2,500 gpm and Master Meter)	Oregon City and CRW
2. Holcomb Road Transmission Piping (16" dia.) and Forsythe Road Master Meter)	Oregon City and CRW
3. Barlow Crest Reservoir (1.75 mg) and Lower Level CRW Master Meter	Oregon City and CRW
4. Barlow Crest Pump Station (900 gpm) and Upper Level District Master Meter	CRW
5. South Fork Water Board Hunter Avenue Transmission Piping Improvements (42" dia.)	Oregon City and South Fork Water Board
6. Oregon City HOPP Pressure Zones 1 and 2 Intertie Facilities	Oregon City

1.6.2.2 South End Area Cooperative Intergovernmental Agreement, 2000

The City of Oregon City and CRW entered into an agreement where both parties agree to jointly fund, connect, and use existing water lines pursuant to the agreement's terms and conditions in the South End area of CRW. Table 1.2 lists all the jointly funded and connected water lines and describes the actions taken.

This agreement was established in February of 2000 and remains in effect through 2020. Appendix D shows CRW's agreement with the City of Oregon City.

Table 1.2 Identification of Joint Usage Lines

Water Line	Action Taken
South End Road	CRW shall install a 4,000 ft. ductile-iron water transmission line. Pipe diameter will be determined.
Salmonberry Drive	CRW shall install an appropriate connection at the east end of street as part of South End line construction.
Maywood Street	CRW shall install an appropriate connection at the north end of street as part of South End line construction.
Finnigan's Way	Oregon City shall connect new development off Parrish Road to CRW water line in Finnigan's Way, and CRW shall approve connection details and activate the connection at the appropriate time.
Longstanding Court	CRW shall install a new 8" connection in the existing 12" line in South End Road and connect this service once Oregon City approves the connection detail.
Rose Road	CRW shall install a new 8" connection in the existing 12" line in South End Road and connect this service, once Oregon City approves the connection detail.
Beutel Road	CRW shall install and connect 8" tee in new South End Road transmission line once Oregon City approves the connection detail.
Parrish Road	CRW shall install 8" tee in new south End Road transmission line. CRW shall make connection to 8" line in Parrish Road if Oregon City provides for the line's development.

Table 1.2 Identification of Joint Usage Lines (Continued)

Water Line	Action Taken
Parkland Court	CRW shall install and connect 8" tee in new South End Road transmission line once Oregon City approves the connection detail.
South End Court	CRW shall install and connect 8" tee in new South End Road transmission line once Oregon City approves the connection detail.
Forest Ridge Lane	CRW shall install and connect 8" tee in new South End Road transmission line once Oregon City approves the connection detail.
Proposed Merchant Meadows Subdivision Development Loop Line	City shall provide for connection to Forest Ridge Lane.
Impala Lane	CRW shall install and connect 8" tee in new South End Road transmission line once Oregon City approves the connection detail.
Navaho Way	CRW shall install and connect 8" tee in new South End Road transmission line once Oregon City approves the connection detail.

1.6.2.3 Clackamas River Water and Oregon City Remuneration Intergovernmental Agreement, 2018

The City of Oregon City and CRW entered into a remuneration agreement for facilities that are within Oregon City's city limits that are withdrawn from CRW and become part of Oregon City's water system. A copy of the agreement is included as Appendix E. This agreement defines a methodology on how the value of an asset is to be calculated, should Oregon City take over a portion of CRW's system. The value is asset based and indexed to Engineering News Record (ENR) Construction Cost Index (CCI), accounting for depreciation. Tables 1.3, 1.4, and 1.5 are assumed equivalents for pipe material, pipe size, and unit costs for pipelines per the remuneration agreement. These costs are based on historical costs that CRW have paid for pipelines in the potential transfer areas in the past, but do not necessarily match the unit costs presented in the CIP as part of this master plan.

Table 1.3 Remuneration Agreement: Assumed Equivalents for Pipe Size

	Assumed % of Ductile Iron Cost for a Given Size Pipe
Asbestos Cement	84%
Cast Iron	80%
Ductile Iron	100%
HDPE	70%
PVC	80%
Steel	123%

Table 1.4 Remuneration Agreement: Assumed Equivalents for Pipe Material

Inch (")	Assumed Multiple of 8-inch Cost for a Given Pipe Material
1"	0.43
1.5"	0.49
2"	0.54
2.5"	0.69
3"	0.70
4"	0.78
6"	0.91
8"	1.00
10"	1.11
12"	1.19
14"	1.49
16"	1.51
20"	1.73
24"	1.95
36"	2.16

Table 1.5 Remuneration Agreement: Unit Pipe Costs, 2017

Assumed Reproduction Unit Costs for Water Pipe by Material and Size in Transfer Year 2017						
Size	Asbestos Cement	Cast Iron	Ductile Iron	HDPE	PVC	Steel
1	57	55	68	48	55	84
1.5	65	62	78	55	62	96
2	72	69	86	60	69	106
2.5	92	88	110	77	88	135
3	93	89	111	78	89	137
4	104	99	124	87	99	153
6	122	116	145	101	116	178
8	134	127	159	111	127	196
10	148	141	176	124	141	217
12	159	151	189	132	151	233
14	199	190	237	166	190	291

Table 1.5 Remuneration Agreement: Unit Pipe Costs, 2017 (Continued)

Assumed Reproduction Unit Costs for Water Pipe by Material and Size in Transfer Year 2017						
Size	Asbestos Cement	Cast Iron	Ductile Iron	HDPE	PVC	Steel
16	202	192	240	168	192	295
20	231	220	275	193	220	338
24	260	248	310	217	248	381
36	288	275	343	240	275	422

Notes:
1. The unit costs shown above represent construction cost only; a 25% markup for engineering and overhead is added later in the calculation. These unit costs are intended to include not just the actual pipe, but also the appurtenances (hydrants, valves, services, meters, etc.) customarily installed along with a water line extension.
2. Benchmark year for cost estimates: 2017.
3. Assumed reference year: 2017.
4. 8" Ductile Iron Unit Cost in Benchmark Year: $159/LF.
5. 8" Ductile Iron Unit Cost in Reference Year: $159/LF.

1.7 Report Organization

This Plan report contains eight chapters, followed by appendices that provide supporting documentation for the information presented in the report. The chapters are briefly described below:

Chapter 1 – Introduction: This chapter presents the need for this Plan and the objectives of the study. Lists of abbreviations and reference materials are also provided to assist the reader in understanding the information presented.

Chapter 2 – Existing System: This chapter describes the existing public drinking water system.

Chapter 3 – Water Requirements: This chapter presents a demographic analysis and the historical water production and consumption trends of CRW's planning areas, as well as the water demand forecasts for the planning period.

Chapter 4 – Policies and Criteria: This chapter presents the policies and criteria that govern various aspects of operations, maintenance, and expansion. It reviews the service area policies, supply policies, the system analysis planning criteria, and seismic criteria.

Chapter 5 – Supply Analysis: This chapter presents the results from the supply analysis and recommendations.

Chapter 6 – Capacity Evaluation: This chapter discusses hydraulic evaluation of the water distribution system, and discuss recommended projects to mitigate identified deficiencies.

Chapter 7 – Seismic Assessment: This chapter defines the seismic system and critical facilities.

Chapter 8 – Capital Improvement Plan: This chapter presents the capital improvement projects, cost estimates, and project timing. This chapter is organized to assist CRW in making financial decisions.

1.8 Acknowledgments

Carollo Engineers, Inc. and their team members would like to acknowledge and thank the following individuals for their efforts and assistance in completing this Plan. Their cooperation and courtesy in obtaining a variety of necessary information were valuable components in completing and producing this report:

- Todd Heidgerken – CRW, General Manager
- Bob George – CRW, Chief Engineer (Retired)
- Adam Bjornstedt – CRW, Chief Engineer
- Joe Eskew – CRW, Engineering Manager
- Betty Johnson – CRW, Hydraulic Modeling
- Lara Kammereck – Carollo Engineers, Inc., Project Manager
- Matt Huang – Carollo Engineers, Inc., Modeling Lead
- Aurelie Nabonnand – Carollo Engineers, Inc., Project Engineer
- Natalie Reilly – Carollo Engineers, Inc., Staff Professional
- Kevin Tice – Carollo Engineers, Inc., Staff Engineer
- Josh Miner – Carollo Engineers, Inc., Staff Engineer
- Karen Hooge – Carollo Engineers, Inc., Document Processor
- Riley Powers – Carollo Engineers, Inc., GIS Analyst
- Kent Yu – Seft Consulting Group, Resiliency Structural Lead
- Wolfe Lang – McMillan Jacobs Associates, Resiliency Geotechnical Lead

Chapter 2

EXISTING WATER SYSTEM – SOUTH SYSTEM

2.1 Introduction

This chapter describes Clackamas River Water (CRW) water system infrastructure in the South System. This chapter also presents the remaining useful life analysis performed on the existing system.

To account for the topography of Clackamas River Water District's (CRW) South System, the water system consists of eight individual pressure zones (including South-End and Meyers), nine storage facilities, and seven booster pump stations (PS) within the 29.4 square miles of CRW's South System service area. CRW's pressure zones and water system facilities in the South System are shown on Figure 2.1.

Currently, CRW's WTP does not provide water to the South System. CRW's South System is currently mostly served by South Fork Water Board (SFWB). It is anticipated that most of the customers located on the South System will be served from CRW's water treatment plant in the future, as part of the Backbone projects. CRW is progressing on the development of their Backbone projects (both Phases 1 and 2) that will allow for water from CRW's water treatment plant to be provided to a majority of the South System. The Meyers/Leland Road area and South end Road will still have the water source with SFWB and Oregon City providing the transmission to these two areas. The Backbone projects are detailed in Chapter 6.

The hydraulic profile for the existing system shown in Figure 2.2 shows how the various components of the water system work together to provide water service to customers.

The South System consists of one (Hunter Heights) hydraulically disconnected system. This Plan focuses on the Holcomb/Barlow Crest/Hunter Heights, and Redland/Beavercreek/Henrici systems during the analysis.

- The Holcomb/Barlow Crest/Hunter Heights system is in the northern portion of the system, close to the Clackamas River, and is served by the South Fork Water Board (SFWB) by wheeling water through the Oregon City distribution system to the Forsythe Master Meter and Hunter Avenue Pump Station. To serve the Barlow Crest connections, water is wheeled through a combination of CRW and Oregon City facilities consisting of the Hunter Avenue Pump Station, Holcomb Blvd. 16-inch transmission main and the Barlow Crest Reservoir. From the Barlow Crest Reservoir, CRW serves the Holcomb and Hunter Heights pressure zones.
- The Redland/Beavercreek/Henrici system contains most of the South System and is served by SFWB at the Anchor Way connection.
- The South End and Meyers connections are two small service areas located south of Oregon City and are served from water wheeled through Oregon City's system.
- There are some CRW customers considered "joint users" who are served from water purchased from Oregon City and served through Oregon City's distribution system.

While developing this Water System Plan (Plan), Carollo Engineers, Inc. (Carollo) performed a site visit. Photos of the various facilities can be found in Appendix F.

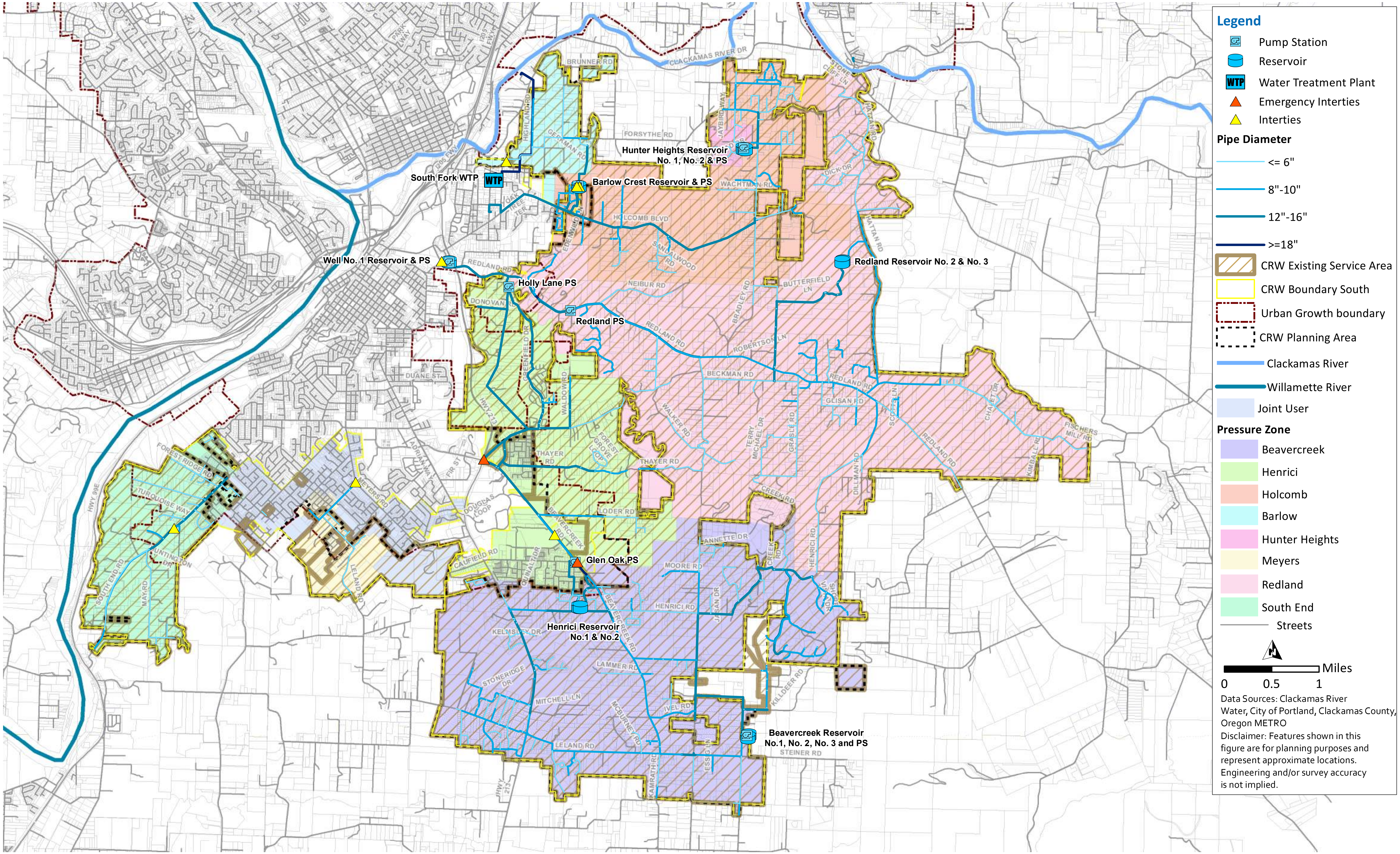

Figure 2.1 CRW Existing System and Facilities - South System

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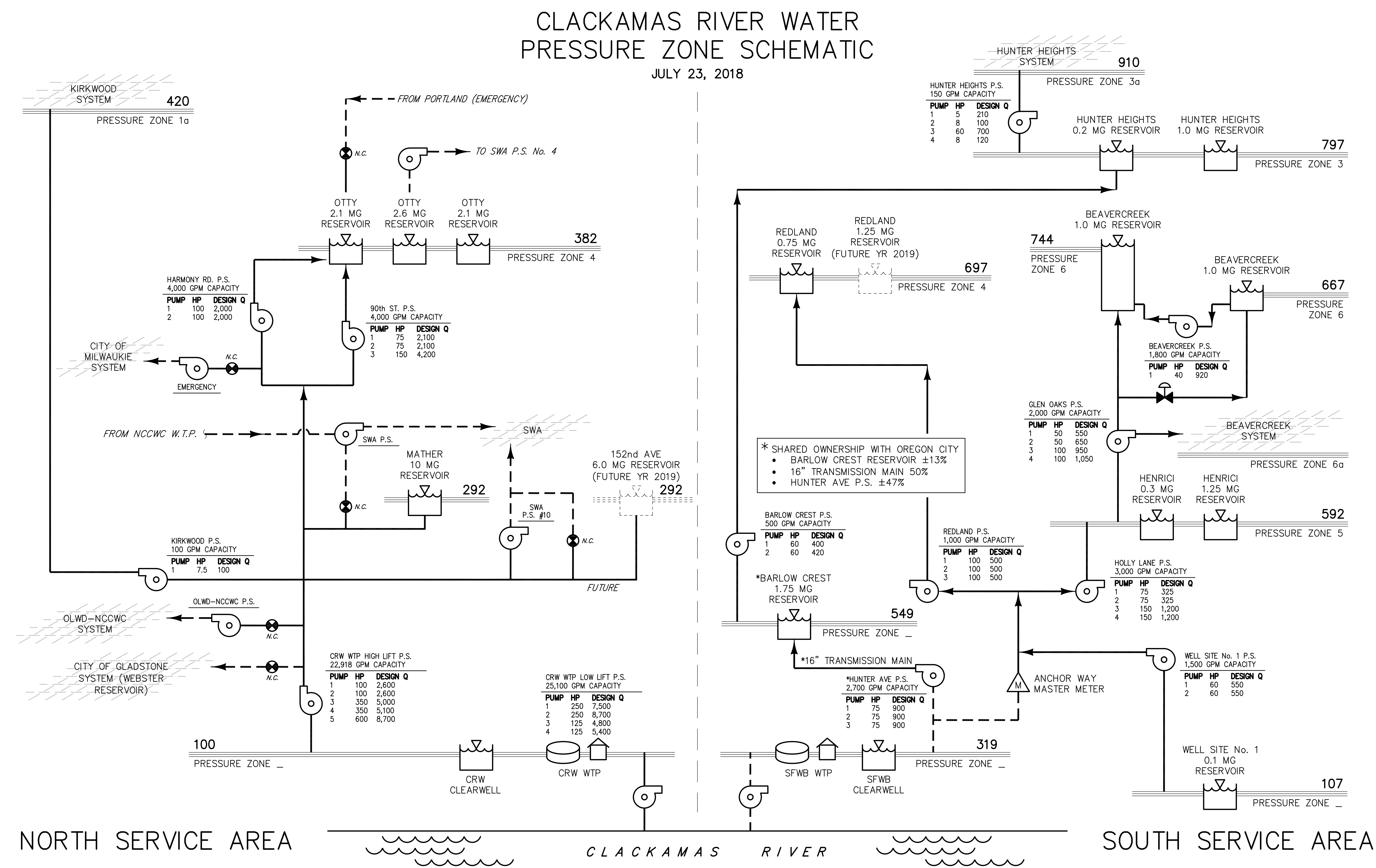

Figure 2.2 Hydraulic Profile (South System)

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2.2 Description of Existing Facilities

2.2.1 South Service Area History

CRW's South System supplies unincorporated portions of Clackamas County south of the Clackamas River, and portions of Oregon City. The region is mainly rural and primarily outside of the Urban Growth Boundary. The South System consists of the area previously known as the Clairmont Water District before it merged with the Clackamas Water District to form CRW.

2.2.2 Water Supply Facilities

CRW's South Service area is predominantly supplied as a wholesale customer of the South Fork Water Board (SFWB). Water supplied to the South Service Area is metered via five separate primary connections:

- Anchor Way Master Meter.
- Barlow Crest Pump Station.
- Gravity feed from Barlow Crest Reservoir.
- Meyers Way connection (Master Meter).
- South End connection (Master Meter).

CRW has an additional source of supply for the South Service Area: Well Site No. 1. However, this well is only used for emergencies. Two 60 horsepower (hp) booster pumps with 550 gallons per minute (gpm) capacity each are at Well Site No. 1 and can supply the entire South Service Area, except for South-end and Meyers zones; however, well capacity is limited compared to system demand. There are some customers considered "joint users" who are served from water purchased from Oregon City and served through Oregon City's distribution system.

2.2.3 Interconnections with Other Systems

CRW's water distribution system is interconnected with several other systems through interties for emergency supply and wholesale water sales and purchases. These interconnections are summarized in Table 2.1.

CRW also shares ownership of the following facilities with Oregon City:

- Barlow Crest Reservoir (13% ownership) – See Section 2.2.6;
- 16-inch Transmission Main (50% ownership) – Starting on Hunter Avenue (at Hunter Ave Pump Station), following Cleveland Street, Holcomb Blvd., Widman Court, and ending at Barlow Crest Reservoir.
- Hunter Heights Pump Station (47% ownership) – See Section 2.2.5.

Table 2.1 CRW Interconnections Summary

ID	Location	Water Supply Intertie(1)	Customer	Description	CRW Pressure Zone	Intertie Use
A	Forsythe	Oregon City	CRW	4-inch Master Meter	Holcomb/Barlow Crest	Secondary Wholesale
B1	Barlow Crest Pump Station	Oregon City	CRW	8-inch Master Meter	Holcomb/Hunter Heights	Primary Wholesale
B2	Barlow Crest Gravity	Oregon City	CRW		Barlow Crest	Primary Wholesale
C	Anchor Way & Redland Road	SFWB	CRW	8-inch Master Meter	Suction of Redland and Holly Lane P.S.	Primary Wholesale
D	Beavercreek Rd north of Glen Oak Rd	Oregon City /CRW	CRW	Normally Closed Valve (Emergency Use)	Henrici	Emergency
E	Meyer/Leland	Oregon City	CRW	Master Meter	Meyers zone	Primary Wholesale
F	Impala/Southend Rd	Oregon City	CRW	Master Meter	South-end zone	Primary Wholesale
G	Maple Lane Court/Beavercreek Rd	Oregon City/CRW	CRW	Normally Closed Valve (Emergency Use)	Henrici	Emergency
A1	Hunter Ave(2)	SFWB	CRW	Hunter Ave P.S. to Barlow Crest Reservoir	Holcomb	Primary Wholesale

Note:
(1) Source of supply for all Interties is SFWB.
(2) Hunter Ave Intertie supplies water to Barlow Crest Reservoir and Forsythe Master Meter.

2.2.4 Pressure Zones

The South System's topography varies greatly and is therefore divided into six pressure zones. The South System also includes both South End and Meyers pressure zones. Elevations generally increase from the Willamette River toward the eastern boundary of the service area.

CRW serves customers at elevations between approximately 70 feet (ft) and 820 ft in the South system. Currently water is purchased from the SFWB to serve most of CRW's pressure zones, with booster pumps lifting water to each zone. Once the Backbone Projects are completed (estimated completion date 2024), CRW's WTP will provide water to the majority of the south service areas. It is anticipated that the interconnect with SFWB and Oregon City will be maintained as an emergency water source.

Table 2.2 lists each pressure zone and provides the nominal HGL, minimum, and maximum elevations served. Reservoir levels establish the hydraulic grade lines of the Henrici, Redland, Beavercreek, Barlow, and Holcomb pressure zones. The Hunter Heights Pressure Zone is a small boosted area of the system with a nominal HGL of 910 ft.

Table 2.2 Pressure Zones Summary

Pressure Zone	Hydraulic Grade Line, ft	Minimum Elevation Served, ft(1)	Maximum Elevation Served, ft(1)
Henrici	592	84	560
Beavercreek	744	156	670
Redland	697	70	665
Holcomb	797	336	764
Hunter Heights	910	683	800
Holcomb-Barlow	549	200	465

Note:
(3) Source: CRW Hydraulic Model.

2.2.5 Pump Stations

Booster pump stations deliver water from areas of lower elevation to areas of higher elevation, typically from one pressure zone to another. CRW owns, operates, and maintains six pump stations in the South Service Area, as shown on Figure 2.1. CRW co-owns part of a seventh pump station, known as Hunter Ave Pump Station, which provides water to the Barlow Crest Reservoir.

In 1998, Oregon City and CRW entered into a Memorandum of Understanding (MOU) known as the HOPP Area Water Service Plan. The improvements within the MOU included the shared design, construction, and ownership of three components that supplied water to Oregon City's Intermediate Park Place Pressure zone and the Barlow Crest Reservoir.

As a result of the MOU, the reservoir now serves CRW's Holcomb service areas with both gravity andpumped water to CRW's Barlow Crest Pump Station. The shared components consist of the Hunter Avenue Pump Station, 8,100 feet of 16-inch ductile iron main and Barlow Crest Reservoir. CRW owns 47, 50, and 14 percent of these facilities, respectively. Redland and Holly Lane pump stations pump water supplied from SFWB into the system, while the other two pump stations (Glen Oak and Hunter Heights pump stations) boost water to higher pressure zones within the service area.

Detailed information on each of CRW's pump station facilities is summarized in Table 2.3. Pump stations in the South Service Area are predominantly controlled by reservoir level set points. A summary of pump station control set points is summarized in Table 2.4.

Table 2.3 Pump Stations Summary

Pump Station	Location	From	To	Total Capacity (mgd)	Firm Capacity (mgd)	Pump Number	Pump Capacity (gpm)	Motor (hp)	Year Constructed / Installed	Speed (constant, VFD)	Standby Power Source
Barlow Crest	15098 Oyer Dr	SFWB	Holcomb	1.2	0.6				2000		Emergency Receptacle
						1	500	60	2000	Constant	
						2	500	60	2000	Constant	
Holly Lane	17098 S Holly Ln	SFWB	Henrici	4.4	2.7				1961		Emergency Receptacle
						1	540	75	1961	Constant	
						2	540	75	1961	Constant	
						3	1,200	150	1961	Constant	
						4	1,200	150	1961	Constant	
Redland	15074 S Redland Rd	SFWB	Redland	2.2	1.4				1967		Emergency Receptacle
						1	500	100	1995	Constant	
						2	500	100	1967	Constant	
						3	500	100	1995	Constant	
Glen Oak	15410 Glen Oak Rd	Henrici	Beavercreek	4.6	3.1				1961		Emergency Receptacle
						1	550	50	1995	Constant	
						2	650	50	1995	Constant	
						3	950	100	1961	Constant	
						4	1,050	100	1961	Constant	
Beavercreek	21760 S Yeoman Rd	Beavercreek	Beavercreek	1.3	0	1	920	40	1975	Constant	Emergency Receptacle
Holcomb-Hunter Heights	16822 S Taylor Terrace	Holcomb	Hunter Heights	1.6	0.6				1973		Generator
						1	210	5	1973	Constant	
						2	100	8	1973	Constant	
						3	700	60	1973	Constant	
						4	120	8	1973	Constant	
Hunter Ave	16310 Hunter Ave	SFWB	Barlow Crest	3.9	2.6				1999		
						1	900	75	1999	Constant	
						2	900	75	1999	Constant	
						3	900	75	1999	Constant	

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Table 2.4 Pump Station Control Set Points

Pump Station	Primary Pump Control	Secondary Pump Control	Pump Number	Start Level (ft)	Stop Level (ft)
Barlow Crest	Hunter Heights Reservoir No. 1	Discharge Pressure	1	21.0	28.0
			2	20.0	28.0
Hunter Heights	System Demand			63 psi	78 psi
Holly Lane	Henrici Reservoir No. 2		1	18.0	29.0
			2	24.0	29.3
			3	19.0	28.0
			4	23.5	29.5
Glen Oak	Beavercreek Reservoir No. 2		1	71.0	91.0
			2	74.0	90.3
			3	73.0	90.5
			4	70.0	90.0
Beavercreek	Beavercreek Reservoir No. 2		1	80.0	91.0
Redland	Redland Reservoir No. 2	Discharge Pressure	1	20.0	28.5
			2	24.0	29.0
			3	25.0	28.5

2.2.5.1 Barlow Crest Pump Station

The Barlow Crest Pump Station is located at 15098 Oyer Drive and has a 400 gpm and 420 gpm pump. Due to discharge piping restrictions, only one pump can be operated at a time. This pump station is supplied with water from the Barlow Crest Reservoir, which is supplied by the SFWB, and pumps water to Hunter Heights Reservoir No. 1 and the Holcomb Pressure Zone. Pumps are controlled by reservoir level setpoints for Hunter Heights Reservoir No. 1.

2.2.5.2 Holly Lane Pump Station

The Holly Lane Pump Station is located at 17098 South Holly Lane and has two 325 gpm pumps and two 1,200 gpm pumps. The station's total capacity is 3,050 gpm. Up to three pumps can be run at a time in any combination. Pump operation is controlled by reservoir level setpoints at Henrici Reservoir No. 2. This station receives water from the SFWB through the Anchor Way Master Meter and pumps water to the Henrici Pressure Zone.

2.2.5.3 Redland Pump Station

The Redland Pump Station is located at 15074 South Redland Road. The pump station has three 500 gpm pumps for a total capacity of 1,500 gpm. One pump is designated as a lead pump controlled by reservoir level setpoints in the Redland Reservoir. This station also receives water from the SFWB through the Anchor Way Master Meter and pumps water to the Redland Pressure Zone.

2.2.5.4 Glen Oak Pump Station

The Glen Oak Pump Station is located at 15140 Glen Oak Road and is used to supply the Beavercreek Pressure Zone. The pump station has four pumps total: one 550 gpm capacity, one 650 gpm capacity, one 950 gpm capacity, and one 1,050 gpm capacity. Its total capacity is 3,200 gpm. Three of the four pumps can be run at one time in any combination. This station draws water from the Henrici Pressure Zone, and pumps water to the Beavercreek Pressure Zone. Pump operation is controlled by level setpoints in Beavercreek Reservoir No. 2.

2.2.5.5 Beavercreek Pump Station

The Beavercreek Pump Station is located at 21760 South Yeoman Road and is used to transfer water from Beavercreek Reservoir No. 1, at ground level, to Beavercreek Reservoir No. 2. Water is periodically moved from Beavercreek Reservoir No. 1, the ground level tank, to maintain the chlorine residual in the tank. The 920 gpm pump is operated either every third day or when the level in Beavercreek Reservoir No. 2 drops below a level setpoint.

2.2.5.6 Hunter Heights Pump Station

The Hunter Heights Pump Station is located at 16822 South Taylor Terrace and is used to maintain system pressure in the Hunter Heights Pressure Zone. This station also has four pumps: one 210 gpm capacity pump, one 100 gpm capacity pump, one 700 gpm capacity pump, and one 120 gpm capacity pump. The pumps are used to pressurize a 1,000 gallon tank that supplies the Hunter Heights Pressure Zone. Under normal operations, the 210 gpm pump maintains system pressure, and the 100 gpm pump serves as a backup. The 700 gpm pump is for fire flow only, and the 100 gpm is an emergency propane-powered back-up pump. Pump flows are not monitored, only station pressures.

2.2.5.7 Hunter Avenue Pump Station

The Hunter Avenue Pump Station is located at 16310 Hunter Avenue and is used to transfer water from the SFWB system through Oregon City's Intermediate, Park Place and Lower Park Place pressure zones supplying water to the Barlow Crest Reservoir. This pump station has three pumps total, with the ability of adding a forth pump. Each pump has a capacity of 900 gpm, with a total current capacity of 2,700 gpm. Pump operation is controlled by level setpoints at the Barlow Crest Reservoir.

2.2.6 Storage Facilities

Water distribution systems rely on stored water to help equalize daily fluctuations between supply and demand to supply sufficient water for firefighting and meet demands during an emergency or an unplanned outage of a major supply source.

The South service area of CRW's water system has nine reservoirs at six different sites with a combined nominal capacity of 7.28 million gallons (MG). The locations of the existing reservoirs are shown on Figure 2.1, while detailed information on each of the reservoirs is presented in Table 2.5.

2.2.6.1 Well Site No. 1 Reservoir

The Well Site No. 1 Reservoir is an onsite storage reservoir for water pumped from the well pumps. The reservoir was constructed in 1974 and rehabilitated in 2008 and is 27 feet in diameter and 21 feet deep.

2.2.6.2 Barlow Crest Reservoir

The Barlow Crest Reservoir was constructed in 2000 and provides storage for water from the SFWB and supply for the Holcomb Pressure Zone. Water is supplied from SWFB and is pumped to the Holcomb Pressure Zone from the Barlow Crest Pump Station. The 1.75 MG tank was constructed in 2000 and is 100 feet in diameter and 30.6 feet deep. CRW and Oregon City share ownership of the reservoir.

2.2.6.3 Henrici Reservoirs

Two reservoirs provide storage for the Henrici Pressure Zone: Henrici No. 1 and Henrici No. 2. Henrici No. 1 has a capacity of 0.3 MG, while Henrici No. 2 has a capacity of 1.25 MG. Henrici No.1 was constructed in 1961, while Henrici No.2 was constructed in 1975. Details on reservoir dimensions can be found in Table 2.5. The reservoirs are fed by the Holly Lane Pump Station.

2.2.6.4 Redland Reservoirs

Two long-term planned reservoirs provide storage for the Redland Pressure Zone. As part of CRW's Backbone project, Redland No. 1, initially constructed in 1967, was demolished in the spring of 2018 while Redland Reservoir No. 3 was constructed. The reservoir, a 1.25 mg steel ground reservoir, is scheduled to be completed midyear 2019.

Redland No. 2.has a capacity of 0.75 MG, was initially constructed in 1984, and will be rehabilitated under the Backbone Project. Details on its dimensions can be found in Table 2.5.

These reservoirs are currently fed by the Redland Pump Station. Once the Backbone Project is complete, these reservoirs will be fed from the future Hattan Road Pump Station. The Redland Pump Station is anticipated to remain as an emergency backup system. See Chapter 6 for the Backbone Project's configuration.

2.2.6.5 Beavercreek Reservoirs

Two reservoirs provide storage for the Beavercreek Pressure Zone: Beavercreek No. 1 and Beavercreek No. 2. Beavercreek No. 1 is a 1.0 MG ground-level tank that provides emergency storage. Beavercreek No.1 was constructed in 1975, while Beavercreek No.2 was constructed in 1985.

The ground-level tank is filled via an altitude valve that opens when the Glen Oak Pump Station is operating. To maintain chlorine residuals, water is transferred from this reservoir every few days.

Beavercreek No. 2 is a 1.0-MG standpipe that sets Beavercreek system's HGL. Both reservoirs are supplied by the Glen Oak Pump Station. Table 2.5 shows its dimensions.

2.2.6.6 Hunter Heights Reservoirs

Two reservoirs provide storage for the Holcomb Pressure Zone: Hunter Heights No. 1 and Hunter Heights No. 2. Hunter Heights No. 1 is a 0.2 MG tank that also serves as a supply source for the Hunter Heights Pump Station and pressure zone. Both reservoirs are supplied by the Barlow Crest Pump Station. Table 2.5 shows its dimensions. Hunter Heights No.1 and No.2 were constructed in 1975 and 1997, respectively.

Table 2.5 Storage Reservoir Summary

Reservoir Name	Location	Pressure Zone Served	Year Constr.	Total Volume (MG)	Base Elevation (ft)	Overflow Elevation (ft)	Height (ft)	Diameter (ft)
Barlow Crest*	15098 Oyer Drive	Holcomb	2000	1.75	518	548.6	30.6	100
Henrici No. 1	15223 South Henrici Road	Henrici	1961	0.3	561.3	592.25	31	40
Henrici No. 2	15223 South Henrici Road	Henrici	1975	1.25	558	592.25	34.25	78
Beavercreek No. 1	21760 South Yeoman Road	Beavercreek	1975	1	642	666.67	24.67	83
Beavercreek No. 2	21760 South Yeoman Road	Beavercreek	1985	1	651.4	743.4	92	43
Redland No. 1**	17909 South Butterfield Lane	Redland	1967	0.3	665	697	32	40
Redland No. 2	17909 South Butterfield Lane	Redland	1984	0.75	665	697	32	64
Redland No.3	17909 South Butterfield Land	Redland	2019	1.25	665	697	37	83
Hunter Heights No.1	16822 South Taylor Terrace	Holcomb /Hunter Heights	1975	0.2	765	797.5	32.5	33
Hunter Heights No.2	16822 South Taylor Terrace	Holcomb / Hunter Heights	1997	1	749.7	797.5	47.8	61

Notes:
(*) Storage Allocated to CRW 14%, which corresponds to 0.25 MG per HOPP MOU.
(**) Demolished in 2018; will be replaced with Redland Reservoir No.3 in 2019.

2.2.7 Pressure Reducing Stations

CRW operates a number of pressure-reducing stations to provide service to portions of the South System at pressures below the nominal HGL. Pressure-reducing valves (PRV) account for topographic variations within each pressure zone.

Nine PRVs located at three pressure-reducing stations in the South Service Area are used mainly to control pressure for two areas: Beaverlake and Country Village. The location of the South Service Area PRVs is shown in Table 2.6, along with summary information.

Table 2.6 Pressure Reducing Valve Summary

Location/Description	Type	Primary	Secondary	Inlet Pressure (psi)	Outlet Pressure Setting (psi)
Beaverlake					
Henrici Road & Driftwood Drive	PRV-Regulating	2"			190
	Pilot		3/8"		n/a
Henrici Road & Driftwood Drive	PRV-Regulating	4"			180
	Pilot		3/8"		n/a
Henrici Road & Driftwood Drive	PRV-Regulating	12"			150
	Pilot		3/8"		n/a
Henrici Road & Driftwood Drive	PRV-Relief	2"			200
	Pilot Relief		1/2"		n/a
Country Village Estates - North					
Ph. 2-3, Country Village Drive & Blue Vista Drive	PRV-Reducing	6"			55
	Pilot		3/8"		
Ph. 2-3, Country Village Drive & Blue Vista Drive		2"			
Ph. 2-3, Country Village Drive & Blue Vista Drive		4"			
			3/8"		
Country Village Estates - South					
Ph. 1,Country Village Drive & Village Court	PRV-Reducing	6"		90	75
	Pilot		3/8"		
Ph. 1,Country Village Drive & Village Court	PRV-Reducing Bypass	2"			

2.2.8 Distribution System

The CRW South Service Area distribution system consists of approximately 120 miles of pipelines ranging from 1 to 24 inches in diameter. Figure 2.1 shows a map of the existing distribution system, pipe diameters, and alignments.

Table 2.7 summarizes the pipe sizes that comprise CRW's South Service Area. The material of water main throughout the distribution system is identified on Figure 2.3. The decade of installation for each pipe segment is shown on Figure 2.4. Table 2.8 summarizes the pipe materials in the South System.

Table 2.7 Summary of South Distribution System by Pipe Size

Pipe Diameter (inches)	Total Length (ft)	Percent total System (%)
6 and less	283,583	42.9%
8	210,099	31.8%
10	4,284	0.6%
12	110,427	16.7%
14	4,054	0.6%
16	38,383	5.8%
18	1,076	0.2%
24	8,583	1.3%
Unknown	984	0.1%
Total	**661,472**	**100.0%**

Table 2.8 Summary of South Distribution System by Pipe Material

Pipe Material	Total Length (feet)	Percent total System (%)
Asbestos Cement (AC)	14,137	2.1%
Cast Iron (CI)	201,942	30.5%
Copper (CU)	3,597	0.5%
Ductile Iron (DI)	352,491	53.3%
Galvanized (GALV)	2,529	0.4%
Steel (OD or STL)	82,120	12.4%
PVC	3,262	0.5%
Unknown	1,394	0.2%
Total	**661,472**	**100.0%**

2.3 Water Main Remaining Useful Life

CRW maintains thorough asset records of pipe material, length, and installation year for over 99 percent of the water mains in its distribution system. Using this data and CRW's pipe useful life assumptions shown in Table 2.9, the remaining useful life of CRW's existing water main was estimated. With this CRW can prepare a long-term pipeline replacement strategy.

Table 2.9 Water Main Useful Life Assumptions

Pipe Material	Original Useful Life Assumption (yrs)
Asbestos Cement (AC)	50
Cast Iron (CI)	75
Copper (CU)	75
Ductile Iron (DI)	100
Galvanized (GALV)	50
Steel (OD or STL)	50
PVC	50
Unknown(1)	64

Note:
(1) Pipes with unknown material were given a useful life of the average of the known useful life assumptions.

The length of time a pipe is anticipated to remain functional after installation is called the useful life. Useful life depends largely on the pipe material, but can also depend on soil conditions, water constituents, and installation. Theoretically, when a pipe is in service beyond its useful life, the increasing costs of maintenance associated with a failing pipe are too high to justify continued maintenance, and thus justify replacement instead. Although pipe age and material were the only factors used for this remaining useful life analysis, it provides a foundation for long-range planning.

In Table 2.10, the linear feet of water mains in CRW's South System are organized by material and installation decade. The cells of this table are color-coded to show the replacement timeline for each category of pipe. For example, the red cells indicate the linear feet of pipe that have reached the end of its useful life. Gray cells indicate that the pipe will not need to be replaced until after the 20-year planning period.

According to Table 2.10, within the 20-year planning period, CRW should prepare to replace approximately 103,700 feet of pipe that will reach the end of its useful life. To accomplish this, CRW will need to replace approximately 9,110 feet of pipe between 2019 and 2028 and approximately 1,260 feet of pipe per year between 2029 and 2038.

Figure 2.5 shows the number of feet of water main that will reach the end of its useful life during each year replacement period for the next 100 years. As the chart shows, a small portion of the system's water main (16 percent) will reach the end of its useful life by 2039. A majority of the mains in the system will not need to be replaced until after 2075. Based on the pipe material useful life assumptions of Table 2.9, nearly 350,900 LF of water main, on average, will reach the end of its useful life annually between 2075 through 2120.

It is recommended that CRW conduct a conditional assessment program to analyze pipe that may be reaching the end of its useful life based on age. To help CRW locate water main with a condition that requires assessment during the 20-year planning period, Carollo created a color-coded table of water main according to its replacement period, shown in Figure 2.6. Only sections of pipe in poor condition need to be replaced.

The leakage records were updated by CRW and used to prioritize pipelines to include in the program under both short- and long-terms. It was decided that all pipes reaching their Remaining Useful Life (RUL) before 2019 will be part of the short-term program, the rest of the pipes are recommended for the long-term program. The leakage records presented in this chapter, in addition to the remaining useful life analysis, will be used to prioritize pipe replacement projects in Chapter 8 - CIP. Additionally, the pipes identified as reaching their remaining useful life in the planning period will be compared to other projects identified in this Plan. If pipes identified as reaching their remaining useful life in the planning period are also identified for other CIP specific projects, they will not be included in the RUL replacement project. Figure 2.6 shows that most of the water mains anticipated to already have reached their remaining useful life also have records for leakage.

It is recommended CRW uses this figure in the Plan to identify projects and which pipe to replace every year.

Table 2.10 Linear Feet of Pipe by Material and Installation Decade

	Total Length (ft) by Decade Installed								
Material Type	Unknown	1959-1963	1964-1968	1969-1978	1979-1988	1989-1998	1999-2008	2009-2018	Total (ft)
Ductile Iron	132			21,313	46,495	110,079	147,019	27,452	352,491
Cast Iron	22	5,804	1,884	172,087	22,133	11			201,942
Copper	324				41	2,104	1,112	16	3,597
Galvanized Pipe		836		1,164	529				2,529
Steel		77,522		4,230	346	22			82,120
PVC					1,378	1,202		682	3,262
Asbestos-Cement		12,753		1,384					14,137
Unknown	1,361	33							1,394
Total Length (ft)	**1,838**	**96,949**	**1,884**	**200,179**	**70,922**	**113,418**	**148,132**	**28,150**	**661,472**
Percent of Total System (%)	**0.3%**	**14.7%**	**0.3%**	**30.3%**	**10.7%**	**17.1%**	**22.4%**	**4.3%**	**100.0%**

Notes on Color coding:

1. Red: Pipeline is past its remaining useful life.
2. Orange: Pipeline will reach its remaining useful life between 2019 and 2028.
3. Yellow: Pipeline will reach its remaining useful life between 2029 and 2038.
4. Purple: Pipeline will reach its remaining useful life between 2039 and 2048.
5. Light Gray: Pipeline will reach its remaining useful life after 2048.
6. Dark Gray: Pipeline with unknown installation year or pipeline with unknown material type.

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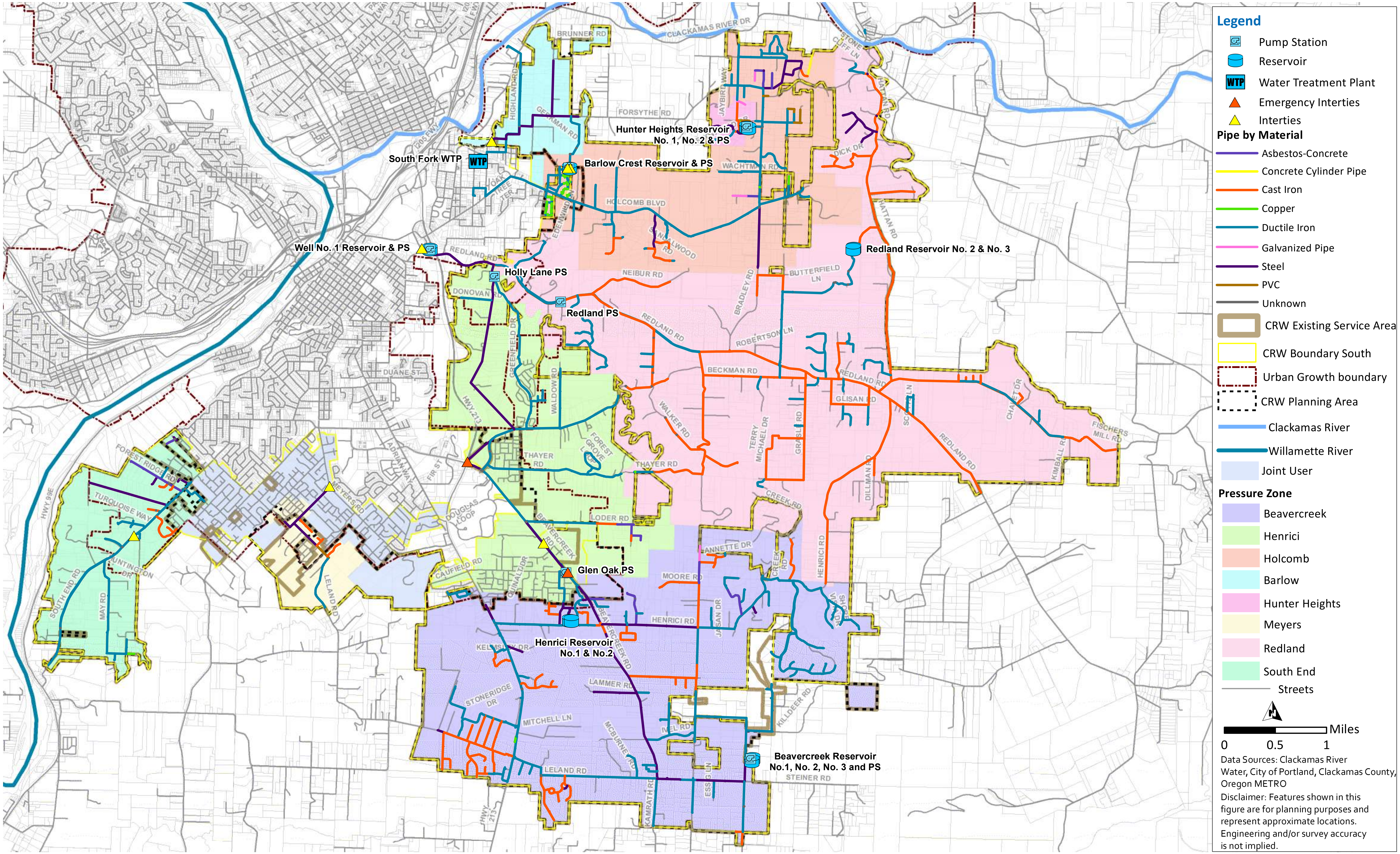

Figure 2.3 Water Main by Pipe Material - South System

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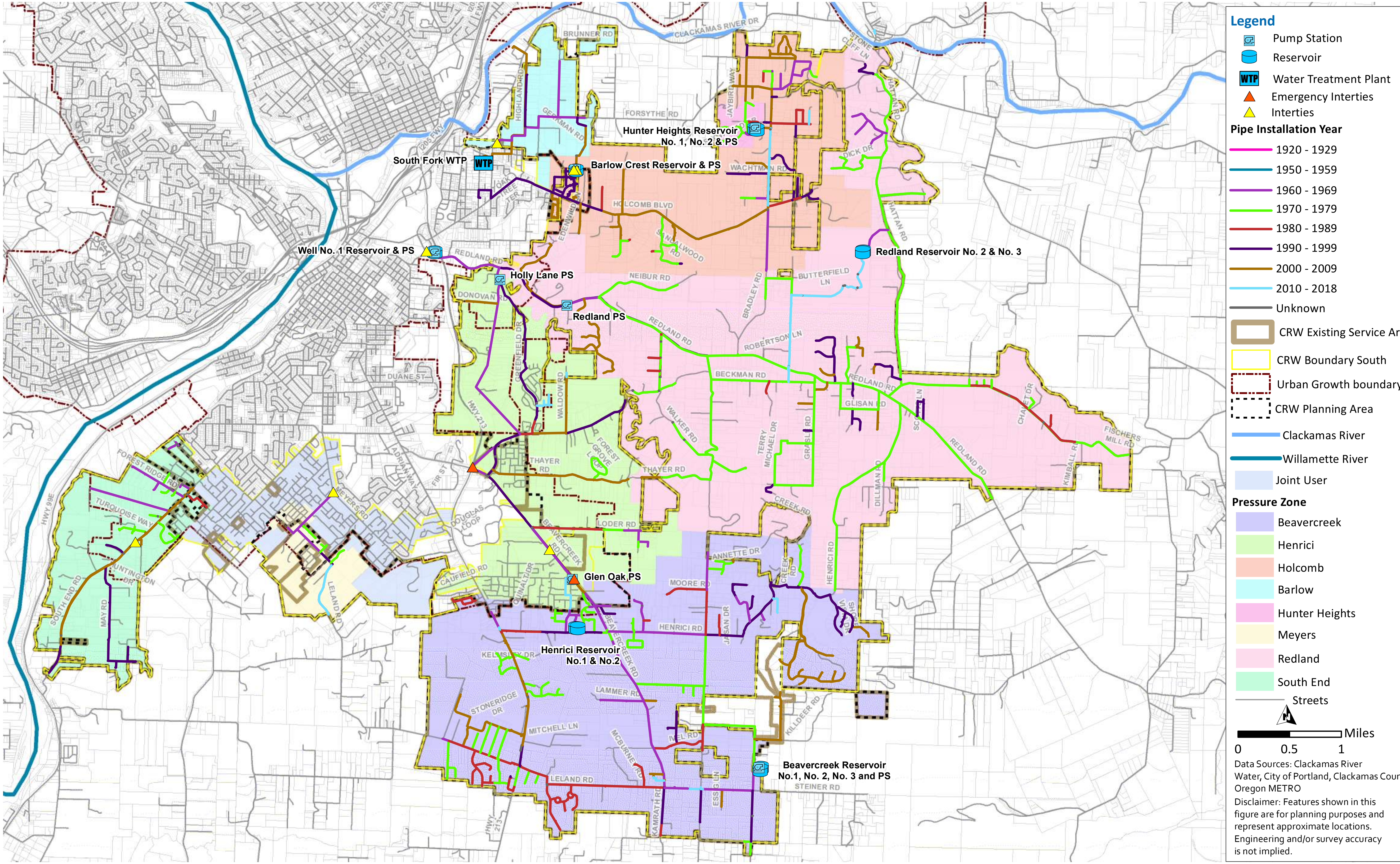

Figure 2.4 Water Main Pipe Installation Year - South System

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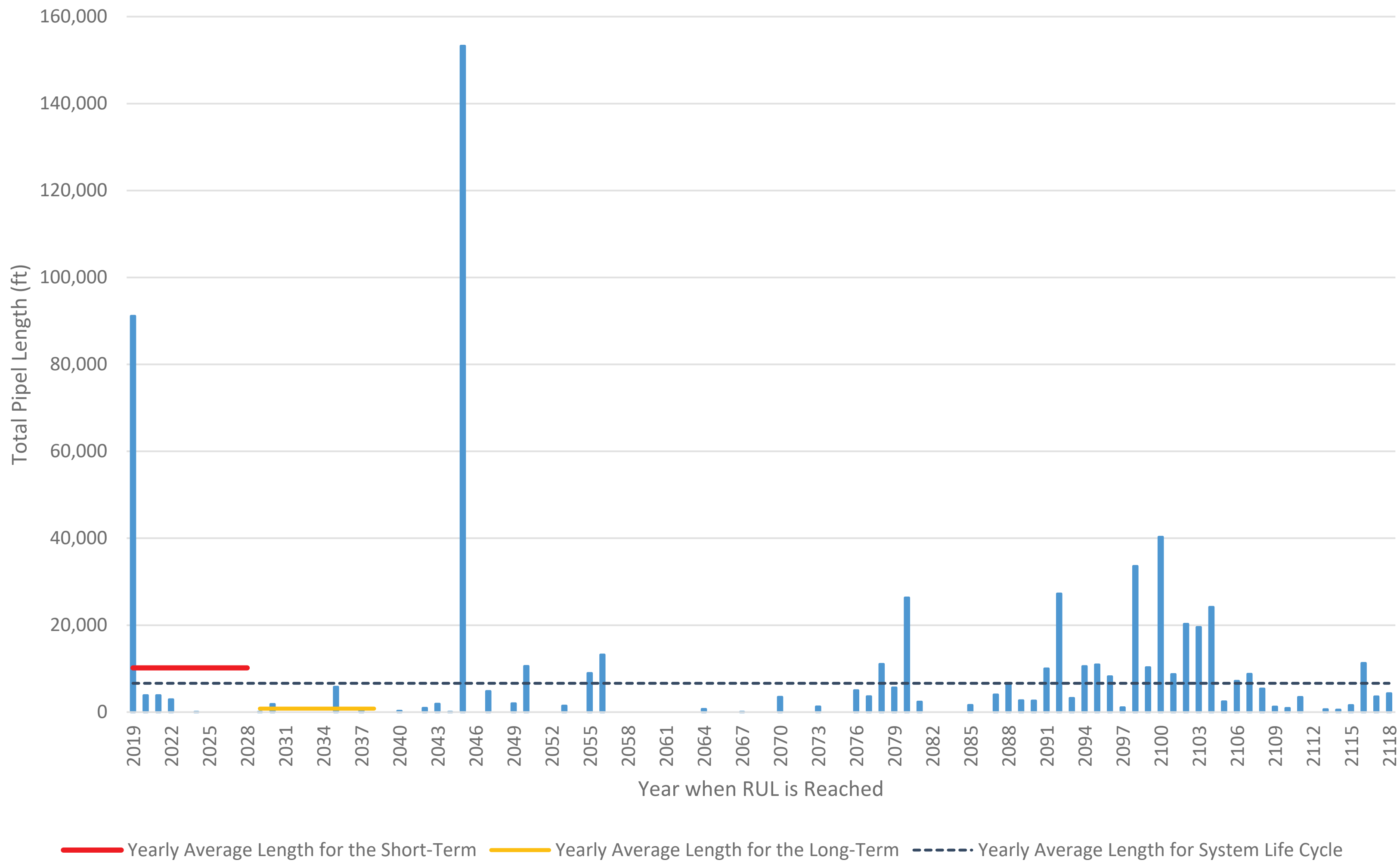

Figure 2.5 Water Main Replacement Schedule Chart

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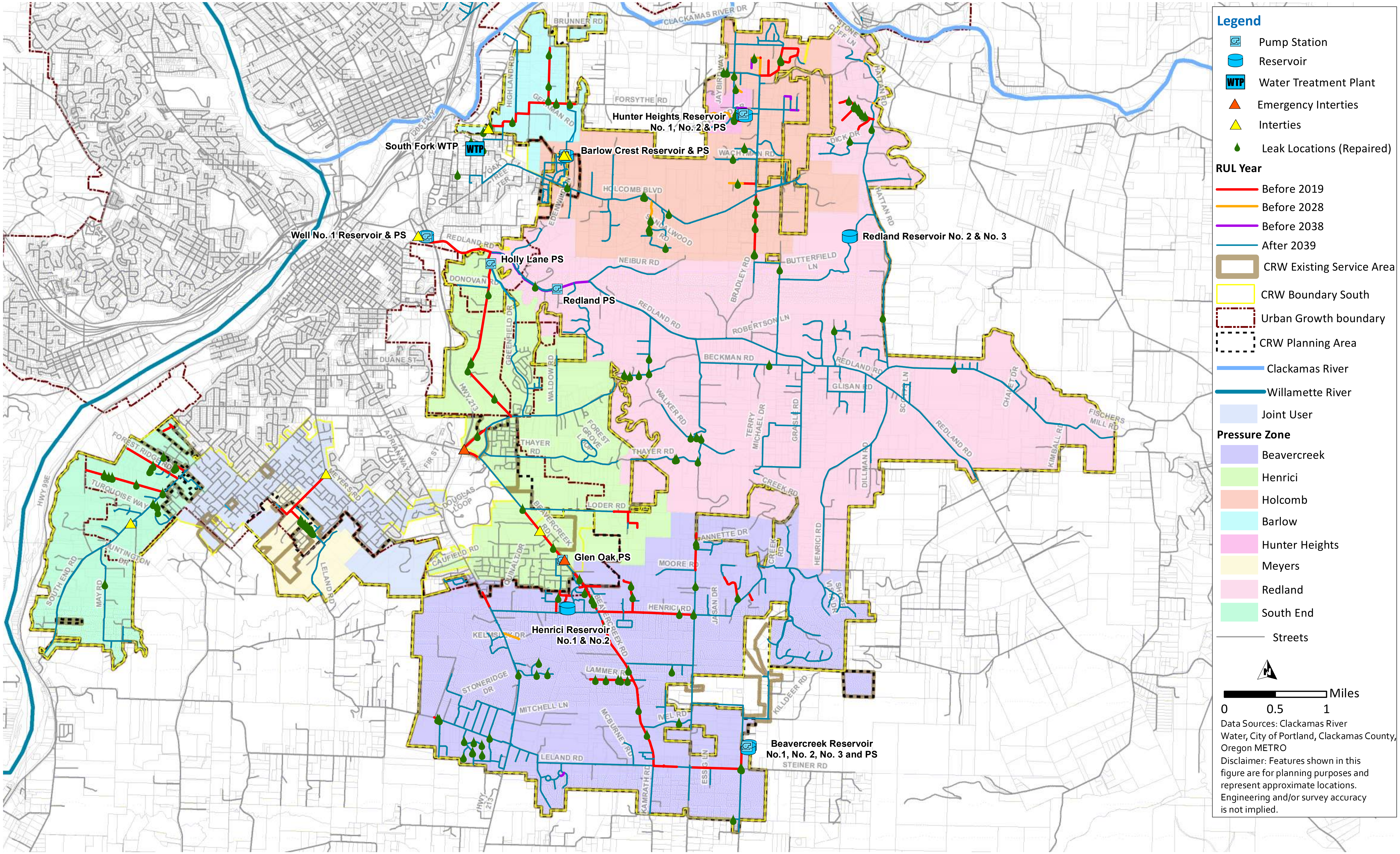

Figure 2.6 Water Main Replacement Schedule Map - South System

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2.4 Known CIP Projects

Additional pipeline projects have been identified in the 1998 WMP, 2005 WMP, or by CRW due to the condition of the pipeline. The projects are outlined in Table 2.11, which includes the project description and project priority, and are shown in Figure 2.7. Most of the pipeline condition projects overlap with the RUL analysis but are identified as individual projects due to the installation year or leakage records. The projects listed in Table 2.11 are incorporated into the CRW CIP as distribution system projects. Some known CIP projects may overlap with projects developed in the system analysis chapter. For these projects, the known CIP project ID will be shown in system analysis ID column of the CIP table, alongside project ID developed in the system analysis chapter.

Table 2.11 South System Known CIP Projects

Project Number(1)	Project Name	Project Description	Project Priority
CRW-100(2)	Forsythe Road	Forsythe Road (Hunter Avenue to Highland Road)	
CRW-101(2,3)	Forsythe Road	Forsythe Road (Highland Road to Brunner Road)	
CRW-102(2)	Bradley Road	Bradley Road (North from Forsythe Road)	
CRW-103(2,3)	Ferguson Road	Ferguson Road (Redland Road to Beckman Road)	Model to determine future main size - (approx. 1,300')
CRW-104(2,3)	S. Thayer Rd	Ferguson Road (North of Copley Ct to Walker)	Model to determine future main size - (approx. 550')
CRW-105	Henrici Road	Ferguson Rd (Copley Ct west to 8" DI main connect	Model to determine future main size - (approx. 3,700')
CRW-106(2,3)	S Ferguson Road	Henrici Road (HWY 213 east to RR Right-of-Way)	Model for FF - Increase capacity (approx. 3,400')
CRW-107(3)	S Maple Lane Road	Between Beckman and Walker Road	Model to determine future main size - (approx. 4,600")
CRW-108	S North End Rd / Terry Michael	S Maple Lane Rd to Anderson	Replace 4" and 6" CI (approx. 3,150')
CRW-109	Ferguson Road	North End / Terry Michael extents from Grasle Rd.	Replace undersized 4" CI main.
CRW-110(2)	Redland Road	Redland Road (Potter Road to Fieldson Road)	Model to determine future main size - (approx. 2,500')
CRW-111(2)	S. Hattan Road	Backbone Phase 1	
CRW-112(2)	S, Henrici Road	Backbone Phase 2 – Alternative Grasle Transmission Route	
CRW-113(2)	Redland Road	Backbone Phase 2 – Alternative Grasle Transmission Route	
CRW-114(2)	S Hattan Rd (Hattan Rd to Redland Reservoir)	Backbone Phase 1	
CRW-115(3)	Redland Road	Redland Rd - Fischers Mills to Scotts Lane	Replace undersized 6" CI main. (approx. 2,200')

Notes:
(1) All projects are from CRW 2018 WSMP Recommended CIP Spreadsheet from CRW.
(2) Project identified in 1998 WMP.
(3) Project identified in 2005 WMP.

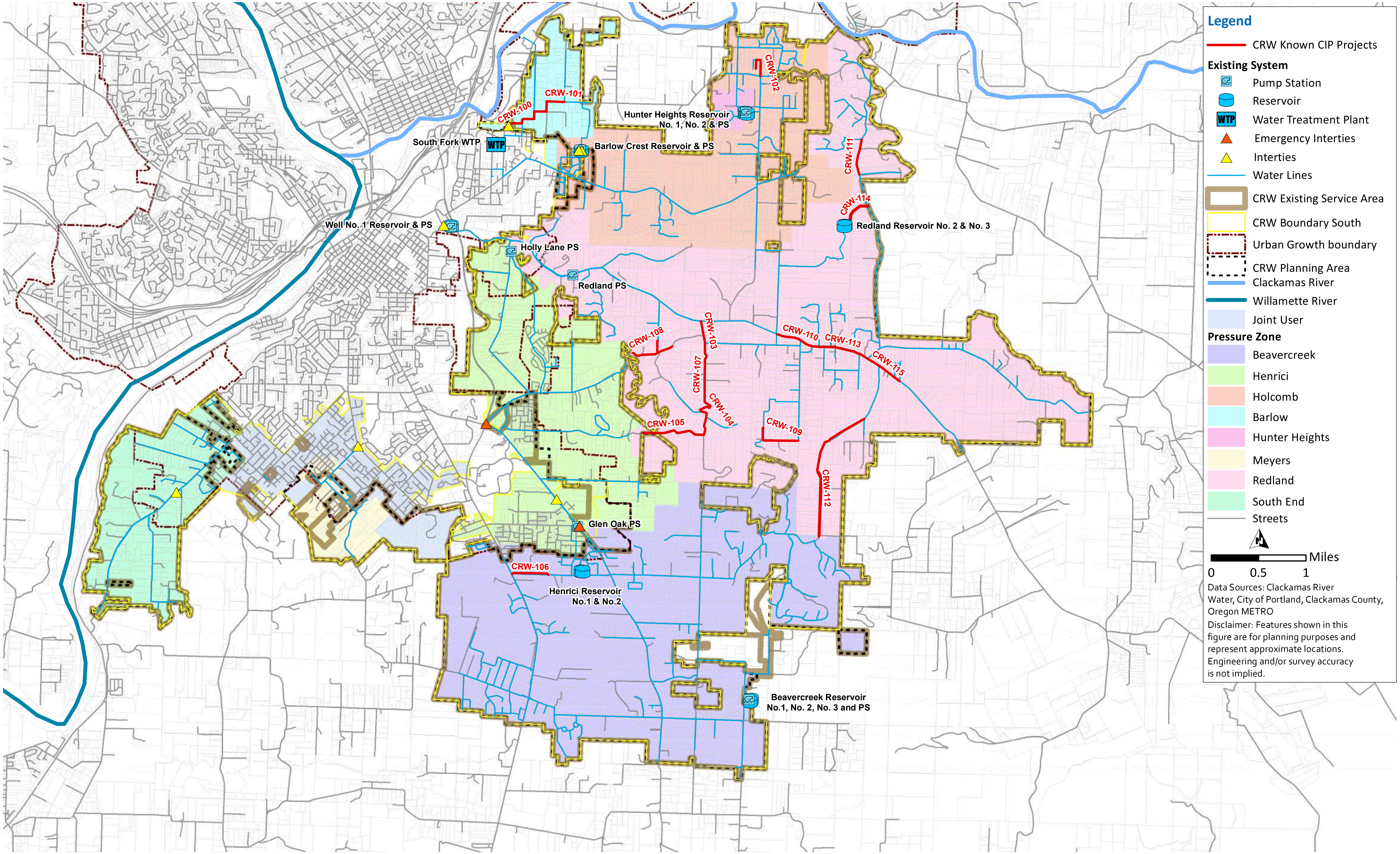

Figure 2.7 South System Known CIP Projects

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Chapter 3

WATER REQUIREMENTS – SOUTH SYSTEM

3.1 Introduction

This chapter presents a demographic analysis and the historical water production and consumption trends of Clackamas River Water's (CRW) planning area, as well as the water demand forecasts for its ten (10)- and twenty (20)-year planning periods. It is important to project realistic future water demands that evaluate the water system's capability to meet future water service requirements, plan for infrastructure projects, and secure adequate water supplies. These future water demands are used as input conditions for the analyses that are used to develop the Capital Improvement Program (CIP).

Accurate demand projections require a detailed demographic analysis to predict where and how population growth will occur. This chapter first describes the demographic trends for each pressure zone in CRW that were analyzed to develop rates of growth. Residential, multi-family, and non-residential growth rates for each of the water system's pressure zones were developed using Oregon Metro Research Center's household, population, and employee forecasts.

The chapter will then offer a thorough review of CRW's unique historical water consumption trends. Historical production data is used to determine the maximum day demand (MDD) and average day demand (ADD) peaking factor. As defined by the Oregon Health Authority (OHA), comparing production data versus consumption data determines distribution system leakage (DSL).

The unique consumption trends of CRW's various customer classes were pulled from customer billing data. The historical average water use for single-family residential (SFR) customers establishes CRW's current Equivalent Household Unit (EHU) water use. Multi-family residential (MFR) and non-residential customers' water use was compared to the EHU value, which expresses their consumption in terms of EHUs.

CRW's top or large consumer in the South System was identified and evaluated separately in this chapter.

Along with the growth rates developed in the demographic analysis, the water use parameters found in the historical production and consumption data were used to predict a range of future water demand. Although low, medium, and high demand projections scenarios were developed, this chapter evaluates the capacity deficiencies in the water system analysis based on medium demand projections.

3.2 Land Use

Land use designations and regulations provide important information for projecting future water demand.

3.2.1 Existing Land Use

Maps of CRW's existing land use within the CRW boundary were developed with data from the Oregon Metro Research Center (Metro). Existing land use for the South System is shown in Figure 3.1.

For the purpose of this Plan, parcels were organized into nine custom land use categories including:

- Industrial
- Agriculture
- Multi-Family Residential
- Single Family Residential
- Commercial
- Rural
- Vacant
- Forest
- Unknown

Figure 3.1 also shows the following types of service connections that are within the land use categories:

- Commercial & Industrial
- Irrigation
- Multi-Family Residential
- Single Family Residential
- Wholesale/Commercial
- Other/Unknown

In general, service connections match the type of parcel; for example, MFR service connections are found exclusively within MFR parcels. However, there can be multiple types of service connections within a type of parcel. The industrial parcels consist of commercial, industrial, irrigation, and at times, SFR and MFR.

The South System is characterized by mostly Forest, SFR, Rural, and Agriculture parcels located throughout the area. Forest parcels make up approximately 5,656 acres, or about 29.2 percent (%) of the South System, while SFR parcels make up approximately 5,327 acres, or about 27.2%. Rural and Agriculture parcels in the South System make up approximately 3,552 and 3,090 acres, respectively, for a total of 34.2% of the South System. Table 3.1 shows the acreage and percent of total for each parcel category in the South System, sorted by largest to smallest.

Table 3.1 Existing Land Use – South System

Land Use Category	Acreage	Percent of Total
Forest	5,656	29.2%
Single Family Residential	5,327	27.5%
Rural	3,552	18.3%
Agriculture	3,090	15.9%
Vacant	1,239	6.4%
Commercial	321	1.7%
Unknown	181	0.9%
Industrial	24	0.1%
Multi-Family Residential	4	0.0%
Total	19,396	100.0%

Notes:
(1) Source: Metro GIS Data.

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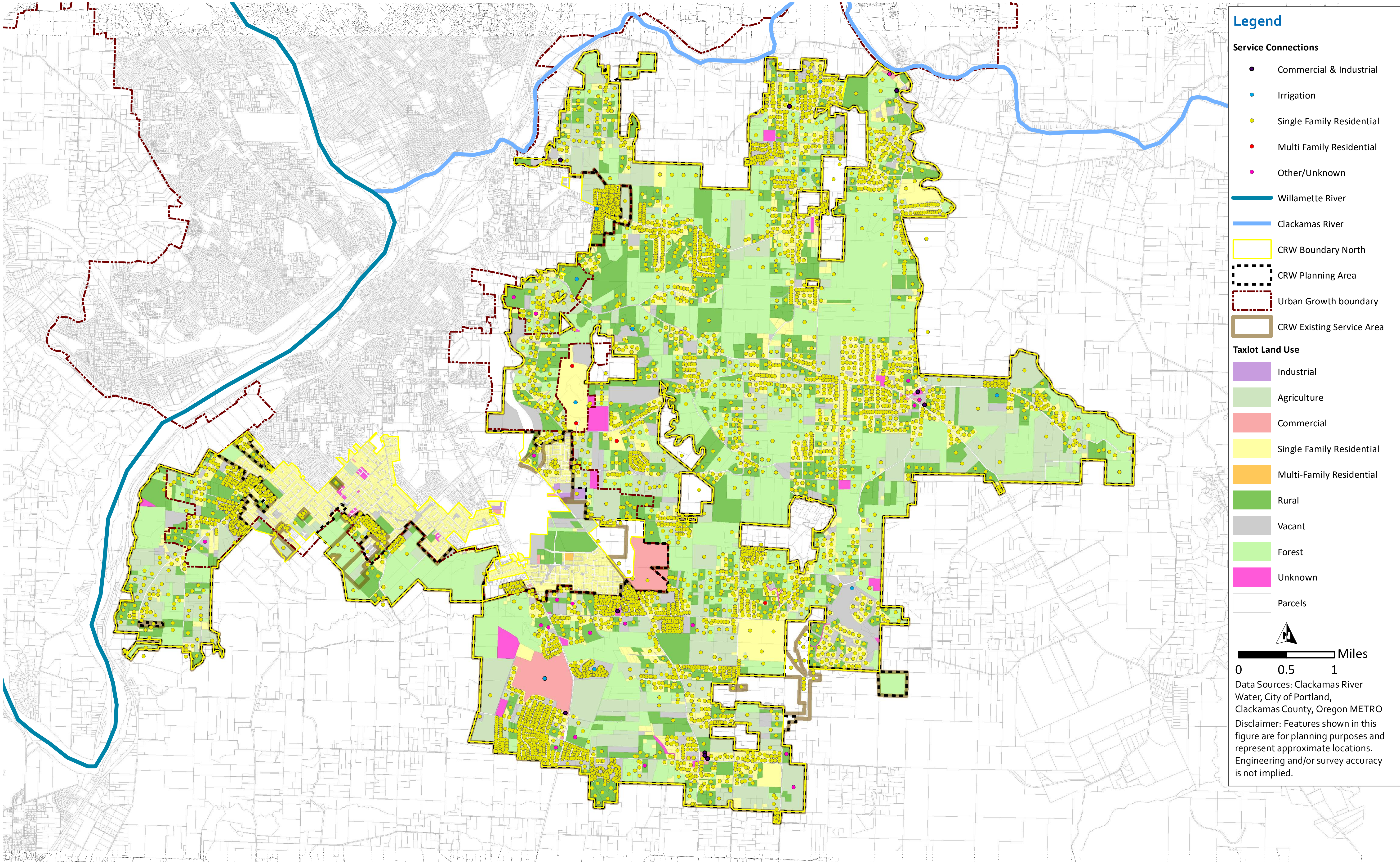

Figure 3.1 CRW Existing Land Use - South System

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3.2.2 Future Land Use

Future land use designations were developed through Metro's data. The future land use designations represent the maximum build-out in the foreseeable future. It is assumed that all parcels within CRW boundary will be served by CRW by the end of the 20-year planning period. The South System's future land use will be increased by approximately 971 acres and adds a "Public" land use category. Because future land use data is not as detailed as existing land use, which uses zoning data, it is assumed that the rural category includes the SFR parcels. Figure 3.2 shows the Future Land Use of the South System.

Table 3.2 Future Land Use – South System

Land Use Category	Acreage	Percent of Total
Rural	11,101	54.51%
Forest	4,088	20.07%
Unknown	3,028	14.87%
Agriculture	1,609	7.90%
Commercial	365	1.79%
Industrial	151	0.74%
Public	25	0.12%
Single Family Residential	0	0.00%
Total	**20,367**	**100.0%**

Notes:
(1) Source: Metro, City of Portland, Clackamas County, and CRW GIS Data.

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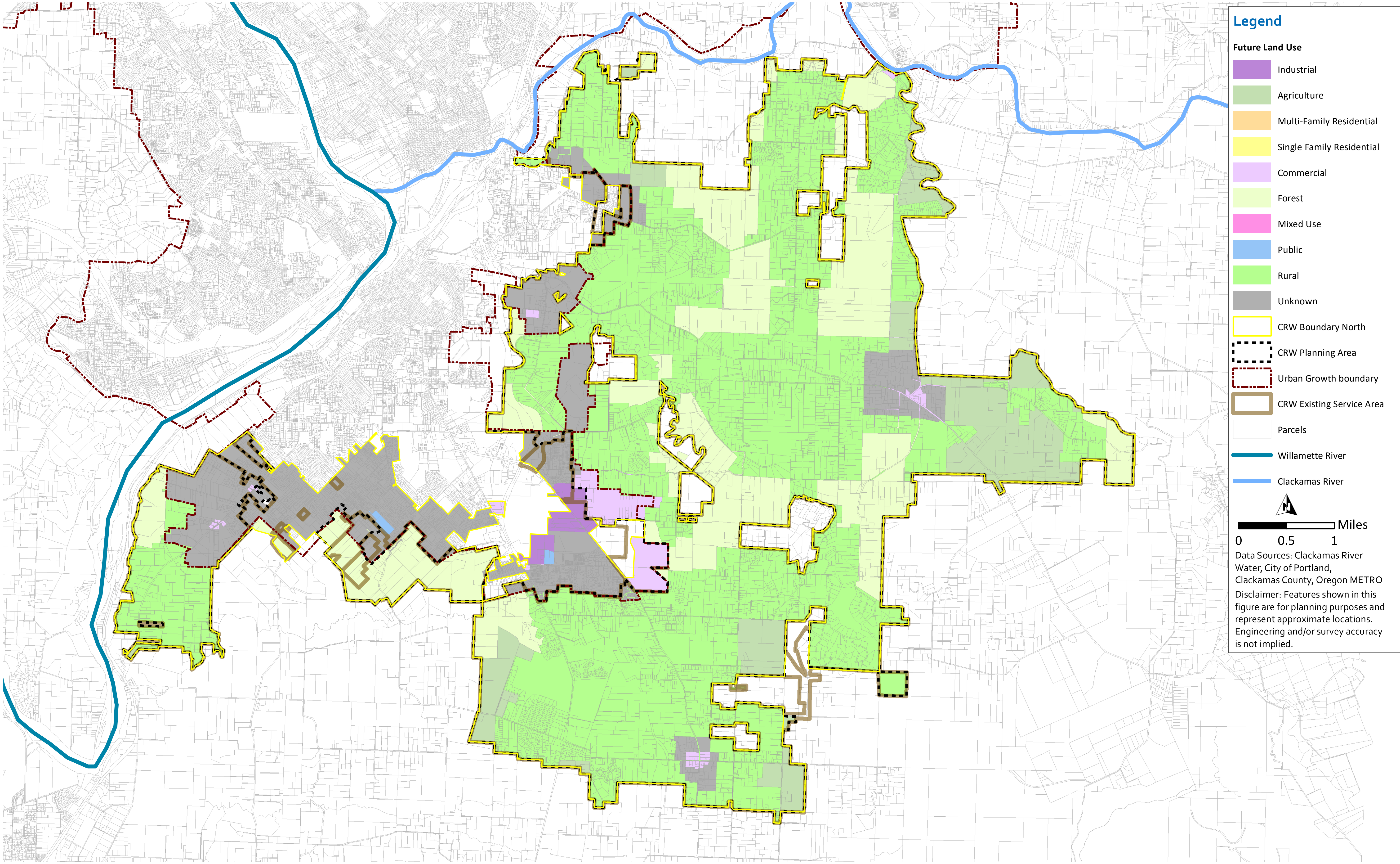

Figure 3.2 CRW Future Land Use - South System

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3.3 Demographic Analysis

The Oregon Metro Research Center (Metro) publishes household, employee, and population growth forecasts for jurisdictions within its regional boundary, which includes all of CRW's jurisdictions.

A demographic analysis of CRW's retail water service area was performed using data from Metro's 2015-2040 Distributed Forecast (Scenario #1610), adopted in 2016 by Metro Ordinance 16-1371. The 2015 dataset contained the most recent forecasts when the demographic analysis was performed.

Appendix G includes the Metro's household and employment projections for each pressure zone. Table 3.3 and Figure 3.3 summarize household and employment projections for CRW's service area. As shown in the figures, the population is expected to grow at an average annual growth rate of 1.6 percent, and employment is expected to grow at an average annual growth rate of 4.9 percent.

Table 3.3 Metro Projections for CRW

	2015	2020	2025	2030	2035	2040	Average Annual Growth
Employment	2,085	3,035	3,985	4,935	5,886	6,836	4.9%
Population	18,158	19,928	21,697	23,467	25,236	27,006	1.6%
Households	6,441	7,193	7,944	8,696	9,448	10,200	1.9%

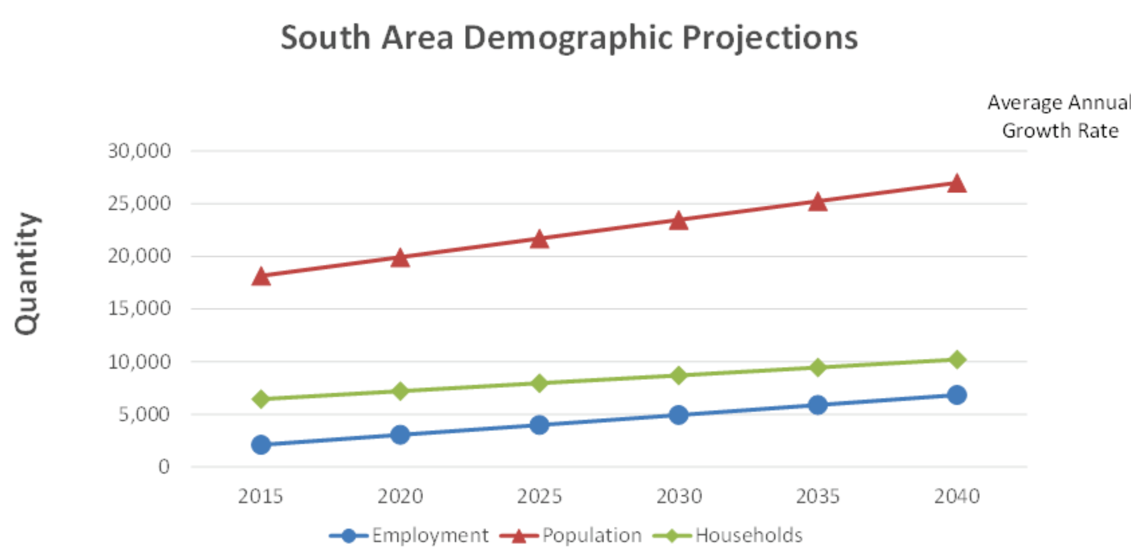

Figure 3.3 South System Demographic Projections

Residential and non-residential annual growth rates were calculated using Metro's household and employee forecasts. To predict the future number of water connections in the 10- and 20-year planning periods, CRW's existing number of water connections was increased by these annual growth rates.

Table 3.4 shows the annual growth rate projections by pressure zone for single-family residential customers. Table 3.4 also shows growth projections for both South End and Meyers Zones. These percentages were calculated using the projected number of households in Table 3.3 and were applied to each customer class's account projections. Although growth rate adjustments for low, medium, and high scenarios were not evaluated, CRW could evaluate them in a future sensitivity analysis.

Tables 3.5 and 3.6 show the annual growth rates for Multi-Family Residential (MFR) and employees, respectively. MFR growth rates were applied to the MFR and Mobile Home Estates connections. Conversely, employee growth rates were applied to the Commercial, Industrial, Institutional, Irrigation, and Government connections.

Table 3.4 SFR Annual Growth Rates by Pressure Zone

Pressure Zone	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Beavercreek Zone	1.8%	1.6%	1.5%	1.4%	1.3%
Henrici Zone	2.4%	2.1%	1.9%	1.8%	1.6%
Holcomb Zone	1.6%	1.5%	1.4%	1.3%	1.2%
Barlow Zone	2.9%	2.6%	2.3%	2.0%	1.8%
Hunter Heights Zone	0.4%	0.4%	0.3%	0.3%	0.3%
Redland Zone	1.0%	1.0%	0.9%	0.9%	0.8%
Meyers Zone	2.4%	2.1%	1.9%	1.7%	1.6%
South End Zone	5.7%	4.4%	3.6%	3.1%	2.7%

Notes:
(1) South System includes Beavercreek, Henrici, Holcomb, Barlow, Hunter Heights, Redland, Meyers, and South End pressure zones.

Table 3.5 MFR Annual Growth Rates

Pressure Zone	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Beavercreek Zone	0.0%	0.0%	0.0%	0.0%	0.0%
Henrici Zone	0.0%	0.0%	0.0%	0.0%	0.0%
Holcomb Zone	0.0%	0.0%	0.0%	0.0%	0.0%
Barlow Zone	0.0%	0.0%	0.0%	0.0%	0.0%
Hunter Heights Zone	0.0%	0.0%	0.0%	0.0%	0.0%
Redland Zone	0.0%	0.0%	0.0%	0.0%	0.0%
Meyers Zone	0.4%	0.4%	0.4%	0.4%	0.4%
South End Zone	0.0%	0.0%	0.0%	0.0%	0.0%

Notes:
(1) South System includes Beavercreek, Henrici, Holcomb, Barlow, Hunter Heights, Redland, Meyers, and South End pressure zones.

Table 3.6 Employees Annual Growth Rates

Pressure Zone	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Beavercreek Zone	0.8%	0.8%	0.8%	0.7%	0.7%
Henrici Zone	0.9%	0.9%	0.8%	0.8%	0.8%
Holcomb Zone	1.0%	0.9%	0.9%	0.9%	0.8%
Barlow Zone	1.6%	1.4%	1.4%	1.3%	1.2%
Hunter Heights Zone	2.8%	2.4%	2.2%	2.0%	1.8%
Redland Zone	0.7%	0.6%	0.6%	0.6%	0.6%
Meyers Zone	0.8%	0.8%	0.8%	0.7%	0.7%
South End Zone	3.9%	3.2%	2.8%	2.4%	2.2%

Notes:

(1) South System includes Beavercreek, Henrici, Holcomb, Barlow, Hunter Heights, Redland, Meyers, and South End pressure zones.

3.4 Historical Supply and Consumption

To help Carollo establish historical demand trends, CRW provided historical water production records, the number of accounts they serve, and consumption data between 2007 and 2016. This data was then evaluated to characterize CRW customers' unique water use. Using that information, several key demand parameters were generated and used to project future demand.

3.4.1 Historical Water Production

In 2016, CRW provided approximately 3,147 MG of water for both the North and South Systems. Approximately 587 MG is provided from multiple master meters to the South System.

Figure 3.4 shows the water sources that produced for the South System in 2016. As shown, the Anchor Way master meter provided approximately 449 MG (76 percent) of the South System's water in 2016.

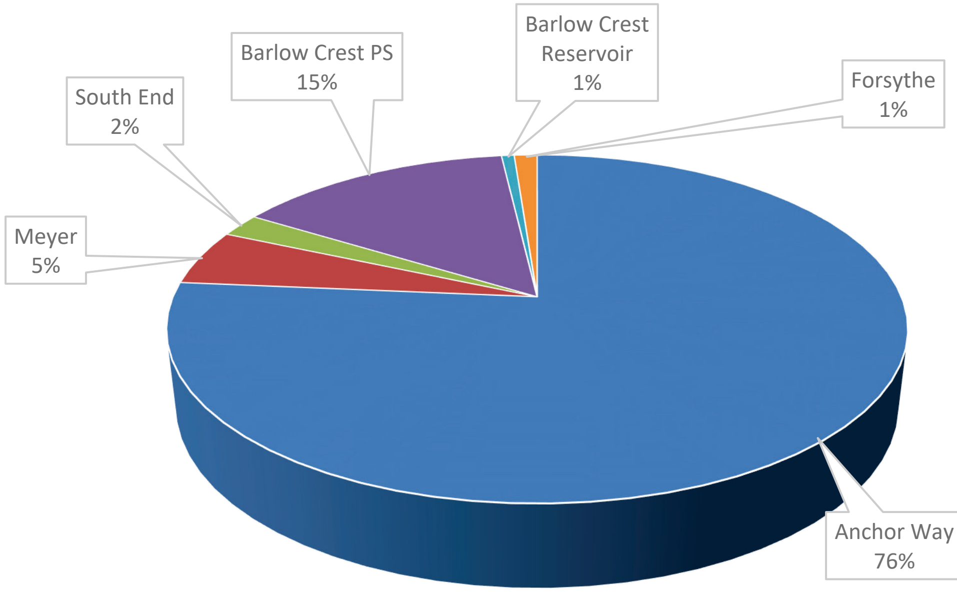

Figure 3.4 2016 Water Sources, South System

Table 3.7 shows the historical annual water production in CRW's South System between 2013 and 2016. Historical production data before 2013 was not used, since it was incomplete and did not accurately reflect CRW's production.

CRW provided the ratio of the maximum monthly demand (MMD) and average day demand (ADD). CRW also calculated the ratio of the maximum day demand (MDD) and MMD using the WTP production. The MDD/ADD peaking factor (PF) was calculated by multiplying the MMD/ADD PF with the MDD/MMD PF, as shown in Table 3.7.

Table 3.7 Historical Water Production, South System

	2013	2014	2015	2016
Annual Production (MG)	593	587	618	587
Average Day Demand (mgd)	1.63	1.61	1.69	1.60
MMD/ADD Peaking Factor	2.18	1.73	2.07	2.04
MDD/MMD Peaking Factor	1.76	1.94	1.58	1.26
MDD/ADD Peaking Factor	3.83	3.36	3.26	2.57

Notes:
(1) South System's water production is from Master Meters.

Figure 3.5 shows the historical water production in the South System between 2007 and 2016. The South System produced an annual average (from 2013 to 2016) of approximately 600 MG from the following sources:

- Anchor Way Master Meter.
- Barlow Crest Pump Station.
- Barlow Crest Reservoir (gravity flow).
- Meyer Master Meter.
- Southern End Master Meter.
- Forsythe Master Mater.

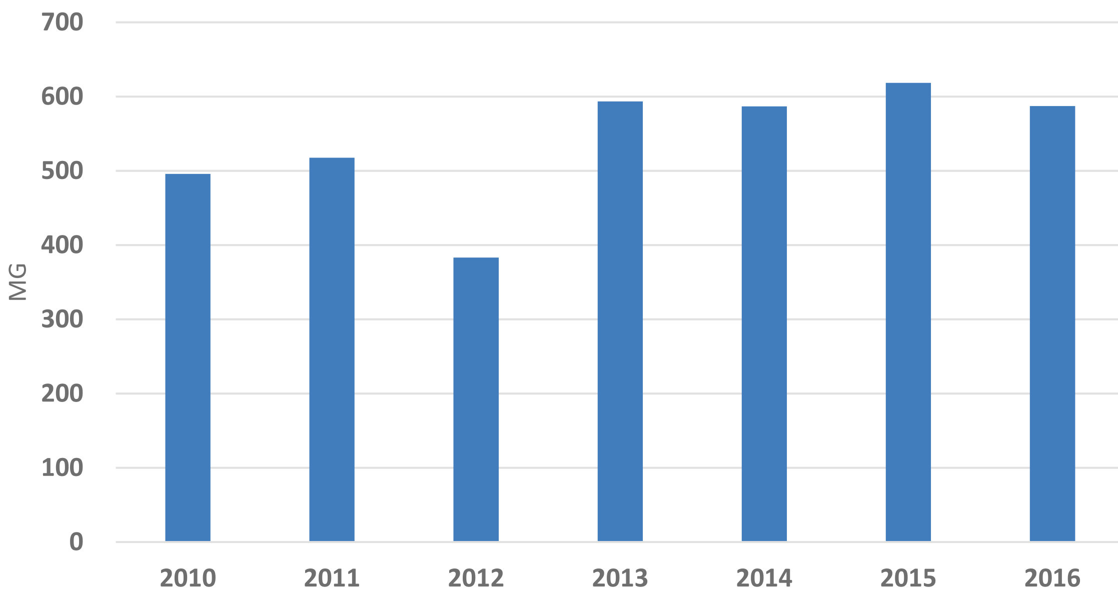

Figure 3.5 Historical Water Production for South System

3.4.1.1 Average Day Demand

The average day demand (ADD) represents a water system's average daily demand for a year. To calculate ADD, the total water produced by CRW in a year is divided by the number of days in a year. Table 3.7 and Figure 3.6 show the South System's ADD values from 2013 to 2016. Over the last four years, the ADD has remained steadily between 1.60 mgd and 1.69 mgd.

3.4.1.2 Maximum Day Demand

Historical maximum day demand (MDD) values are the highest water consumption in a single day in a given year, usually occurring in the summer when irrigation use is highest. MDD must be established to determine system requirements for supply capacity, pump station discharge rates, and reservoir capacity.

After discussion with CRW staff, it was determined that the peaking factor for the South System would be more accurate to be estimated through CRW's SCADA data, which only uses the demands from the South System. These numbers are used in the projected scenarios discussed later in this chapter.

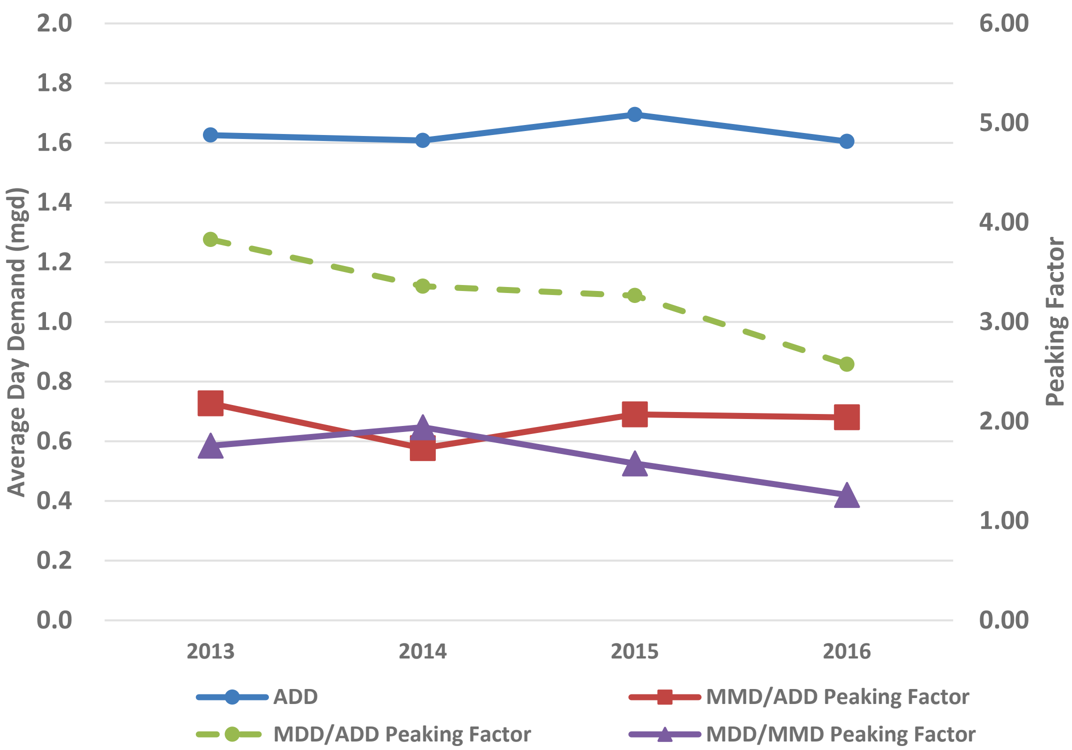

Figure 3.6 Historical Average Day and Maximum Day Demand for South System

3.4.2 Historical Customer Connections

CRW's water customers are divided into the following categories:

- Single Family Residential (SFR).
- Multi-Family Residential (MFR).
- Commercial.
- District-Wide.
- Industrial.
- Schools.
- Medical Office/Hospital.
- Churches.
- Seasonal/Irrigation.
- Mobile Home Estates.
- Government/State/County.
- Fire Service.
- Wholesale.

SFRs comprise 99 percent of the South System's customers and approximately 83 percent of the North System's water customer connections.

Table 3.8 summarizes the total number of connections in each customer category for the South System from 2007 to 2016. To simplify demand projections, certain categories were combined into one customer class since demand projections were similar. The following categories were established:

- Institutional: Churches, medical offices, hospitals, and schools.
- Other Authorized Use: Fire service and connections dealing with "District-Wide" accounts.
- Top Consumers: Connections correlating with the South System's top ten consumers.

To generate the total connections by customer class (shown in Table 3.9), connections for the large consumer account in the South System were subtracted from the appropriate number of connections for that customer type. Country Village Estates, LLC has one SFR connection, one irrigation connection, and two mobile home estate connections. Therefore, those connections were removed from the SFR, Irrigation, and Mobile Home Estates tallies, respectively, to avoid double counting. Historical consumption data for large consumers was separated this way to more accurately predict the quantity and location of future demands.

Table 3.8 shows the connections by customer type, which are also shown graphically in Figure 3.7. In Figure 3.7, the vertical axis for the number of SFR accounts is on the right because there are significantly more SFR connections than other types. As shown, the number of water connections has risen slightly over the last decade, at about 0.3 percent annually.

For each pressure zone in the South System, Table 3.9 allocates the number of connections by customer type for 2016. Beavercreek, Holcomb, and Redland zones make up approximately 70 percent of the customers in the South System, while SFR make up approximately 99 percent of its connections.

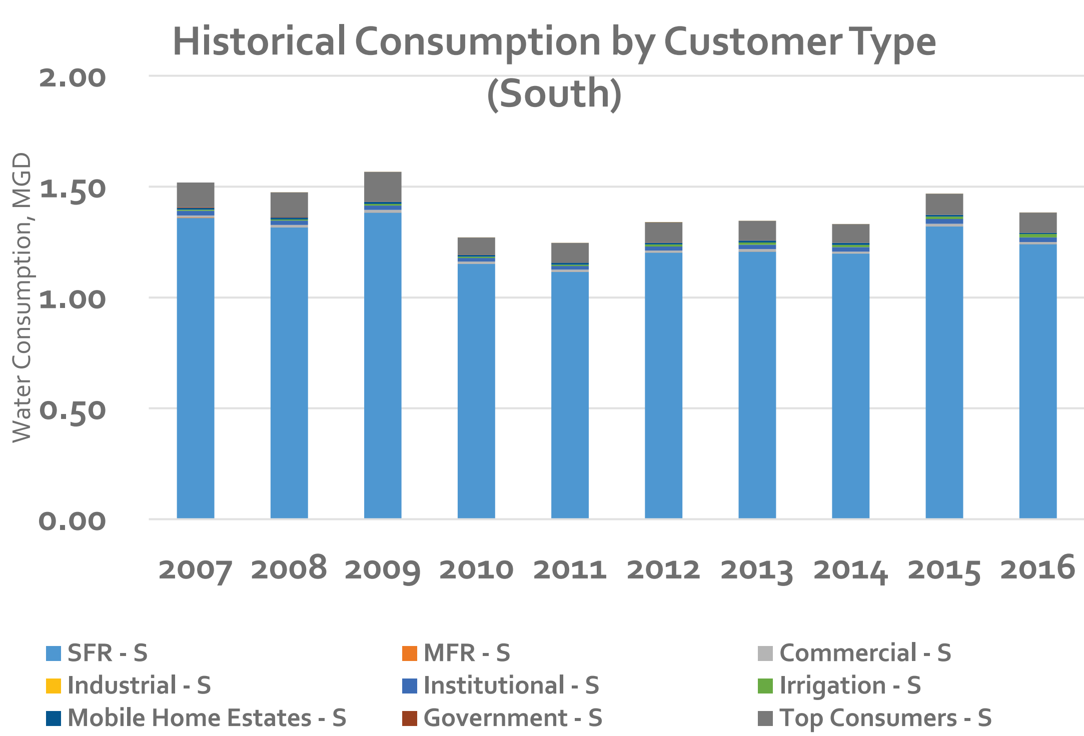

Figure 3.7 Historical Connections by Customer Type, South System

Table 3.8 Historical Customer Connections, South System

Customer Class	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
SFR	4,793	4,784	4,827	4,840	4,851	4,885	4,920	4,893	4,901	4,922
MFR	4	1	1	1	1	1	1	1	1	1
Commercial	14	16	16	15	15	15	15	15	15	15
Industrial	0	0	0	0	0	0	0	0	0	0
Institutional	19	19	19	19	19	19	19	19	19	18
Irrigation	8	8	10	9	10	10	11	11	11	10
Mobile Home Estates	1	1	1	1	1	1	1	1	1	1
Government	1	1	1	1	1	1	1	1	1	1
Top Consumers	4	4	3	3	4	4	3	3	3	4
Wholesale	0	0	0	0	0	0	0	0	0	0
Other Authorized Use	7	13	13	14	14	14	14	14	14	14
Total	**4,851**	**4,847**	**4,891**	**4,903**	**4,916**	**4,950**	**4,985**	**4,958**	**4,966**	**4,986**

Notes:
(1) South System includes Beavercreek, Henrici, Holcomb, Barlow, Hunter Heights, Redland, Meyers, and South End pressure zones.

Table 3.9 2016 Connections by Pressure Zone, South System

	SFR	MFR	Commercial	Industrial	Institutional	Irrigation	Mobile Home Estates	Government	Largest Consumers	Wholesale
Beavercreek Zone	1,766	1	9	0	11	4	0	1	0	0
Henrici Zone	418	0	0	0	3	0	1	0	4	0
Holcomb Zone	822	0	1	0	0	3	0	0	0	0
Barlow Zone	84	0	1	0	0	0	0	0	0	0
Hunter Heights Zone	79	0	0	0	0	0	0	0	0	0
Redland Zone	1,261	0	4	0	3	3	0	0	0	0
Meyers Zone	99	0	0	0	0	0	0	0	0	0
South End Zone	393	0	0	0	1	0	0	0	0	0
Total	**4,922**	**1**	**15**	**0**	**18**	**10**	**1**	**1**	**4**	**0**

Notes:
(1) 2016 number of connections in this table does not include connections for Other Authorized Use customer class.

3.4.3 Historical Water Consumption

3.4.3.1 Historical Consumption by Customer Type

Figure 3.8 shows the South System's historical consumption by customer type. Over the past decade, water has been consumed at an average of 1.39 mgd. As the figure shows, SFR customers make up the majority of this consumption, using an annual average of 1.25 mgd over the past 10 years.

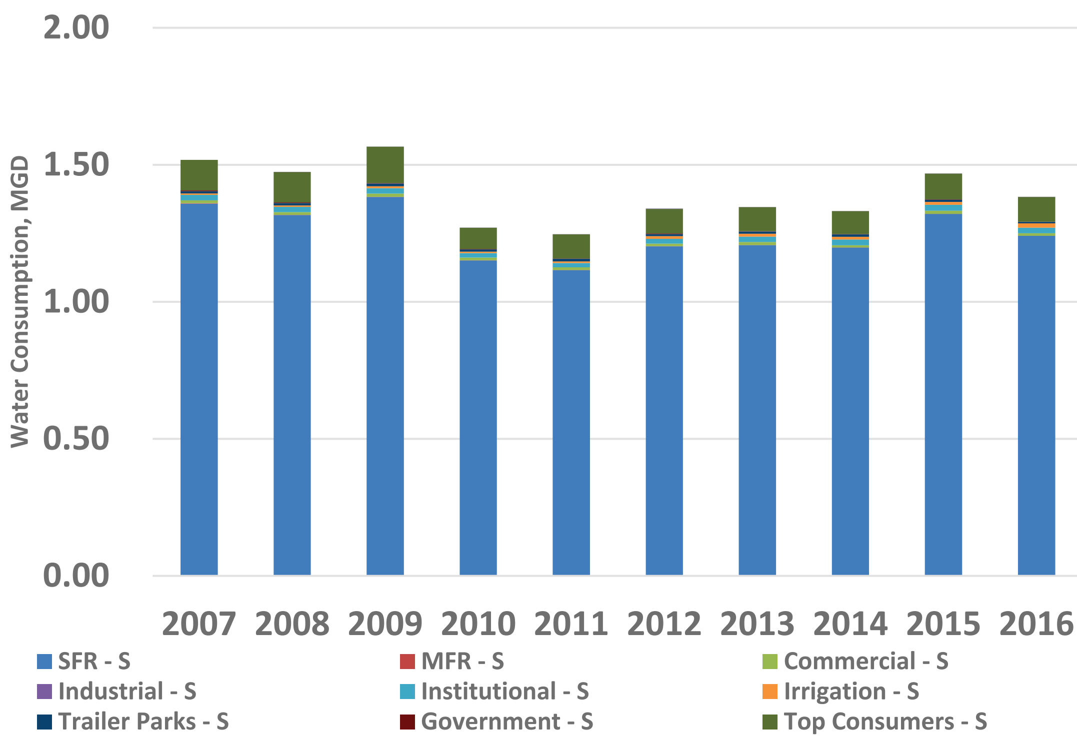

Figure 3.8 Historical Consumption by Customer Type, South System

Table 3.10 shows the South System's historical consumption by customer type. On average, the customers consume approximately 1.39 mgd. Of those customers, SFR customers consume approximately 89.6 percent of that total, while the top consumer uses approximately 6.9 percent.

3.4.3.2 Large Consumers

The South System consists of only one large consumer, Country Village Estates, LLC, found in the Mobile Home Estate customer category. This consumers' use was evaluated apart from other customer categories and thus appears in a separate row in Table 3.10. As mentioned earlier, this customer has four types of connections: one SFR, one irrigation, and two mobile home estate connections.

To more precisely predict the magnitude and location of future demands, the customer's consumption was separated from the other account types. Table 3.11 shows the historical consumption of the South System's largest consumer between 2007 and 2016.

3.4.3.3 Other Authorized Use

In addition to billing data, CRW tracks non-revenue water use, shown as "Other Authorized Use" in Table 3.10. Other Authorized Use includes non-revenue water used by CRW for activities such as water main flushing, new water main construction flushing, fire flow testing, and maintenance. CRW's water usage is also included in this category. Although Other Authorized Use is not metered, CRW tracks and estimates it based on flow and the duration of use.

Over the last decade, Other Authorized Use has taken up only a minimal amount of the South System's total consumption, mainly for fire service.

3.4.3.4 Distribution System Leakage

Distribution system leakage (DSL) is the total water produced minus the total authorized consumption. This includes both authorized metered consumption and the authorized, tracked, and estimated consumption of the Other Authorized Use.

All water not authorized for consumption, including both apparent and real losses, is considered DSL. Apparent losses include water theft, meter inaccuracies, and data collection errors. Real losses are physical losses from the distribution system, such as reservoir overflows, water main breaks, and water main leaks.

Table 3.10 shows the South System's total production and DSL. The percent total DSL was also calculated, and has decreased since 2014.

3.4.3.5 Equivalent Household Units

An equivalent household unit (EHU) is the amount of water consumed by a typical full-time single-family residence, regardless of meter size. It can be used to express water use by non-residential customers as a multiple of the demand of a typical SFR customer.

To calculate ADD water use per EHU, also called the "EHU value," the total annual volume of water consumed in the SFR customer class is divided by the total number of active SFR connections. This value defines the average annual SFR water use per connection. To determine the number of EHUs used by other customer classes, the volume of water used by other customer classes is divided by the EHU value.

Table 3.12 shows the South System's ADD per connection for each customer class between 2007 and 2016. The average SFR daily consumption volume was 257 gallons, which means the South System's EHU value was 257 gpd/EHU.

The last column in Table 3.12 shows the average number of EHUs per connection for each customer category CRW serves. The typical MFR connection consumes 1.5 EHUs, while other uses use the following amounts on average:

- Commercial uses 2.6 EHUs per connection.
- Mobile Home Estate (not including the large consumer) uses 32 EHUs per connection.
- Government uses 5.6 EHUs per connection.
- Institutional uses 3.9 EHUs per connection.
- Irrigation uses 3.3 EHUs per connection.

Table 3.10 Historical Consumption (MGD) by Customer Type, South System

Customer Class	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Average
SFR	1.36	1.32	1.38	1.15	1.12	1.20	1.21	1.20	1.32	1.24	1.25
MFR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Industrial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Institutional	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Irrigation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
Mobile Home Estates	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Government	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Top Consumers	0.11	0.11	0.13	0.08	0.09	0.09	0.09	0.08	0.09	0.09	0.10
Other Authorized Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**1.52**	**1.47**	**1.57**	**1.27**	**1.25**	**1.34**	**1.35**	**1.33**	**1.47**	**1.38**	**1.39**
Total South Production (MGD)							1.63	1.61	1.69	1.60	1.63
Distribution System Leakage (MGD)							0.28	0.28	0.23	0.22	0.24
Percent Distribution System Leakage (DSL)							17.2%	17.2%	13.4%	13.8%	14.6%

Notes:
(1) South System includes Beavercreek, Henrici, Holcomb, Barlow, Hunter Heights, Redland, Meyers, and South End pressure zones.
(2) Institutional class includes churches, hospitals, and schools.

Table 3.11 South System Largest Consumer

Customer	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	10-Yr Average	2016 Percent of System
Country Village Estates LLC	112,000	111,000	133,000	77,000	88,000	90,000	88,000	84,000	94,000	90,000	96,700	1.2%
Total	**112,000**	**111,000**	**133,000**	**77,000**	**88,000**	**90,000**	**88,000**	**84,000**	**94,000**	**90,000**	**96,700**	**1.2%**

Notes:
(1) South System consists of only one large customer: Country Village Estates, LLC.

Table 3.12 Historical Consumption (GPD) per Connection, South System

Customer Class	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	10-Yr Average	EHUs per Connection
SFR	283	275	286	238	230	246	245	245	269	252	257	1.0
MFR	440	476	418	381	330	446	414	246	258	356	376	1.5
Commercial	716	640	752	684	645	603	739	536	744	596	666	2.6
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Institutional	1,068	1,008	1,029	835	824	935	1,040	1,093	1,146	1,164	1,014	3.9
Irrigation	659	666	691	645	612	975	917	921	972	1,547	860	3.3
Mobile Home Estates	8,193	8,443	10,085	8,085	9,095	7,725	8,421	8,749	8,193	5,383	8,237	32.0
Government	2,398	2,589	1,646	1,387	1,025	2,097	863	881	762	695	1,434	5.6
Top Consumers	27,965	27,671	44,230	25,816	22,043	22,443	29,338	27,912	31,334	22,573	28,133	109.4

Notes:
(1) South System includes Beavercreek, Henrici, Holcomb, Barlow, Hunter Heights, Redland, Meyers, and South End pressure zones.
(2) Institutional class includes churches, hospitals, and schools.
(3) EHUs per connection are calculated by dividing the customer class average gpd/connection by the SFR EHU value.

3.5 Water Demand Projections

Projecting future water demand is a key part of a water system's planning process. Demand projections are used to identify system improvements such as supply, pumping, storage, and piping requirements.

This section summarizes ADD and MDD projections developed for CRW's water system using historical water demand trends and future demographic growth assumptions. Demand projections are presented as a range of demands that may be experienced in the future.

The demand projections are presented as a range in demands that may be experienced in the future. Low, medium, and high water demand projection scenarios were developed by adjusting various demand projection parameters. The medium demand projection scenario is used for the system analysis described in Chapter 6. The system analysis determines future pumping, storage, and distribution system deficiencies and identifies potential improvements to achieve CRW's established capacity criteria. The low and high projection scenarios provide a sense of the extent of uncertainty in the demand forecasts.

3.5.1 Demand Projection Methodology

Water demand projections were developed in the following steps, which are also summarized in Figure 3.9:

1. Increase historical water connection numbers for each pressure zone according to the zone-specific residential and non-residential growth rates derived from the demographic analysis.
2. Convert account projections into EHU projections and then into ADD projections using demand projection parameters derived from historical data, which consists of CRW's starting EHU value, MDD/ADD peaking factor, DSL, percent of Other Authorized Use, and large consumer demand
3. Apply the MDD to ADD peaking factor to convert ADD to MDD.

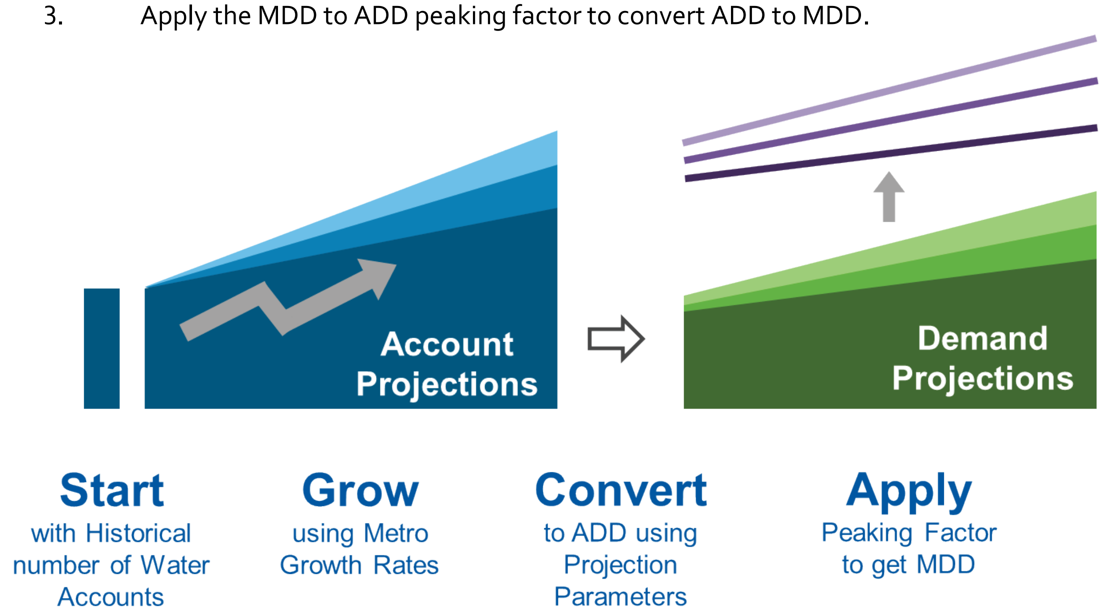

Figure 3.9 Demand Projection Methodology

3.5.2 Demand Projection Parameters

Numerous factors and assumptions affect the accuracy of the projected future water demands. To project CRW's future ADD and MDD, several parameters were used, all of which are listed in Table 3.13. These parameters include the starting EHU value, peaking factor (MDD/ADD), DSL percentage, and Other Authorized Use.

Using historical data and assumptions, low, medium, and high parameters were established for each demand projection scenario. These parameters were then used to develop the low, medium, and high demand forecasts. For each parameter, Table 3.13 summarizes the values selected to develop the range of demand projections. The following sections discuss demand projection in further detail.

Table 3.13 Projected Parameters, South System

Projected Scenario	Low		Medium		High	
Parameter	Parameter	Notes	Parameter	Notes	Parameter	Notes
Starting EHU Value (gpd/EHU)	230	lowest year	253	Ave last 4 years	257	Hist. Ave.
Peaking Factor (MDD/ADD)	2.38	SCADA data	2.74	SCADA data	3.05	SCADA data
DSL (Percent of Production)	10.00%	2011	14.4%	Annual Ave.	14.4%	Existing
Other Authorized Use (Percent of Production)	0.00%	25th %	0.00%	Hist. Ave.	0.00%	Max

3.5.2.1 Starting EHU Value

CRW agreed that the starting EHU value in the South System would be the historically lowest EHU value for the SFR customer class, which was 230 gpd/EHU in 2011. The medium scenario used the average of the previous four years, calculating an EHU value of 253, while the high scenario used the historical 10-year average for an EHU value of 257.

3.5.2.2 MDD to ADD Peaking Factor

Based on current SCADA data for the South System, which gives a more accurate representation than using the historical WTP production to find the peaking factor, CRW decided that a peaking factor of 2.38 was the lowest it should plan for in the future when analyzing the low demand projection scenario. Peaking factors of 2.74 and 3.05 were used for the medium and high demand scenarios, respectively.

3.5.2.3 Distribution System Leakage

On average, the low demand scenario's DSL took up 10 percent of the total water production annually, while the medium demand scenario took up 14.4 percent. According to CRW, the medium scenario's DSL will be reduced to 10 percent over 10 years and then remain flat. Meanwhile, the high demand scenario's DSL also used 14.4 percent of the total water production.

3.5.2.4 Other Authorized Use

For the South System, Other Authorized Use was set to zero for all scenarios.

3.5.2.5 Largest Consumers

For each scenario, CRW recommended that the largest customers do not have any assumed growth in consumption.

3.5.3 EHU, ADD, and MDD Projections

When converting account projections to ADD projections, the first step is to convert the number of connections into the number of EHUs. To calculate the projected number of EHUs for the RWSA, the projected number of connections were multiplied by the number of EHUs per connection for each customer category.

To calculate ADD projections for each customer class, EHU projections were multiplied by EHU values unique to each demand projection scenario, as presented in Table 3.13. To establish total ADD projections, non-revenue water consumption, including Other Authorized Use and DSL, was then added given the low, medium, and high assumptions. Finally, MDD projections were established by multiplying ADD projections with the appropriate MDD to ADD peaking factor for each demand projection scenario.

Tables 3.14, 3.15, and 3.16 show the EHU, ADD, and MDD projections of each pressure zone in the South System for low, medium, and high demand projection scenarios, respectively. Projections are presented for ten- and 20-year planning periods. ADD and MDD demands include DSL, which is not calculated from the peaking factors.

Figure 3.10 shows a graph of the South System's historical ADD and MDD demands and the projected demands of the medium scenario, with low-to-high ranges for both ADD and MDD. The ADD was approximately 1.4 mgd in 2017. In 2038, it is estimated to be between 1.9 and 2.2 mgd, while the medium demand scenario predicts 2.1 mgd. In 2038, MDD is estimated to be between 4.6 and 6.9 mgd, while the medium demand scenario predicts 5.7 mgd.

Table 3.14 South System Demand Projection Summary - Low Scenario

	EHUs			ADD (mgd)			MDD (mgd)(1)		
Pressure Zone	**2017**	**2028**	**2038**	**2017**	**2028**	**2038**	**2017**	**2028**	**2038**
Beavercreek Zone	2,098	2,537	2,936	0.48	0.58	0.68	1.15	1.39	1.61
Henrici Zone	1,008	1,160	1,298	0.22	0.26	0.29	0.53	0.61	0.69
Holcomb Zone	942	1,105	1,253	0.22	0.25	0.29	0.52	0.61	0.69
Barlow Zone	99	130	159	0.02	0.03	0.04	0.05	0.07	0.09
Hunter Heights Zone	88	92	95	0.02	0.02	0.02	0.05	0.05	0.05
Redland Zone	1,451	1,613	1,760	0.33	0.37	0.40	0.79	0.88	0.96
Meyers Zone	113	142	168	0.03	0.03	0.04	0.06	0.08	0.09
South End Zone	466	760	1,026	0.11	0.17	0.24	0.26	0.42	0.56
Total	**6,265**	**7,539**	**8,695**	**1.43**	**1.71**	**2.00**	**3.41**	**4.11**	**4.74**

Notes:
(1) Per CRW SCADA data, MDD is calculated based on the peaking factor in Table 3.13.

Table 3.15 South System Demand Projection Summary - Medium Scenario

	EHUs			ADD (mgd)			MDD (mgd) (1)		
Pressure Zone	**2017**	**2028**	**2038**	**2017**	**2028**	**2038**	**2017**	**2028**	**2038**
Beavercreek Zone	2,206	2,537	2,936	0.56	0.64	0.74	1.50	1.76	2.03
Henrici Zone	1,051	1,156	1,294	0.25	0.27	0.31	0.70	0.74	0.84
Holcomb Zone	990	1,105	1,253	0.25	0.28	0.32	0.70	0.77	0.87
Barlow Zone	104	130	159	0.03	0.03	0.04	0.10	0.09	0.11
Hunter Heights Zone	93	92	95	0.02	0.02	0.02	0.10	0.06	0.07
Redland Zone	1,526	1,613	1,760	0.39	0.41	0.45	1.10	1.12	1.22
Meyers Zone	118	142	168	0.03	0.04	0.04	0.10	0.10	0.12
South End Zone	490	760	1,026	0.12	0.19	0.26	0.30	0.53	0.71
Total	**6,578**	**7,535**	**8,691**	**1.65**	**1.88**	**2.18**	**4.60**	**5.17**	**5.97**

Notes:
(1) Per CRW SCADA data, MDD is calculated based on the peaking factor in Table 3.13.

Table 3.16 South System Demand Projection Summary - High Scenario

	EHUs			ADD (mgd)			MDD (mgd) (1)		
Pressure Zone	**2017**	**2028**	**2038**	**2017**	**2028**	**2038**	**2017**	**2028**	**2038**
Beavercreek Zone	2,248	2,668	3,087	0.58	0.69	0.79	1.76	2.09	2.42
Henrici Zone	1,065	1,210	1,355	0.25	0.29	0.33	0.77	0.88	0.99
Holcomb Zone	1,006	1,162	1,318	0.26	0.30	0.34	0.79	0.91	1.03
Barlow Zone	107	137	167	0.03	0.04	0.04	0.08	0.11	0.13
Hunter Heights Zone	93	96	100	0.02	0.02	0.03	0.07	0.08	0.08
Redland Zone	1,542	1,696	1,851	0.40	0.44	0.48	1.21	1.33	1.45
Meyers Zone	121	149	177	0.03	0.04	0.05	0.09	0.12	0.14
South End Zone	518	799	1,079	0.13	0.21	0.28	0.41	0.63	0.85
Total	**6,700**	**7,917**	**9,134**	**1.70**	**2.03**	**2.34**	**5.18**	**6.15**	**7.09**

Notes:
(1) Per CRW SCADA data, MDD is calculated based on the peaking factor in Table 3.13.

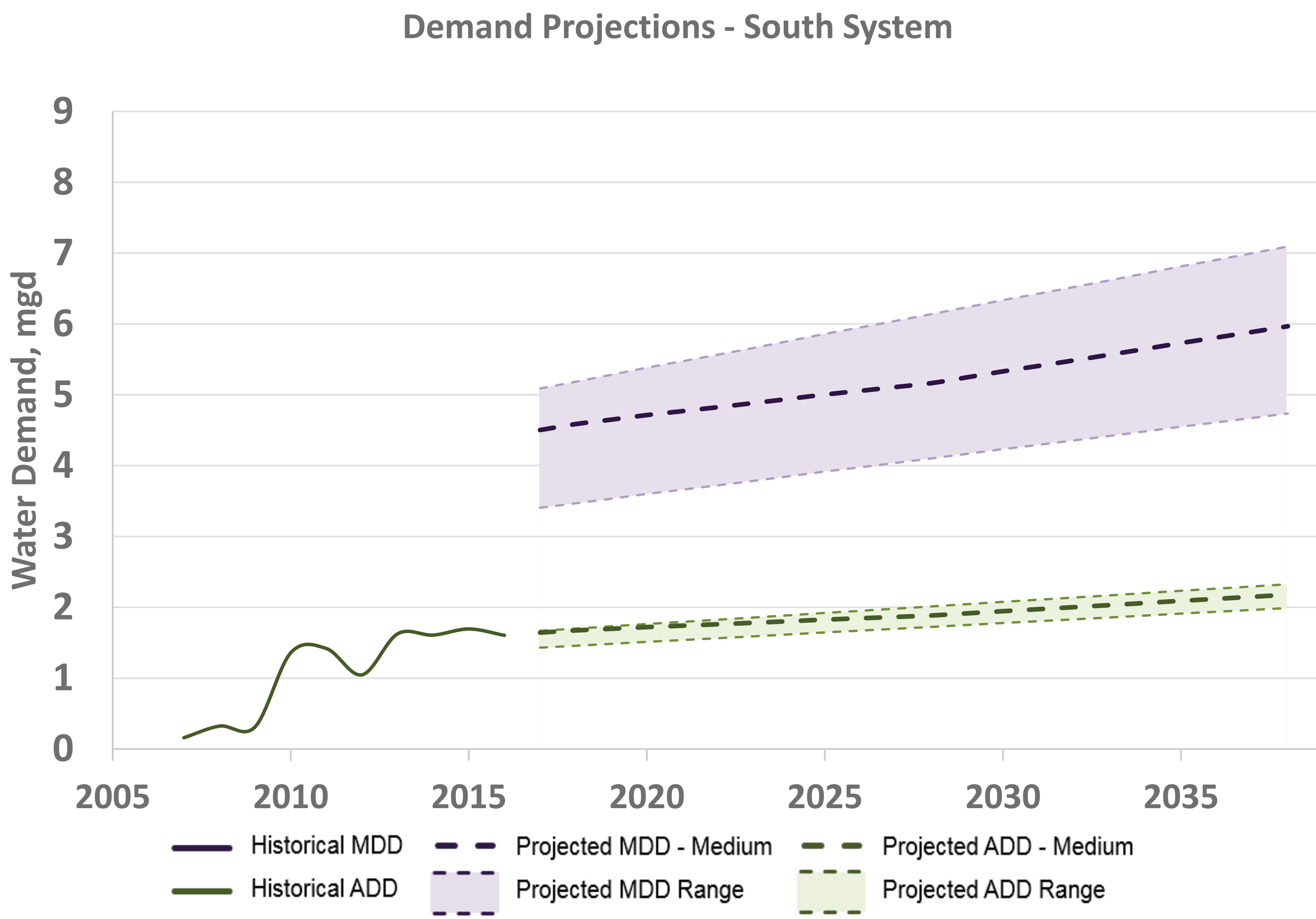

Figure 3.10 Demand Projections, South System

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Chapter 4

POLICIES AND CRITERIA – SOUTH SYSTEM

4.1 Introduction

Clackamas River Water (CRW) manages its water utility under established water system policies and criteria that govern various aspects of operations, maintenance, and expansion. The policies and criteria detailed in this chapter help CRW develop new water infrastructure and maintain its desired level of service (LOS) while working within a geographically and environmentally challenging area. These policies and criteria also help CRW provide uniform treatment to all utility customer and information to current and potential District customers.

CRW's water system criteria include design parameters and performance criteria to ensure that policies governing the water system are followed. Although not precise rules, they are standards CRW can use to evaluate its water system with when planning capital improvement and capital maintenance projects.

The Water System Master Plan (Plan) established the following vision and mission for the utility and public services:

- **Our Vision:** We believe that an ample supply of high quality water is essential to our region's vitality.
- **Our Mission:** We will provide high-quality, safe drinking water to our customers at rates consistent with responsible planning for our district's long-term health.

CRW will fulfill its "duty to serve" by meeting or exceeding water quality regulations and following the LOS guidelines for its water systems as established in the Oregon Resilience Plan (ORP).

4.2 Policy Sources

Most of the policies discussed in this section were included in the previous Water System Master Plan and extracted from the Water Management and Conservation Plan (WMCP). The WMCP provides long-term guidelines for CRW's management and conservation of water supplies.

The Plan fulfills the requirements of the Oregon Administrative Rules (OAR) adopted by the Water Resources Commission in November 2002 (OAR Chapter 690, Division 86). Beyond that, it describes water management, water conservation, and curtailment programs that guide the proper use and stewardship of CRW's water supply.

The policies are organized into four categories: service area, supply, system analysis planning, and seismic. Appendix H details all policies and criteria in tabular form.

4.3 Service Area Policies

4.3.1 Water Service and Planning Area

CRW's jurisdictional boundary is the area which CRW formerly served, and citizens within this boundary vote for CRW's board of commissioners. Some regions in CRW's boundary are now within the city limits of Milwaukie, Oregon City, and Happy Valley, and are partially served by those cities (with the exception of Happy Valley).

The area that CRW currently serves water to is considered to be CRW's existing service area. CRW's service area is located in Clackamas County and is divided into two regions; the North Service Area, which is north of the Clackamas River, and the South Service Area, which is south of the river. CRW's planning area is the region CRW expects to serve in the future, throughout the planning horizon of this Plan. The planning area is the same as service area, except that the planning area includes the Windswept Waters area south of the Highway 212 and 224 junction, and west of Highway 224, which CRW expects to annex into its service area in the future. Figure 1.1 in Chapter 1 shows CRW's South service area and planning area boundaries.

Currently, CRW supplies the Sunrise Water Authority (SWA) as a wholesale customer from its water treatment plant. CRW can also serve wholesale emergency water to Oak Lodge Water Services District, the City of Milwaukie, and the City of Gladstone.

CRW could wholesale water to neighboring agencies. It will also provide up to 10 million gallons per day (mgd) through the Clackamas Regional Water Supply Commission (CRWSC).

4.3.2 Interconnections with other Systems

CRW's drinking water system is beneficially interconnected with several other systems (e.g., wholesale water sales and purchases, and interties) that allow the exchange of water during emergency or shortage events. CRW will continue to look for opportunities to implement emergency interconnections with neighboring water agencies.

4.4 Supply Policies

CRW has sufficient water supply facilities available to meet the maximum day demand (MDD) even under firm capacity conditions. Firm capacity is the capacity of the pump station with the largest pump out of service.

4.4.1 System Reliability/Redundancy

Wherever possible, CRW must anticipate system interruptions by designing and operating the system to minimize the impact of such disruptions on customers. To be reliable, all facilities must have backup power. For mechanical equipment that might be out-of-service for repair or maintenance, CRW has redundant components and equipment that significantly limits interruption of service.

4.4.2 Water Quality

CRW's goal is to provide water that meets or exceeds water quality regulations. CRW will continue to take the actions necessary to ensure that water quality standards are met. This includes monitoring compliance with all Oregon Health Authority (OHA) and Federal Environmental Protection Agency water quality regulations.

4.4.3 Water Use Efficiency

As good stewards of its resources, CRW values water use efficiency. In recent years, CRW has implemented a number of efficiency measures to ensure that the water use isn't wasteful and to maximize the benefits of its water resources. CRW will continue to implement water use efficiency programs to keep water demand per equivalent household unit (EHU) and peaking factors constant or declining in the future.

4.4.3.1 Leak Detection Program

CRW is currently revitalizing its leak detection program to increase the frequency of leak detection from an intermittent, "as needed" basis to a more planned, annual approach. Some of the more leak-prone pipes (e.g., steel, PVC, galvanized steel, and asbestos cement/transite) are monitored during the summer and checked as part of routine maintenance throughout the year.

CRW's goal is to maintain its water loss rate to less than 10 percent and necessary strategies will be implemented to achieve this goal.

4.4.3.2 System-Wide Metering

CRW requires meters for all customers. It also requires metering of fire hydrant water used by contractors, annual testing and repair of production meters and all meters three inches and larger.

Master meters are tested annually and are repaired as needed.

4.4.4 Curtailment Plan

CRW prepared a water curtailment plan to deal with water shortages when consumption exceeds production capabilities. The plan is designed to save and extend CRW's water supply through conservation, waste reduction, and equitable usage while prioritizing protection supplies for public health, fire protection, and domestic use.

CRW has four curtailment stages:

- Stage 1 "Water Shortage Alert": The least severe of the four stages and is characterized by the on-set of conditions that, if unabated, will lead to Stage 2. All associated curtailment actions are advisory or voluntary.
- Stage 2 "Serious Water Shortage": The stage where an actual water shortage occurs. Most associated curtailment actions are mandatory.
- Stage 3 "Severe Water Shortage": Characterized by an acute water shortage. All associated curtailment actions are mandatory.
- Stage 4 "Emergency Water Shortage": The most severe of the four stages, characterized by widespread water supply disruption, loss of source supply, or a condition that poses an immediate risk to public health and safety.

4.5 System Analysis Planning Criteria

CRW developed and adopted system analysis criteria it uses to identify deficiencies in and design water system improvements for the existing distribution system.

Table 4.1 summarizes the system analysis criteria and its content is detailed in the sections below. Figure 4.1 illustrates the three components of storage identified in Table 4.1 below.

Table 4.1 South System Analysis Criteria Summary

Pipeline Velocities and Head Loss Criteria		
Pipeline Type	Maximum Velocity	Maximum Head Loss
Maximum Distribution Velocity		
Pipeline Diameter <12 inches @ PHD(1) (distribution)	10 fps(6)	10 ft(2)/1,000 ft(2)
Pipeline Diameter ≥12 inches @ PHD(1) (transmission)	5 fps(6)	5 ft(2)/1,000 ft(2)
Service Pressure Criteria		
Type	Criteria	
Minimum pressure		
PHD(1)	40 psi(3)	
MDD(7) plus Fire Flow	20 psi(3)	
Pressure Reducing Valves (PRVs)	Supply PHD(1)	
Water Storage Evaluation Criteria		
Water Storage Type	Criteria	
Operational Storage	25 percent of MDD(7) of the area	
Emergency Storage	2 x ADD(4) for emergencies	
Fire Storage	Largest fire flow demand	
Fire Flow Criteria		
Customer Type	Fire Flow Rate	Duration
Single-Family Residential (South)	1000 gpm(5)	2 hours
Multi-Family Residential (South)	1500 gpm(5)	2 hours
Commercial/Industrial (South)	1500 gpm(5)	2 hours
Beavercreek Elementary School	2500 gpm(5)	2 hours
Ogden Middle School	3000 gpm(5)	3 hours
Redland Elementary School	2750 gpm(5)	2 hours
Minimum Line Size		
Customer	Pipe Diameter	
Residential	8-inch diameter	
Commercial/Industrial	12-inch diameter	

Notes:
(1) Peak hour demand (PHD).
(2) Feet (ft).
(3) Pounds per square inch (psi).
(4) Average Day Demand (ADD).
(5) Gallons per minute (gpm).
(6) Feet per second (fps).
(7) Maximum Day Demand (MDD).

Figure 4.1 Storage Components Illustration

4.5.1 Transmission Pipelines

Transmission pipelines convey large volumes of water to reservoirs, high demand users, and feed distribution mains. They are considered to be greater than or equal to 12 inches in diameter and have the following criteria:

- Pipeline flow velocities in transmission pipelines must be less than 5 fps, and head loss in the pipelines must be below 5 feet per 1,000 feet of pipeline.
- All water transmission pipelines greater than or equal to 24 inches in diameter must be capable of providing MDD.
- All other transmission pipelines must be capable of supplying peak hour demands.

4.5.2 Pump Stations

CRW has two types of pump stations, each with its own criteria:

- Pump stations serving areas without storage reservoirs (i.e., closed zones): these pump stations must be sized to serve the maximum between MDD at firm capacity plus the required fire flow demand and PHD.
- Pump stations serving areas with reservoirs: these pump stations must be sized to serve MDD at firm capacity.

To increase emergency reliability, each pump station must be supplied with onsite standby power or be able to connect to a portable power supply. With this capability, some emergency supply capacity is available, even during a general power outage.

4.5.3 Pressure Reducing Stations

Pressure-reducing valves (PRV) have the following criteria:

- They must supply the PHD within the valve's continuous flow rating.
- Fire flows must be delivered within the valve's intermittent flow rating.
- Pressure zones must be served by multiple PRV stations wherever possible to increase supply reliability.

4.5.4 Storage

Storage facilities are required for each operating area serving single-family residential and non-single-family service areas. System storage is required to meet the following three functions:

- Operational storage.
- Emergency storage.
- Fire storage.

The total storage requirement in any tank or reservoir is the sum of these three components plus dead storage, which is volume of the tank unavailable for use at 20 psi due to physical constraints. Thus, emergency storage and fire storage are considered "stacked."

Storage facilities may also contain dead storage that is unused, primarily due to the facility's configuration. Storage facilities must be sized to accommodate the following volume components.

4.5.4.1 Operational Storage

Operational storage is the volume of distribution storage associated with source or booster pump cycling times under normal operating conditions. This storage is used to meet instantaneous water system demands that exceed the transmission/pumping delivery capacity.

The criteria for this storage to hold 25 percent of MDD is typically sufficient to meet peak demands and to maintain water quality by turning over the required reservoir.

4.5.4.2 Emergency Storage

In case its primary source becomes temporarily unavailable, a water purveyor with a single supply source must have an emergency source. Emergency storage is the volume of water held in reserve at all times to meet demands in the event of a supply failure. Emergency situations may include power outages, equipment failures, pipe failures, and/or natural disasters.

CRW must maintain an emergency storage volume of two times the ADD.

4.5.4.3 Fire Storage

CRW must provide, maintain, and improve the infrastructure system necessary to supply water for firefighting. To do this, the water supply must meet or exceed all minimum applicable standards and regulations for fire flow, storage, and peak-use periods, except under emergency conditions created by major disasters such as earthquake or flood.

Fire storage is the volume held in the reservoir for firefighting. It is determined by multiplying the required maximum fire flow rate (gpm) for a reservoir's service area by the required duration.

This storage is provided to meet the single most severe fire flow demand within the pressure zone served by the storage facility. Table 4.2 lists the minimum fire flow requirements.

Table 4.2 Required Minimum Fire Flows (South System)

Pressure Zone	Fire Flow Criteria	Flow (gpm)	Duration (hours)
Beavercreek	Beavercreek Elementary School	2,500 gm	2
Henrici	Ogden Middle School	3,000	3
Holcomb	Commercial (South)	1,500	2
Barlow	Commercial (South)	1,500	2
Hunter Heights	Single-Family Residential (South)	1,000	2
Redland	Redland Elementary School	2,750	2

4.5.5 Distribution Piping

The distribution system is designed to convey water to customers at adequate service pressures under all system demand conditions. The distribution system must also provide fire flows with adequate minimum residual pressures throughout the service area.

Distribution pipelines must be sized to serve peak hour demands and fire flow requirements with system reservoirs/tanks ten (10) feet from the overflow. For new distribution pipes, the minimum pipeline diameter is eight inches.

Any pipeline below six inches in diameter must be upgraded before being equipped with a fire hydrant. A six-inch diameter line with a fire hydrant must be part of a looped system or be no more than 500 feet in length. Distribution pipelines must also be looped where possible.

4.5.5.1 Velocity

Flow velocities for a distribution pipeline must be below 10 fps, and head loss in the pipeline must be below 10 ft per 1,000 ft of pipeline under PHD or MDD plus fire demand conditions.

4.5.5.2 Service Pressure

Per Oregon Health Authority (OHA) standards, the minimum pressure in the system must be maintained at 20 psi at all times, even during a fire flow event on a maximum demand day.

CRW's Plan recommends maintaining pressures between 40 and 90 pounds per square inch gauge (psig) during normal operating conditions. CRW's maximum service goal is to not exceed 150 psi.

4.6 Seismic Criteria

4.6.1 Seismic Design Criteria

All structures integral to water production are risk category IV structures. For these structures, the seismic performance goal is to keep them operational even after a maximum credible earthquake. All other facilities and most mechanical equipment are Category III structures. Note, mechanically restrained DIP is recommended as a design standard for pipeline design.

The seismic design criteria will be determined after the final site selection. Seismic design will be in line with the current adopted edition of International Building Code (IBC)/ Oregon Structural Specialty Code (OSSC). Any identified local seismic hazards, such as nearby faults, liquefiable soils, lateral spread, or excessive differential settlement, will be mitigated to meet the seismic design performance goals.

4.6.2 Level of Service Goals – Oregon Resilience Plan

CRW will follow the LOS guidelines for the water systems as established in the ORP.

The Oregon Seismic Safety Advisory Committee (OSSPAC) developed the ORP as requested by the Oregon State Legislature. The ORP lists goals for specific functions of water systems, which are listed in Table 4.3.

For water treatment plants, the ORP recommends that 20 to 30 percent of the potable supply be available within 24 hours after the event and near full restoration within one to two weeks.

Table 4.3 Target States of Recovery: Water and Wastewater Sector (Valley) – Oregon Resilience Plan

	Event Occurs	0-24 hours	1-3 days	3-7 days	1-2 weeks	2-4 weeks	1-3 months	3-6 months	6-12 months
Supply Sources								X	
Backbone System							X		
Supply to Critical Facilities							X		
Supply for Key Fire Flow				X					
All Fire Hydrants									X
Supply to Distribution Points					X				
Full Distribution System									X

Notes:
(1) G 80 – 90 percent Operational.
(2) Y 50 – 60 percent Operational.
(3) R 20 – 30 percent Operational.
(4) × Current State / 90 percent Operational.

4.7 Miscellaneous

4.7.1 Repair and Replacement

CRW's goal is to replace pipelines with more than four breaks per mile. CRW consistently tracks water statistics to determine if repair or replacement action is needed. Identified leaks will continue to be repaired promptly.

CRW's capital improvement plan (CIP) identifies pipe replacements for areas with historic leakage. At a minimum, CRW will plan on replacing infrastructure when they reach the end of their useful life; these pipelines were identified in the remaining useful life analysis detailed in Chapter 3 – Existing System and Condition Assessment.

Furthermore, CRW will identify opportunities to implement redundancy, reliability, operational improvements, and other collaborative planning as it implements its repair and replacement program.

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Chapter 5

WATER SUPPLY – SOUTH SYSTEM

5.1 Introduction

This supply evaluation describes Clackamas River Water (CRW)'s sources of supply and existing water rights, summarizes the purchased water supply, and makes recommendations for future supply facilities. The study was done to evaluate current and future water resources to identify potential deficiencies and improvements needed in the South system. This chapter summarizes the various issues related to the South System' supply source currently and in the future.

5.2 Existing Supply Sources

Currently, the entire water supply for CRW's South System comes from water produced at South Fork Water Board's (SFWB) 25 mgd water treatment plant. This treatment plant is located on Hunter Avenue in Oregon City, south of the Clackamas River. SFWB serves most of the water directly to CRW, while some locations are provided through Oregon City's distribution system (purchased from SFWB).

CRW also owns one groundwater well, known as Well No. 1, located near Abernathy Creek close to Oregon City. Although water from this well is available for the South System, it is used only for backup in emergencies.

CRW has a permit allowing it to test Well No. 1 as an aquifer storage and recovery (ASR) system.

5.2.1 South Fork Water Board (SFWB)

5.2.1.1 Water Rights

As noted above, CRW's South System is served by water from SFWB. Although water supply agreements have existed in the past, no water supply agreement between CRW and SFWB currently exists. However, in 2010, SFWB and CRW entered into a settlement agreement recognizing that SFWB has continued to supply wholesale water under an implied contract to CRW. The settlement agreement between CRW and SFWB can be found in Appendix B.

5.2.1.2 Treatment Capacity

To continue meeting all of the SFWB's system demands, the SFWB treatment plant was expanded in 2005 to a total capacity of 25 mgd by adding pumping and treatment plant improvements. However, the treatment plant has been producing only approximately 22 mgd during peak periods. Nonetheless, the SFWB treatment plant is ultimately capable of expansion to 52 mgd.

5.2.1.3 Performance

Although the SFWB's treatment plant is over 50 years old, it produces quality treated water. Historically, the SFWB system has performed consistently and has been able to meet all of CRW's demands in the South System. The current peak day demand for the South System is 4.86 mgd, and the annual average day demand is approximately 1.64 mgd.

5.2.1.4 Reliability

The SFWB WTP provides a quality and reliable supply source used by several purveyors in Clackamas County. With the development of an intertie pipeline between the CRW WTP, the North Clackamas County Water Commission (NCCWC) WTP and the SFWB WTP, these agencies have further strengthened the overall reliability of the Clackamas River source in and around CRW's system. However, due to increased demand, the SFWB plant has operated at or near its maximum capacity in recent years.

5.2.1.5 Auxiliary Power

The treatment plant does not have an auxiliary power source onsite. Instead, two separate feeds from different substations supply power to the site.

The SFWB plan considered the separate feeds adequate during an emergency and thus did not offer plans for onsite emergency power. Staff reviews its emergency response plan annually, which covers power outages.

5.2.2 Groundwater Well

In 1973, CRW constructed Well No. 1 near Oregon City. The well was constructed to a depth of 560 feet with a capacity of approximately 1.3 mgd. However, due to poor water quality in the well, CRW backfilled it to a depth of 450 feet in 2001. In 2009, CRW completed a permit extension allowing for further development of the current water right.

In July of 2007, CRW began augmenting its SFWB supply with water from Well No. 1. Before then, Well No. 1 was used only as an emergency water source. In May of 2013, the well was taken offline due to taste and odor concerns. CRW's current permit extension for this water right will expire on October 1, 2029.

Aquifer Storage and Recovery Limited License 003 authorizes CRW to store up to 200 MG of surface water in the basalt aquifer using up to 6 injection wells (including Well No. 1) for testing. CRW plans to continue exploring the possibilities of an ASR program. The limited license, which has a number of conditions for monitoring and reporting, expires in 2021. This license is included in Appendix J.

5.2.2.1 Water Rights

Table 5.1 summarizes CRW's groundwater well right. CRW owns one municipal groundwater permit (G-6728) for 5.76 mgd for a single groundwater well. This water right is included in Appendix K.

Table 5.1 Water Rights Held by CRW

Source	Priority Date	Application, Permit, and Certificate #	Quantity	Type of Use
Well No. 1 & Future Other Sources	7/13/1973	App: G-6228 Permit: G-6728	8.9 cfs (5.76 mgd)	Municipal

5.2.2.2 Treatment Capacity

CRW treats the well water with chlorine as the primary disinfectant. Although the well's estimated potential yield is 4.5 mgd, it is currently limited to 1.3 mgd.

5.2.2.3 Performance

The well is not currently in operation due to challenges with water quality (secondary contaminant levels, taste and odor) but is maintained so that it is available for emergency use.

5.2.2.4 Reliability

CRW has the ability to use groundwater to serve a majority of the South System as a secondary source during an emergency. This additional source provides reliability in the case that water from the Clackamas River is not available.

5.2.3 Existing Supply Interconnections

As Table 2.1 shows, CRW has several existing supply interconnections that rely on water from SFWB as the primary supply. Currently, the South System receives water from Oregon City through the Barlow Crest Pump Station, Barlow Crest Gravity, Meyers/Leland Intertie, Forsythe Road and the Impala/South End Road Intertie; and from SFWB through the Anchor Way interconnection from SFWB. (Note- Oregon City's water source of supply is SFWB).

Once the backbone system is completed, the Forsythe, Barlow Crest Pump Station, Barlow Crest Gravity, and Anchor Way interconnections will become secondary emergency connections only. Note that besides the CRW Well No. 1, there are no other emergency connections that are not relying on water to be provided from SFWB (including connections with Oregon City, as noted above). Additional ground water studies in the easterly portions of CRW for potential well sites are recommended. The 2011 Preliminary Groundwater Evaluation report by GSI Water Solutions, Inc. indicated that the westerly areas of the District have poor water quality and quantity, and recommended additional groundwater research in the easterly areas.

5.2.4 Emergency Supply Interconnections

While CRW has an interconnection with SFWB to serve the South System, it must prepare for SFWB water being unavailable due to a catastrophic loss of system, drought, or other cause. The water providers have created a way to provide water from the NCCWC WTP to SFWB with the construction of "Pipeline B". This emergency connection assumes that SFWB WTP is out of service yet still relies on water from the Clackamas River (NCCWC's water source). Pipeline B is routinely exercised to make sure it is available for emergencies. Aside from the proposed Backbone system and Well No. 1, all of CRW's interconnections in the South System rely on SFWB. Besides the Pipeline B connection, there is no other emergency supply intertie, other than CRW's ground water Well No. 1, for the South System if the SFWB plant is unavailable. While Well No.1 has some taste and hardness issues, it does meet drinking standards and can definitely be used during emergencies. (Note- Well No. 1 can only supply water to the Redland, Henrici, and Beavercreek pressure zones.)

5.3 Future Supply Sources

As discussed in Chapter 5 – Water Supply (North), the North System has sufficient water rights to meet projected demand through 2038. The existing water rights are also sufficient to meet existing and future demands from the South System through 2038. As a result, CRW is currently developing connectivity from the North System to the South System.

5.3.1 Clackamas River Water's Water Treatment Plant (WTP)

Once Phase 1 of the CRW Backbone project is complete (2019), CRW's South System will begin to receive water supply from CRW's WTP through an interconnection via CRW's Backbone projects. Figure 5.1 maps CRW's existing WTP with existing and future connections to the South System.

5.3.1.1 Reliability

Overall, CRW seems to have reliable surface water rights and an ample water supply. The Clackamas River has always been able to meet system demands even during the driest months of the year and high turbidity flood events in the mid-1990s. The development of an intertie pipeline between the CRW WTP, NCCWC WTP, and SFWB WTP has further strengthened the Clackamas River source's overall reliability in and around CRW system. Because CRW's water rights on the Clackamas River are certificated, the maximum withdrawal and maximum monthly use do not need to be quantified.

5.3.1.2 Existing Supply Interconnections

By 2020, CRW plans to have built the first phase of its backbone system that would connect its South System to its North System, with Phase 2 completed by year 2024. As part of Phase 1, a 6 MG reservoir is being constructed at 152nd Avenue to serve the Mather zone, with a transmission pipeline across the Clackamas River. The Hattan pump station will then feed the Redland Reservoir site via a proposed transmission main. The 152nd Avenue Reservoir is jointly owned with SWA, and will also allow include an interconnection with SWA that will allow for water to serve CRW during an emergency. Additional pipelines and pump stations are planned as Phase 2 to further improve water distribution to the South System.

5.4 Water Use Projections

This section summarizes the assumptions used to develop the following water use projections from Chapter 3 – Demand Forecast. Since the South system is rural, compared to the North system, which is suburban, separate projections were made for the North and South systems.

5.4.1 Comparison of Projected Demand to Available Sources

Table 5.2 presents 10- and 20-year medium demand projections of the South System. The total demand projection is equal to the sum of the projections in the North System and South System. For comparison, a constant wholesale water demand is shown.

According to these projections, the CRW water system (both North and South) will need to provide an average day demand of 16.9 mgd and a single day maximum demand of 26.7 mgd within the 20-year planning horizon.

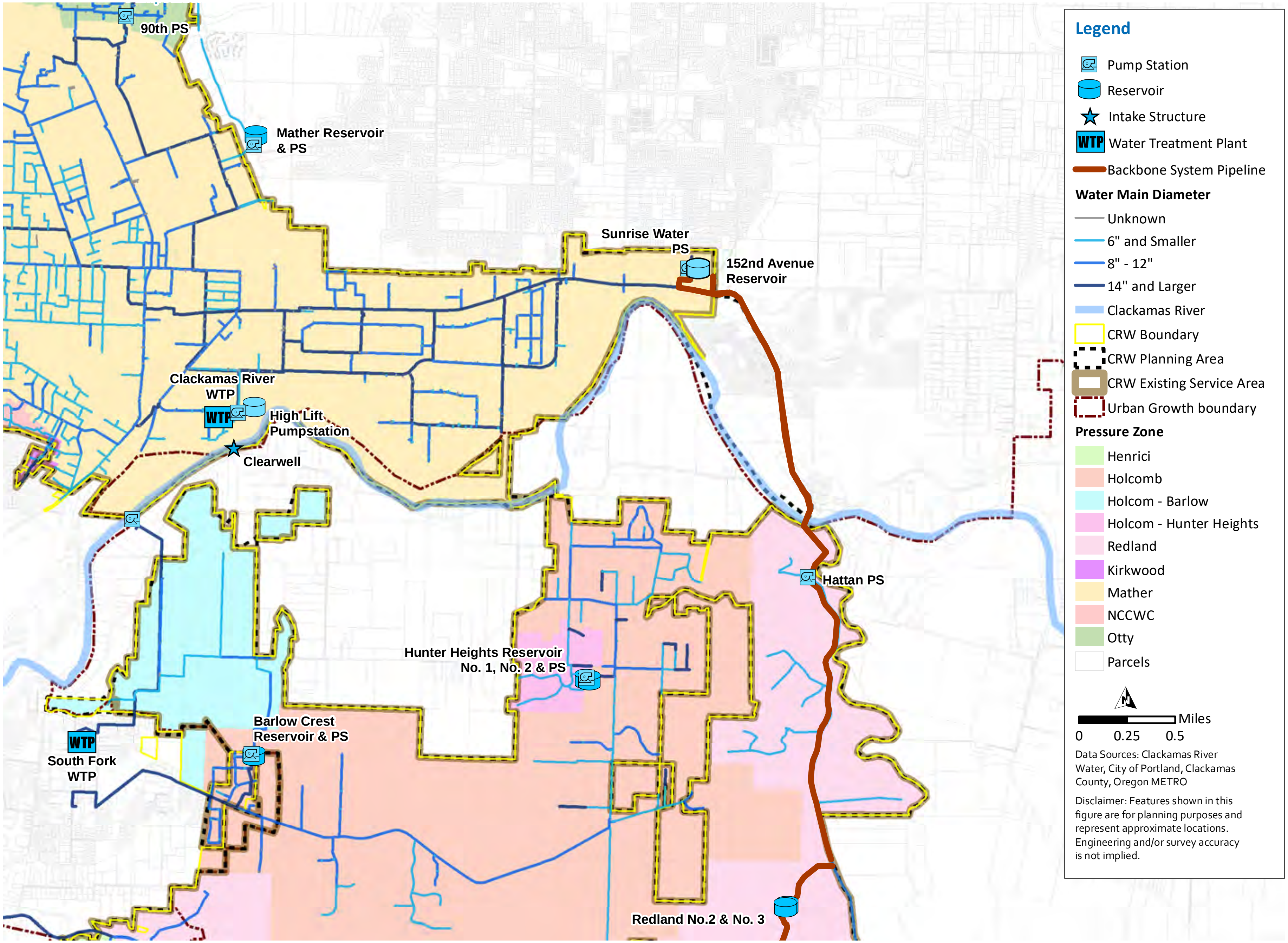

Figure 5.1 Backbone System Connectivity

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Currently, CRW provides water to the South System by purchasing water at an annual average rate of 2 mgd. In the SFWB's 2009 Master Plan Update, the SFWB assumed that CRW's maximum withdrawal rate will remain at 3.67 mgd throughout the 20-year planning period. Although this value is below the South System's existing demand of 5.2 mgd on max day, SFWB has been able to supply CRW's demand with no known issues.

We recommend that CRW continues to supply its demand this way until the first phase of the backbone system is completed in 2020.

5.5 Water Supply Strategy Plan

According to the comparison of water rights and the MDD, CRW has sufficient water rights to meet projected demand through 2038, however, until the South System is connected to the CRW WTP, CRW will continue to rely on SFWB and their associated water rights. As previously noted, CRW and SFWB do not have a current wholesale water supply agreement and are currently operating under a settlement agreement entered into in 2014. We recommend that CRW negotiate an emergency supply agreement with the SFWB on how water will be supplied after the backbone system is constructed.

5.5.1 Potential Additional Water Supplies

Although there are sufficient water rights to serve the South System from SFWB, additional potential water supplies were identified as possible ways to increase water supply during normal conditions or emergencies. This section describes these supplies.

5.5.1.1 Pump Groundwater

To date, CRW's maximum rate of beneficial use of its groundwater permit is 2.05 cfs of the 8.9 cfs authorized. If CRW needs additional supply, additional groundwater could be investigated under permit G-6728.

CRW's future use of this permit could add to its existing supply capacity and increase system reliability, since using the water under this permit will not likely be regulated in favor of other uses.

CRW is only using its groundwater source for emergencies mainly because of taste and odor challenges. CRW performed an analysis on potential types of treatment, and it was found that the source would require reverse osmosis (RO) treatment, which is very expensive. As a result, additional studies are recommended to investigate the feasibility of wells in other parts of the system. The GSI Water Solutions Report recommended additional research in the easterly portions of the South System for groundwater, as the quantity and quality of the water may be better in the easterly portion compared to the westerly portion.

5.5.1.2 ASR Project

CRW's Well No. 1, which is used as a backup water source for emergencies but has poor water quality, may be a potential Aquifer Storage and Recovery (ASR) well. Additional studies are required to evaluate the feasibility of utilizing the well for purposes beyond emergency water supply use. This may include a water quality evaluation.

Currently, CRW has the ability to conduct ASR pilot testing under ASR Limited License Application #003, which allows CRW to store up to 200 MG of water in a basalt aquifer. Under this license, CRW is allowed up to 6 ASR wells for injection and recovery. However, additional potential well locations could also likely have taste and odor issues if they are near the existing well.

5.5.1.3 Purchase water from SFWB

CRW operates under the terms and conditions of a settlement agreement with SFWB to purchase water for the majority of the South Side. However, CRW intends to make all existing connections from SFWB secondary use only, except for the South End and Meyers interconnections. If CRW needs additional water, its connections with SFWB could be used as regular connections rather than emergency connections.

We recommend that CRW and SFWB establish a supply agreement to accomplish this.

5.5.1.4 Conservation

CRW has a long history of fostering water conservation and is dedicated to maximizing the benefits of its water resources. CRW can identify additional conservation measures for significant water savings compared to their implementation costs. By reducing demands, conservation programs that focus on reductions in indoor use, irrigation, and commercial/industrial use can increase CRW's supply. Because CRW has sufficient water rights to serve the South System, these additional conservation programs are not expected to be needed by 2038.

Chapter 6

SYSTEM ANALYSIS –SOUTH SYSTEM

6.1 Introduction

Carollo Engineers, Inc. (Carollo) evaluated Clackamas River Water's (CRW) water distribution system for its ability to meet its reliability criteria under 2019, 2028, and 2038 future conditions. This evaluation was performed using the medium demand projection scenario presented in Chapter 3.

CRW has started making major changes to its distribution system. One of those changes is to connect the North and South systems through a new backbone system and serve the majority of its customers from its water treatment plant (WTP). With this new configuration, the South Fork Water Board (SFWB) Clearwell will no longer serve the South System (details in Section 6.2). Note, CRW will need to continue to purchase water from SFWB until Phase 2 of the backbone project is complete in 2024, and later on to serve areas currently fed by water wheeled through Oregon City. CRW will also rely on Oregon City (which relies on SFWB) to provide water to the Joint Users.

The existing system and backbone system served as the baseline condition for the system analysis. Using CRW's updated hydraulic model, the distribution system was evaluated for its pumping capacity and reliability, the capacity of its storage facilities, and adequate pressures and fire flow capacity.

6.2 Backbone Projects Overview

To evaluate the South System, the planned backbone projects were assumed to be implemented as shown in Figure 6.1. The backbone system will be implemented in two phases:

- Phase I – anticipated to be completed by 2020.
- Phase II - anticipated to be completed by 2024.

Once the backbone system is in place, non-emergency water will be pumped from the CRW WTP, with the exception of areas fed by water wheeled through Oregon City. CRW will also rely on Oregon City (which relies on SFWB). At that point, CRW will no longer use the SFWB Clearwell to directly supply most of the South System under normal conditions, which this analysis accounted for. CRW will still rely on Oregon City (which relies on SFW B) to provide water to our Joint Users.

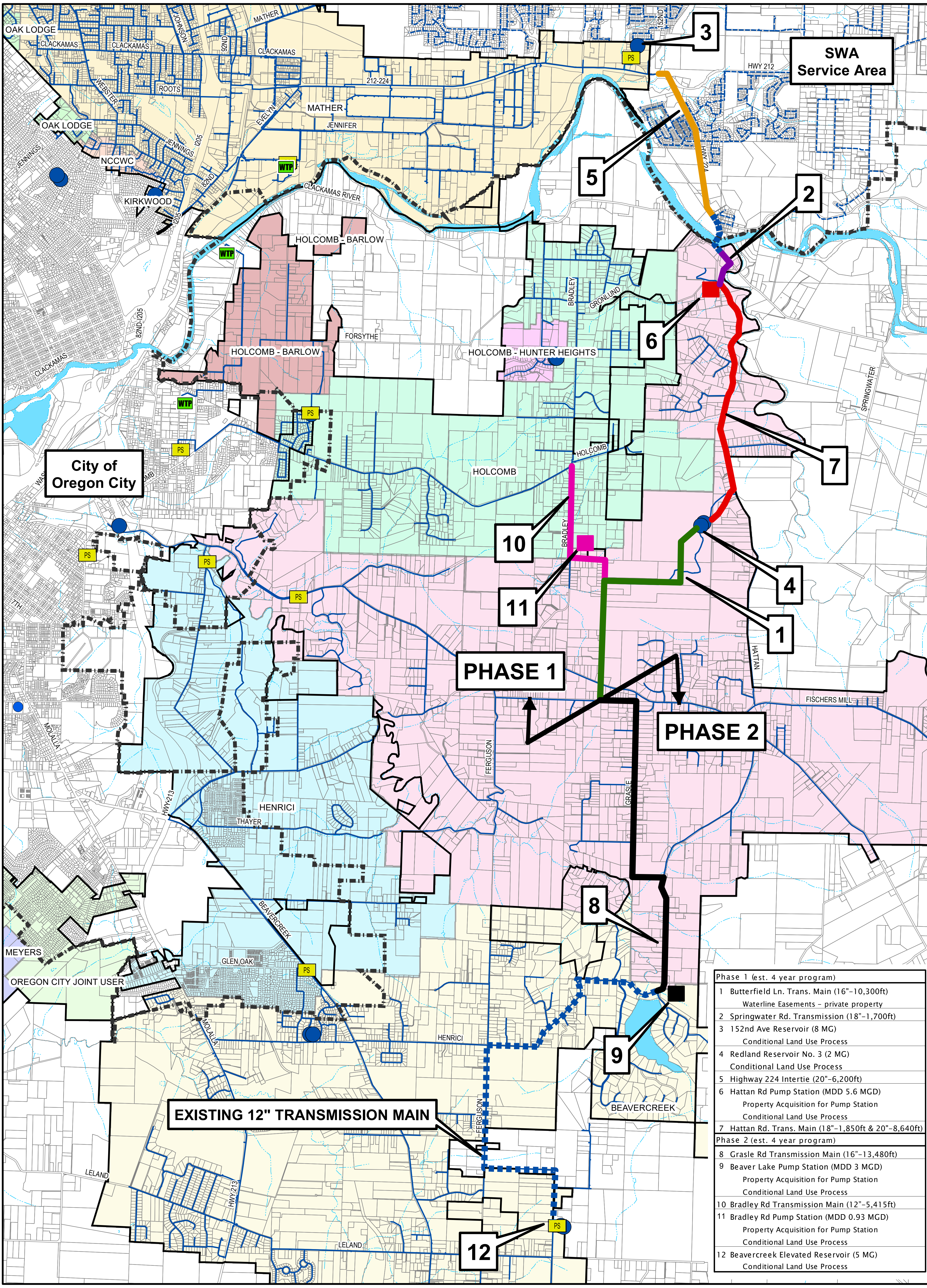
The backbone projects in the South System storage and pumping analysis consist of the following:

- Redland Reservoir No. 3 (1.25 MG) – The reservoir will be located in the Redland Service Area and will be supplied from the Hattan Rd Pump Station. Redland Reservoir site will have a storage capacity of 2.0 MG.
- Hattan Rd Pump Station – The PS will be located in the Redland Service Area and will pump from the 152nd Ave Reservoir in the North Zone to the Redland Reservoirs.

- Beaver Lake Pump Station – The PS will be located in the Beavercreek Service Area and will pump from the Redland Service area to the Beavercreek Service Area.
- Bradley Rd Pump Station - The PS will be located in the Redland Service Area and will pump from the Redland Service Area to the Holcomb Service Area.
- Beavercreek Elevated Reservoir – The reservoir will be located in the Beavercreek Service area and will be supplied from the Beaver Lake PS. The Beavercreek Elevated Reservoir will have an ultimate capacity of 5 MG However, this capacity may be achieved with two new reservoirs. In the short-term of the next 20 years, which corresponds to the planning period for this document, a 2.5 MG reservoir appears sufficient.

Figure 6.2 shows the pressure zone schematic for CRW's water distribution system, with the Backbone System Improvements serving as the baseline for the system analysis. This schematic shows how the various components of the water system work together to provide water service to customers.

BACKBONE PROJECTS - CRW PRESSURE ZONES



Phase 1 (est. 4 year program)	
1	Butterfield Ln. Trans. Main (16"-10,300ft) Waterline Easements - private property
2	Springwater Rd. Transmission (18"-1,700ft)
3	152nd Ave Reservoir (8 MG) Conditional Land Use Process
4	Redland Reservoir No. 3 (2 MG) Conditional Land Use Process
5	Highway 224 Intertie (20"-6,200ft)
6	Hattan Rd Pump Station (MDD 5.6 MGD) Property Acquisition for Pump Station Conditional Land Use Process
7	Hattan Rd. Trans. Main (18"-1,850ft & 20"-8,640ft)
Phase 2 (est. 4 year program)	
8	Grasle Rd Transmission Main (16"-13,480ft)
9	Beaver Lake Pump Station (MDD 3 MGD) Property Acquisition for Pump Station Conditional Land Use Process
10	Bradley Rd Transmission Main (12"-5,415ft)
11	Bradley Rd Pump Station (MDD 0.93 MGD) Property Acquisition for Pump Station Conditional Land Use Process
12	Beavercreek Elevated Reservoir (5 MG) Conditional Land Use Process

N S E W

Date: October 2018
Drawing Name: BACKBONE_PROJECTS_CRW_WALLMAP_OCT2018.mxd
Drawing Location: F:\GIS\ArcMap MXD Project Files
Drawing By: M. Grose

Clackamas River Water

CLACKAMAS RIVER WATER
GEOGRAPHIC INFORMATION SYSTEM
16770 SE 82nd Drive - Clackamas, Oregon
503-722-9220 - www.crwater.com

Figure 6.1 CRW Backbone Projects

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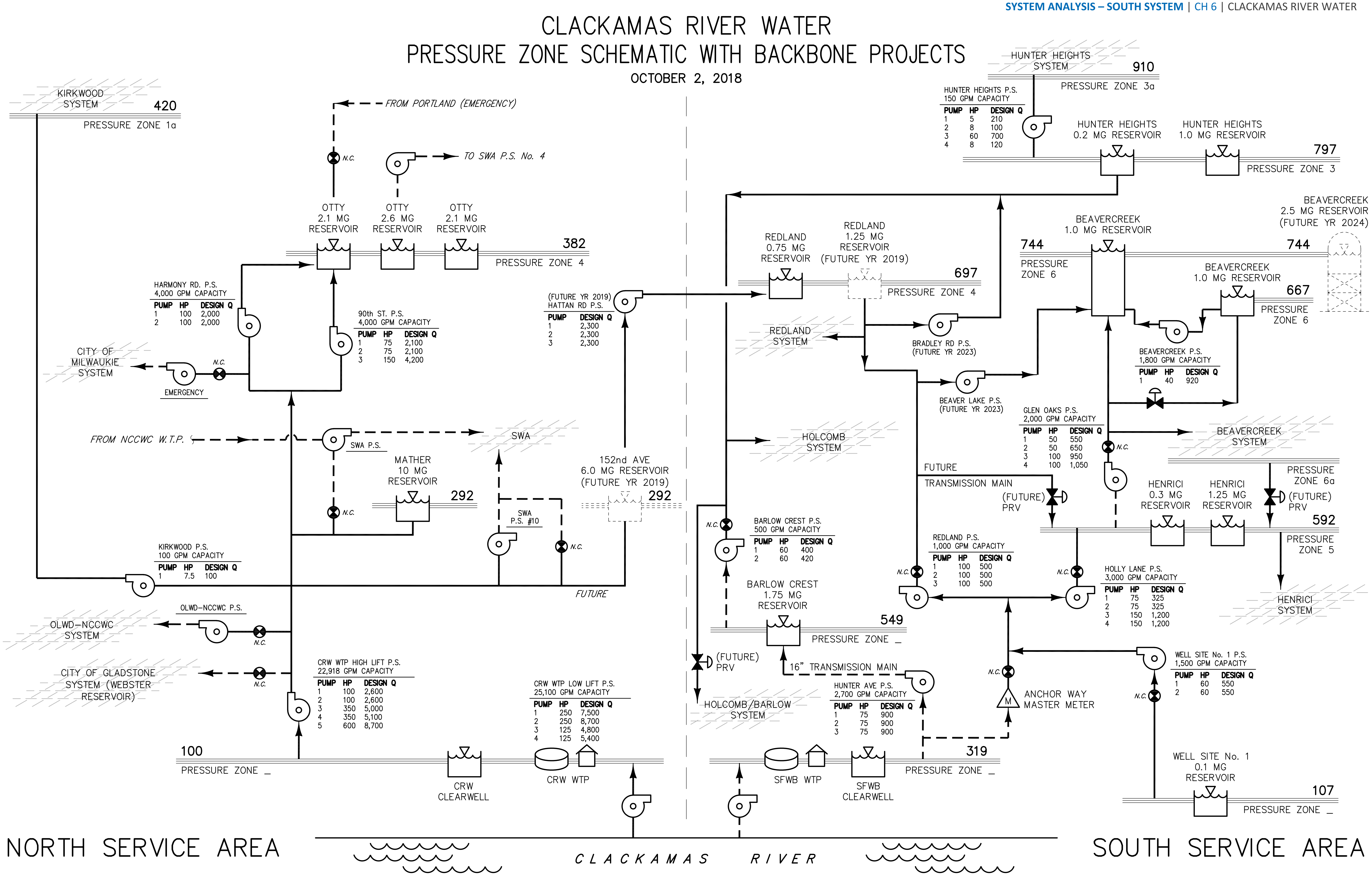

Figure 6.2 Pressure Zone Schematic with Backbone Projects

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6.3 Service Areas

For the system analysis, the South System was divided into three areas referred to as "service areas." Each service area has its own storage facilities and was evaluated by comparing it with CRW's pumping and storage criteria. Note, a fourth service area is not included (South End, Meyers) since it is not reliant on CRW pumping or storage.

As shown in Figure 6.3, the three service areas are as follows:

1. Redland Service Area: Consists of the Redland pressure zone. It will be supplied via the Hattan Rd PS from the 152nd Ave Reservoir. Redland Reservoirs No. 2 & 3 serve the Redland pressure zone.
2. Beavercreek Service Area: Consists of the Beavercreek and Henrici pressure zones. It will be supplied via the Beaver Lake PS (Backbone Projects Phase 2) from the Redland Service Area. The Henrici pressure zone is supplied from the Beavercreek pressure zone via a Pressure Reducing Valve (PRV). Beavercreek Reservoirs No. 1 & 2 serve the Beavercreek pressure zone, and Henrici Reservoirs No. 1 & 2 serve the Henrici pressure zone.
3. Holcomb Service Area: Consists of the Holcomb, Hunter Heights, and Barlow pressure zones. It will be supplied via the Bradley Rd PS from the Redland Service Area. The Hunter Heights pressure zone is supplied from the Holcomb pressure zone via the Hunter Heights PS. Hunter Heights Reservoirs No. 1 & 2 serve the Holcomb pressure zone. Currently the Barlow Crest Reservoir serves the Barlow pressure zone. Per the planned Phase 2 Backbone projects the Barlow pressure zone will be supplied from the Holcomb pressure zone via a PRV.

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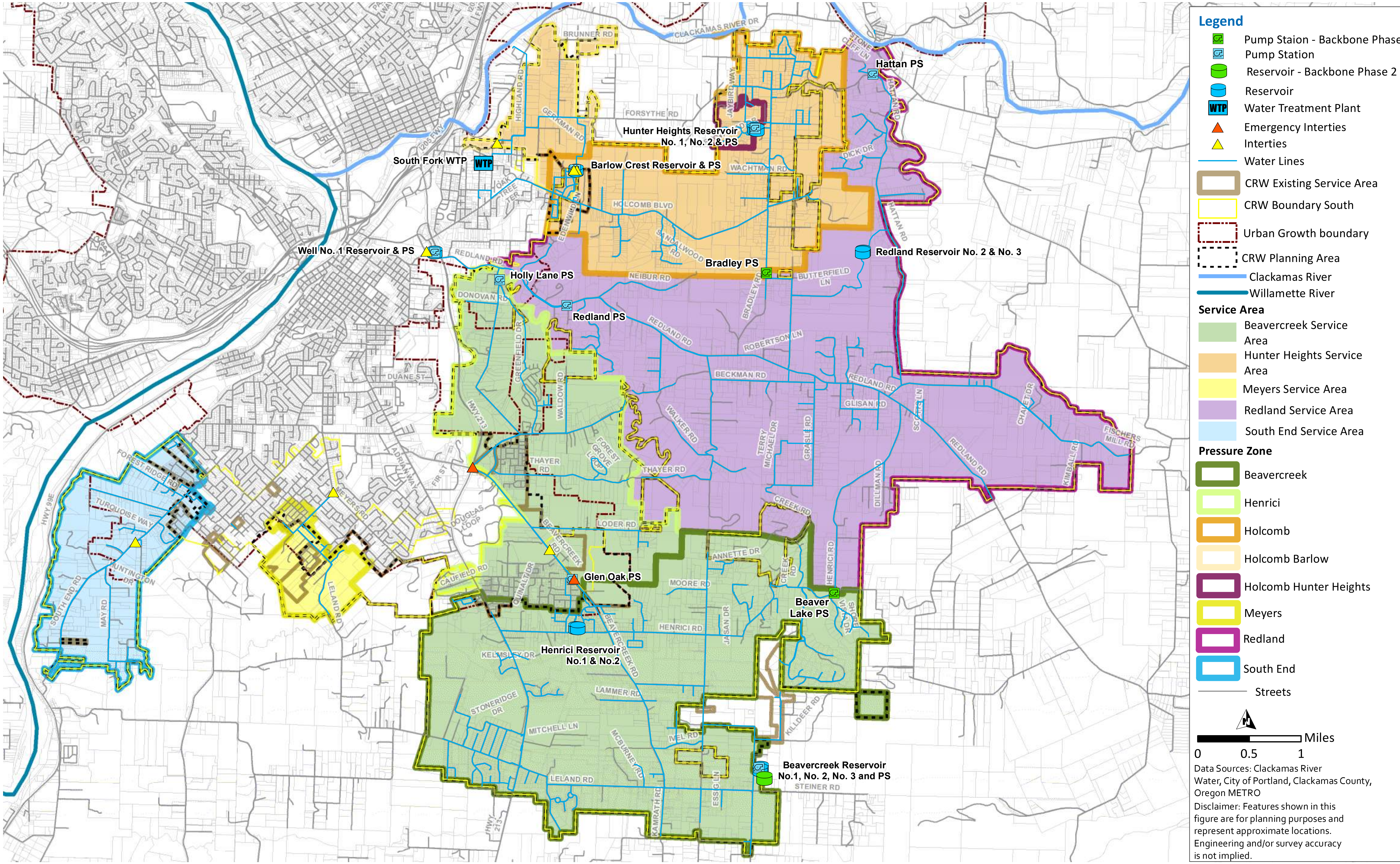

carollo

Figure 6.3 Service Areas - South System

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6.4 Pumping Analysis

6.4.1 Pumping Criteria

The capacity of pumping into each of CRW's service areas was evaluated using the following criteria:

1. Open Zone Booster Pump Station (BPS) Capacity: Pump stations supplying open zones shall contain multiple booster pumps of sufficient capacity to meet the MDD demands with the largest pump out of service.
2. Closed Zone BPS Capacity: Pump stations supplying closed zones shall contain multiple booster pumps of sufficient capacity to meet the higher of MDD plus required fire flow demand or peak hour demand (PHD) with the largest pump out of service.

6.4.2 BPS Capacities

The South System has five booster pump stations, including the Hattan Rd PS that connects the North System to the South System. Table 6.1 provides details on these pump stations.

Table 6.1 South System BPS Capacities

BPS	Area From	Area To	Number of Pumps	Rated Capacity(1) (gpm)	Firm Capacity(2) (gpm)
Hattan Rd	Mather	Redland	TBD	TBD	3,889
Bradley Rd	Redland	Holcomb	TBD	TBD	750
Hunter Heights	Holcomb	Hunter Heights	4	1,130	430
Beaver Lake	Redland	Beavercreek	TBD	TBD	2,083
Beavercreek	Beavercreek No. 1	Beavercreek No. 2	1	920	0

Notes:
(1) Rated Capacity: Capacity with all pumps in service at design flow.
(2) Firm Capacity: Capacity of pump station with largest pump out of service.
(3) Total rated capacity will need to be confirmed during pre-design based on number of pumps identified in the station.

6.4.3 Open Zone BPS Capacity

An "open zone" is one that contains a storage reservoir fed by a BPS. The Redland, Beavercreek, Henrici, Holcomb, and Barlow pressure zones are considered open zones. Table 6.2 shows that the Bradley Rd PS should be designed to provide sufficient capacity to serve the Holcomb, Hunter Heights, and Barlow pressure zones.

Table 6.2 Open Zone BPS Capacity (in gpm)

Operational Area System Type	Redland Open			Beavercreek Open			Henrici Open			Holcomb Open			Barlow Open		
Planning Year	2019	2028	2038	2019	2028	2038	2019	2028	2038	2019	2028	2038	2019	2028	2038
PS Capacity		TBD			TBD			-			TBD			-	
BPS Firm Capacity		3,889			2,083			-			TBD			-	
Required Demand of Service Area	641	699	762	1,097	1,222	1,410	478	514	583	489	535	604	53	63	76
Required Demand of Higher Elevation Zones(1)	2,258	2,467	2,826	-	-	-	-	-	-	142	133	152	-	-	-
Required Demand of Lower Elevation Zones(2)	-	-	-	478	514	583	-	-	-	53	63	76	-	-	-
Required Pumping Capacity	**2,900**	**3,166**	**3,588**	**1,575**	**1,736**	**1,993**	**478**	**514**	**583**	**684**	**731**	**833**	**53**	**63**	**76**
Surplus(Deficit) BPS Pumping Capacity	**898**	**723**	**301**	**508**	**347**	**80**	**-**	**-**	**-**	**66**	**19**	**(83)**	**-**	**-**	**-**

Notes:

(1) The Required Demand of Higher Elevation Zones refers to any demand from pressure zones at higher elevation than operational area that are supplied by the operational area.

(2) The Required Demand of Lower Elevation Zones refers to any demand from pressure zones at lower elevation than operational area that are supplied via PRV from the operational area.

6.4.4 Closed Zone BPS Capacity

A "closed zone" is one without a reservoir. The Hunter Heights pressure zone is considered a closed zone. The Hunter Heights Pump Station has a firm capacity of 430 gpm, but is required to have a fire flow of 1,000 gpm. Thus, the Hunter Heights PS is deficient, as shown in Table 6.3.

Table 6.3 Closed Zone BPS Capacity (in gpm)

Operational Area	Hunter Heights		
System Type	Closed		
Planning Year	2019	2028	2038
PS Capacity	1,130		
BPS Firm Capacity	430		
Required Demand of Service Area	1,045	1,042	1,049
Required Pumping Capacity	1,045	1,042	1,049
Surplus(Deficit) BPS Pumping Capacity	**(615)**	**(612)**	**(619)**

6.4.5 Pumping Recommendations

To provide sufficient firm pumping capacity for the Hunter Heights PS, installing a redundant fire flow pump (700 gpm rated capacity) at the pump station is recommended. The pumping analysis for the Hunter Heights pressure zone with the recommended improvements is shown in Table 6.4.

Table 6.4 Hunter Heights Pumping Analysis with Recommended Improvements (in gpm)

Operational Area	Hunter Heights		
System Type	Closed		
Planning Year	2019	2028	2038
PS Capacity	1,830		
BPS Firm Capacity	1,130		
Required Demand of Service Area	1,045	1,042	1,049
Required Pumping Capacity	1,045	1,042	1,049
Surplus(Deficit) BPS Pumping Capacity	**85**	**88**	**81**

6.5 Storage Analysis

CRW's storage system was evaluated using the criteria described in Chapter 4. CRW's storage requirements depend on requirements for the water demands, fire flows, and pressure. The following sections summarize the available storage of the water system, describe the required storage components, and present recommendations to address identified storage deficits.

6.5.1 Storage Components and Governing Criteria

As described in Chapter 4, the three components of storage listed below and shown in Figure 6.4

1. Operational Storage
2. Emergency storage.
3. Fire suppression storage.

CRW's goal is to make operational storage available to all customers at a pressure of at least 40 pounds per square inch (psi) under peak hour demand (PHD) flow conditions. Emergency and fire suppression storage must be available to all customers at a residual pressure of at least 20 psi under maximum day demand (MDD) and fire flow condition.

Each storage component is described in detail in Chapter 4. The following sections present the equations used to calculate each storage component.

Figure 6.4 Storage Components Illustration

6.5.1.1 Operational Storage

CRW's operational storage requirement is to meet the following criterion: 25 percent of MDD of the service area.

6.5.1.2 Emergency Storage

CRW's emergency storage requirement is to meet the following criterion: 2 x average day demand (ADD) for emergencies.

6.5.1.3 Fire Suppression Storage

Per the CRW's fire suppression storage requirement, the largest fire flow demand of the service area must be met. The required fire flow rates for the South System are shown in Table 6.5.

Table 6.5 Fire Flow Requirements

Customer Type	Fire Flow Rate	Duration
Single-Family Residential	1,000 gpm	2 hours
Multi-Family Residential	1,500 gpm	2 hours
Commercial/Industrial	1,500 gpm	2 hours
Redland Elementary School	2,750 gpm	2 hours
Beavercreek Elementary School	2,500 gpm	2 hours
Ogden Middle School	3,000 gpm	3 hours

6.5.2 Available Storage

CRW's South System has 9 storage tanks with a total capacity of 7.6 MG.

The available storage in each service area is controlled by the elevation of the highest customer in the system and the HGL required to serve that customer with a pressure of at least 40 psi. The total available storage above the 20 psi HGL in CRW's South System is 7.16 MG, and the available storage above the 40 psi HGL is 3.24 MG. Table 6.6 shows the highest service elevation and the amount of storage available in each service area.

6.5.3 Required Storage

Table 6.7 summarizes the operational, emergency, and fire suppression storage requirements for each service area and planning year. The total required storage above the 40 psi HGL is the operational storage. The total required storage above the 20 psi HGL is the sum of operational, emergency, and fire suppression storage.

Table 6.8 summarizes the storage analysis in the South System by comparing required storage volumes with available storage. .

6.5.4 Storage Recommendations

When the Backbone Phase 2 Project is implemented, the South System has sufficient storage through the planning horizon. No additional improvements are recommended.

The Beavercreek service area shows a deficiency of 0.31 MG in 2019 in the interim of building the new Beavercreek reservoir. The analysis shows that the service area is anticipated to have sufficient storage for both short and long terms.

The Holcomb area shows a very slight deficiency of 0.02MG of storage in the long-term. This small of a deficiency does not necessarily warrant a recommended project. It is highly recommended that CRW closely monitor demands in the Holcomb area in the short-term.

The Barlow Crest service area also shows a small deficiency of 0.03MG and 0.06MG in the short and long-term, respectively. This reservoir's ownership is shared and CRW owns approximately 13 percent of the reservoir. New storage is not recommended in the service area, however, it is highly recommended that CRW monitor demands in the short-term and may consider using a slightly larger volume from the shared Barlow Crest reservoir. Approximately 17 percent of the total 1.75 MG would cover the required volume through the planning period.

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Table 6.6 Available Storage

Pressure Zone	Henrici			Beavercreek				Redland			Holcomb			Barlow	South Total
HGL		**592**		**667**	**744**	**744**			**697**			**797**		**549**	-
Facility	**Henrici No. 1**	**Henrici No. 2**	**Total**	**Beavercreek No. 1[(1)]**	**Beavercreek No. 2**	**Elevated Beavercreek[(2)]**	**Total**	**Redland No. 2**	**Redland No. 3**	**Total**	**Hunter Heights No. 1**	**Hunter Heights No. 2**	**Total**	**Barlow Crest**	-
Storage Capacity (MG)	0.3	1.25	1.55	1.0	1.0	2.5	3.5	0.75	1.25	2.0	0.2	1.0	1.2	0.23	8.48
Elevation of Overflow (ft)	592	592	-	667	743	750	-	697	697	-	798	798	-	549	-
Base of Tank (ft)	561	558	-	642	651	710	-	665	665	-	765	750	-	518	-
High Service Elevation (ft)	468	468	-	648	648	648	-	595	595	-	695	695	-	332	-
HGL Required by Highest Customer at 40 psi (ft)	560	560	-	740	740	740	-	687	687	-	787	787	-	424	-
HGL Required by Highest Customer at 20 psi (ft)	514	514	-	694	694	694	-	641	641	-	741	741	-	378	-
Existing Storage above 40 psi HGL (MG)	0.3	1.162	1.462	0.0	0.033	0.60	6.4	0.225	0.375	0.6	0.062	0.212	0.273	0.23	3.20
Percent of Storage above 40 psi HGL	100%	93%	94%	0%	3%	24%	18%	30%	30%	30%	31%	21%	23%	100%	38%
Existing Storage above 20 psi HGL (MG)	0.3	1.25	1.55	1.0	0.53	2.5	3.04	0.75	1.25	2.0	0.2	1.0	1.2	0.23	8.01
Percent of Storage above 20 psi HGL	100%	100%	100%	100%	53%	100%	87%	100%	100%	100%	100%	100%	100%	100%	95%

Notes:
(1) Beavercreek No. 1 is assumed to be available in 2019 but will be demolished and unavailable for 2028 and 2038.
(2) The Elevated Beavercreek Reservoir will be online in 2028 and 2038.
(3) Barlow Crest reservoir.

Table 6.7 Required Storage

Source Reservoir	Henrici Reservoirs			Beavercreek Reservoirs			Redland Reservoirs			Hunter Heights Reservoirs									Barlow Crest			South System Total		
Pressure Zone	Henrici			Beavercreek			Redland			Holcomb			Hunter Heights			Total			Barlow					
Planning Year	2019	2028	2038	2019	2028	2038	2019	2028	2038	2019	2028	2038	2019	2028	2038	2019	2028	2038	2019	2028	2038	2019	2028	2038
MDD (mgd)	0.69	0.74	0.84	1.58	1.76	2.03	0.92	1.01	1.10	0.70	0.77	0.87	0.06	0.06	0.07	0.77	0.83	0.94	0.08	0.09	0.11	-	-	-
Required Operating Volume (MG)	0.17	0.19	0.21	0.39	0.44	0.51	0.23	0.25	0.27	0.18	0.19	0.22	0.02	0.02	0.02	0.19	0.21	0.24	0.03	0.02	0.03	1.01	1.11	1.25
ADD (mgd)	0.25	0.27	0.31	0.58	0.64	0.74	0.34	0.37	0.40	0.26	0.28	0.32	0.02	0.02	0.02	0.28	0.30	0.34	0.03	0.03	0.04	-	-	-
Emergency Storage (MG)	0.50	0.54	0.62	1.16	1.28	1.48	0.67	0.73	0.80	0.52	0.56	0.64	0.04	0.04	0.04	0.56	0.60	0.68	0.06	0.06	0.08	2.95	3.21	3.66
Largest Fire Flow Requirement (gpm)		3,000			2,500			2,750			1,500			1,000			-			1,500			-	
Fire Flow Duration (minutes)		180			120			120			120			120			-			120			-	
Required Fire Suppression Storage (MG)		0.54			0.3			0.33			0.18			0.12			0.30			0.18			1.65	

Table 6.8 Storage Analysis Summary

Service Area	Redland			Beavercreek						Holcomb									Barlow		
Storage	**Redland Reservoirs**			**Beavercreek Reservoirs**			**Henrici Reservoirs**			**Hunter Heights Reservoirs**			**n/a**						**Barlow Crest**		
Pressure Zone	**Redland - 697**			**Beavercreek - 667 & 744**			**Henrici - 592**			**Holcomb - 797**			**Hunter Heights - 910**			**Total**			**Barlow - 549**		
Planning Year	2019	2028	2038	2019(1)	2028(2)	2038(3)	2019	2028	2038	2019	2028	2038	2019	2028	2038	2019	2028	2038	2019	2028	2038
Consolidation	Stacked			Stacked			Stacked			Stacked			Stacked						Stacked		
Projected Demand																					
EHUs	1,550	1,615	1,760	2,280	2,535	2,935	1,075	1,155	1,295	1,015	1,105	1,255	93	92	95	1,108	1,197	1,350	110	130	160
ADD (gpm)	235	255	280	405	445	515	175	190	215	180	195	220	14	14	14	194	209	234	20	20	30
MDD (gpm)	640	700	760	1,110	1,220	1,410	480	515	585	490	535	605	45	42	49	535	577	654	55	65	75
PHD (gpm)	1,135	1,235	1,335	1,905	2,080	2,380	885	940	1,055	910	980	1,095	142	133	152	1,052	1,113	1,247	160	180	205
Available Storage (mg)																					
Total Storage	2.00	2.00	2.00	2.00	3.50	3.50	1.55	1.55	1.55	1.20	1.20	1.20	0.00	0.00	0.00	1.20	1.20	1.20	0.23	0.23	0.23
Highest Service Elevation	595	595	595	648	648	648	468	468	468	695	695	695				695	695	695	332	332	332
Meeting 40 psi Requirement	0.60	0.60	0.60	0.27	0.63	0.63	1.46	1.46	1.46	0.27	0.27	0.27	0.00	0.00	0.00	0.27	0.27	0.27	0.23	0.23	0.23
Meeting 20 psi Requirement	2.00	2.00	2.00	1.54	3.04	3.04	1.55	1.55	1.55	1.20	1.20	1.20	0.00	0.00	0.00	1.20	1.20	1.20	0.23	0.23	0.23
Dead Storage @ 20 psi	0.00	0.00	0.00	0.46	0.46	0.46	0.00	0.00	0.00	0.00	0.00	0.00				0.00	0.00	0.00	0.00	0.00	0.00
Required Storage Components (mg)																					
Operational Storage	0.23	0.25	0.27	0.39	0.44	0.51	0.17	0.19	0.21	0.18	0.19	0.22	0.01	0.02	0.02	0.19	0.21	0.24	0.02	0.02	0.03
Emergency Storage	0.67	0.73	0.80	1.16	1.28	1.48	0.50	0.54	0.62	0.52	0.56	0.64	0.04	0.04	0.04	0.56	0.60	0.68	0.06	0.06	0.08
Fire Suppression Storage	0.33	0.33	0.33	0.30	0.30	0.30	0.54	0.54	0.54	0.18	0.18	0.18	0.12	0.12	0.12	0.18	0.18	0.18	0.18	0.18	0.18
Required Storage (mg)																					
To meet 40 psi Requirement	0.23	0.25	0.27	0.39	0.44	0.51	0.17	0.19	0.21	0.18	0.19	0.22	0.01	0.02	0.02	0.19	0.21	0.24	0.02	0.02	0.03
To meet 20 psi Requirement	1.24	1.32	1.41	1.85	2.02	2.29	1.21	1.27	1.37	0.88	0.93	1.04	0.18	0.18	0.18	1.05	1.11	1.22	0.26	0.26	0.29
Final Surplus/(Deficit) @ 40 psi(mg)	**0.37**	**0.35**	**0.33**	**(0.12)**	**0.19**	**0.12**	**1.29**	**1.28**	**1.25**	**0.10**	**0.08**	**0.06**	**(0.02)**	**(0.02)**	**(0.02)**	**0.08**	**0.07**	**0.04**	**0.21**	**0.21**	**0.20**
Final Surplus/(Deficit) @ 20 psi(mg)	**0.76**	**0.68**	**0.59**	**(0.31)**	**1.02**	**0.34**	**0.29**	**0.18**	**0.60**	**0.33**	**0.27**	**0.16**	**(0.18)**	**(0.18)**	**(0.18)**	**0.15**	**0.09**	**(0.02)**	**(0.03)**	**(0.03)**	**(0.06)**

Notes:

(1) In 2019, the 1-MG stand pipe (Beavercreek No. 1) and 1-MG ground reservoir (Beavercreek No. 2) are assumed to be online.

(2) In 2028, the 1-MG stand pipe (Beavercreek No. 1) is assumed to be demolished and offline. The 2.5-MG elevated reservoir and 1-MG ground reservoir (Beavercreek No. 2) are assumed to be online.

(3) In 2038, the 2.5-MG elevated reservoir and 1-MG ground reservoir (Beavercreek No. 2) are assumed to be online.

6.6 Hydraulic Model Update

CRW's hydraulic model is the primary tool used to evaluate its distribution system. The model evaluates how CRW's water infrastructure handles future demands and verifies that recommended improvements will eliminate system deficiencies.

CRW maintains the hydraulic model of its distribution system using InfoWater by Innovyze. For this Plan, the hydraulic model had been updated and calibrated to steady state condition before Carollo received it. Carollo then updated and calibrated the model for extended period simulation (EPS) condition and developed a calibration plan when this project began. The calibration plan is detailed in Technical Memorandum 2, which is included in Appendix L.

6.6.1 Demand Allocation Process

Demands for planning years 2028 and 2038 from the medium demand projection scenario presented in Chapter 3 were allocated to CRW's hydraulic model. To reflect existing water system production, the existing system demands were scaled in the model.

For future planning years, demands for existing customers were scaled down to account for water conservation. Additional future demands for new customers were allocated to vacant parcels and parcels with potential redevelopment (i.e., zoning is different than the existing land use).

The resulting model demand allocation does not represent actual water use for individual customers. Instead, it represents typical water use based on large groups of customers. Similarly, the actual sites of future development within the planning period are not known. As a result, future demands were spread across all vacant parcels.

6.6.2 Fire Flows

The quantity of water available for firefighting establishes an important level of service for a water system. CRW's established criteria for fire flow were used to update the hydraulic model and are summarized below:

- 1,000 gpm for 2 hours for all single-family residential (SFR) areas.
- 1,500 gpm for 2 hours for multi-family residential (MFR) areas.
- 1,500 gpm for 2 hours for commercial/industrial areas.
- 2,750 gpm for 2 hours for Redland Elementary School.
- 2,500 gpm for 2 hours for Beavercreek Elementary School.
- 3,000 gpm for 3 hours for Ogden Middle School.
- Parks and open spaces were not allocated fire flows.

Figure 6.5 shows the fire flow requirements throughout the South Distribution System.

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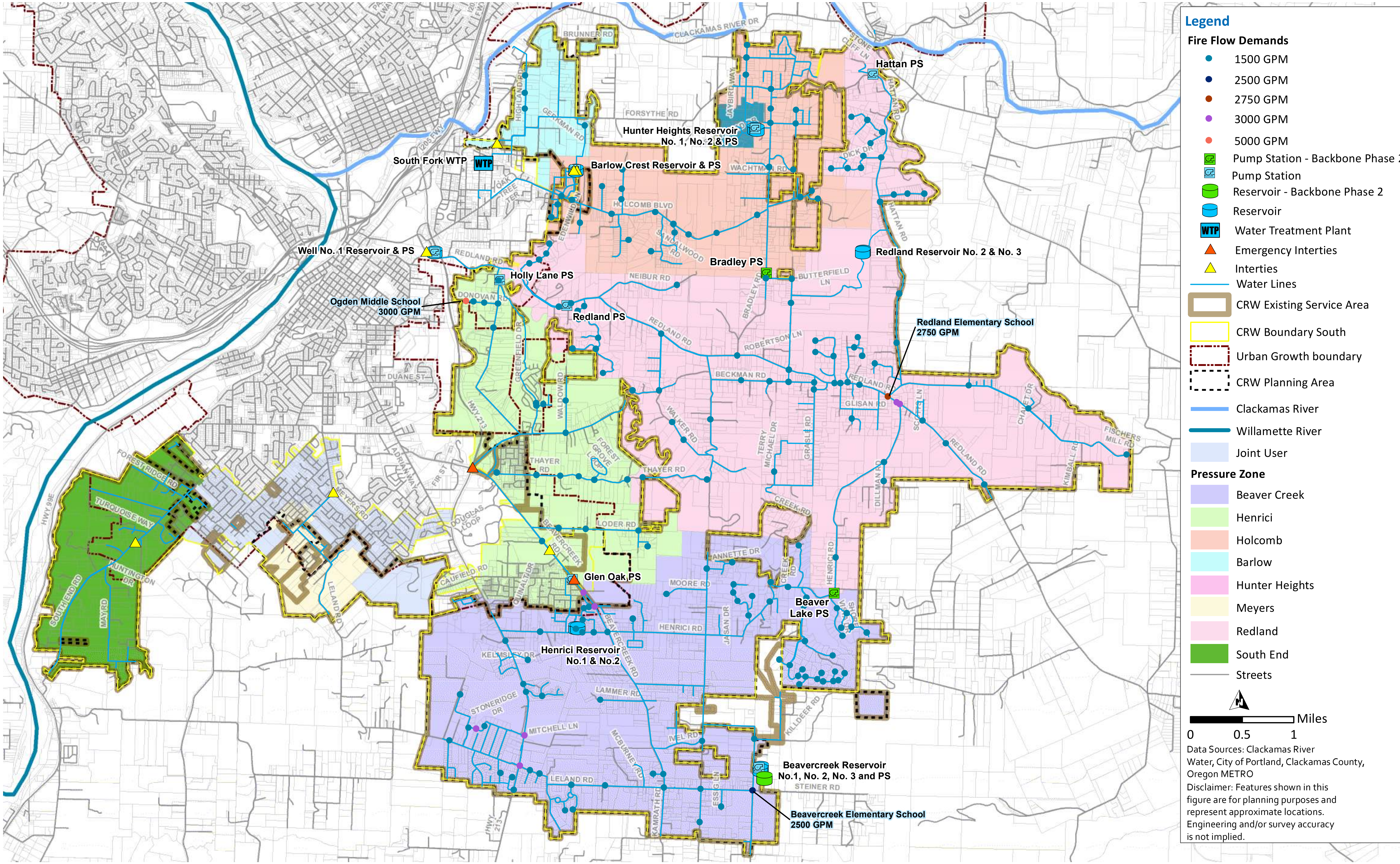

Figure 6.5 Fire Flow Requirements - South System

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6.7 Distribution System Analysis

The hydraulic model was used to evaluate the distribution system under 2019, 2028, and 2038 demand conditions. For the 2019 system analysis, the Backbone Phase 1 projects were assumed to be online. The distribution system was evaluated using three performance criteria. Areas not meeting the criteria were considered deficient, and system improvements were identified to achieve the desired level of service.

6.7.1 Evaluation Criteria

The three evaluation criteria are from CRW's policies and criteria presented in Chapter 4. These policies are at least as stringent as the OAR Chapter 690, Division 86 requirements. The distribution system was evaluated for the following criteria:

1. Low PHD Pressure. The minimum allowed pressure is 40 psi.
2. High Velocity and High Head loss. The maximum velocity allowed is 10 feet per second (fps) for pipes with diameters less than 12 inches and 5 fps for pipes with diameters equal to, or greater than, 12 inches. The maximum head loss allowed is 10 ft/1,000 ft for pipes with diameters less than 12 inches and 5 ft/1,000 ft for pipes with diameters equal to, or greater than, 12 inches.
3. Available Fire Flow. System pressures must remain above 20 psi during MDD plus fire flow conditions.

6.7.2 Identified Deficiencies

6.7.2.1 Low PHD Pressure

To identify areas with operating pressures below 40 psi, peak hour demand (PHD) conditions were simulated for each planning year. Figures 6.6, 6.7, and 6.8 show areas where pressures dropped below 40 psi during PHD in 2019, 2028, and 2038, respectively. In Figure 6.6, the Backbone Phase 1 projects were assumed to be online.

Figure 6.8 shows areas where pressures dropped below 40 psi during PHD in 2038, which is the planning year of highest demand and thus has the lowest pressure. During PHD, CRW's policies require the pressure to be at least 40 psi. Areas where pressures are below this criteria are marked on the map: pressures below 20 psi are black, pressures between 20 and 30 psi are red, and pressures between 30 psi and 40 psi are orange.

The following five areas of low pressures were flagged during the analysis:

- Beavercreek Zone: S Mountain Meadow Rd to S Mompano Overlook Dr.
- Henrici Zone: Loder Rd.
- Holcomb Zone: S Overlook Rd.
- Barlow Zone: S Mason Heights Dr.
- Henrici Zone: Henrici Rd.

6.7.2.2 High Velocity

To identify areas with high velocities and high head loss, PHD conditions were simulated for each planning year. Figures 6.9, 6.10, and 6.11 show the areas with high velocities and high head loss during PHD in 2019, 2028, and 2038, respectively. In Figure 6.9 the Backbone Phase 1 projects were assumed to be online.

Figure 6.11 shows the areas with high velocities and high head loss during PHD in 2038, which is the planning year of highest demand and thus has the highest velocities and head loss. Pipes with velocities and head loss above CRW's criteria are highlighted according to the legend.

The pipeline west from Redland Reservoir to Butterfield Lane in the Redland zone shows as outside of criteria under 2019, 2028, and 2038 conditions. The high velocities and head losses in this pipeline will be addressed by the proposed 12-inch diameter pipeline (replacing an 8-inch diameter pipeline) on Hattan Road south from the Redland Reservoirs to Redland Road.

6.7.2.3 Available Fire Flow

CRW's criterion requires fire flows to be met while supplying MDD and maintaining 20 psi throughout the distribution system. Fire flows are typically the largest flows a system experiences and are often a major factor in pipe sizing and configurations.

The hydraulic model was used to systematically simulate a fire at each model node representing a fire hydrant for each planning year. Deficient nodes that cannot provide required fire flows while maintaining system pressures everywhere else in the system during 2038 conditions are shown in Figure 6.12.

Figure 6.12 shows the percentage of fire flow available at hydrant at the minimum residual pressure of 20 psi. According to the green nodes, the fire hydrant is receiving over 100 percent of the required fire flow and is thus not deficient. However, the yellow, orange, red, and black nodes show that the fire hydrant *is* deficient according to the percentages outlined in the legend. The black nodes have the largest deficiencies.

Reservoirs were set at the bottom of the fire suppression storage component during the fire flow analysis, as shown in Table 6.9. Considering the high demands and the reservoir levels, locations that may have sufficient pressure and flow during annual hydrant testing could be deficient with these lower reservoir levels.

Fire flow deficiencies were identified throughout the system. Areas of particular susceptibility are dead end mains, areas of older 4-inch and 6-inch piping networks, and areas near high elevation points in a pressure zone. Most deficiencies occur in planning year 2019, however a few additional locations are triggered in the future conditions 2028, and 2038.

Table 6.9 Initial Water Surface Level for Reservoirs during Fire Flow Analysis

Reservoir	Initial Water Surface Level (ft)
Beavercreek No. 1	23.0
Beavercreek No. 2	73.0
Henrici No. 2	19.0
Hunter Heights No. 1	15.0
Hunter Heights No. 2	30.3
Redland No. 2	22.0

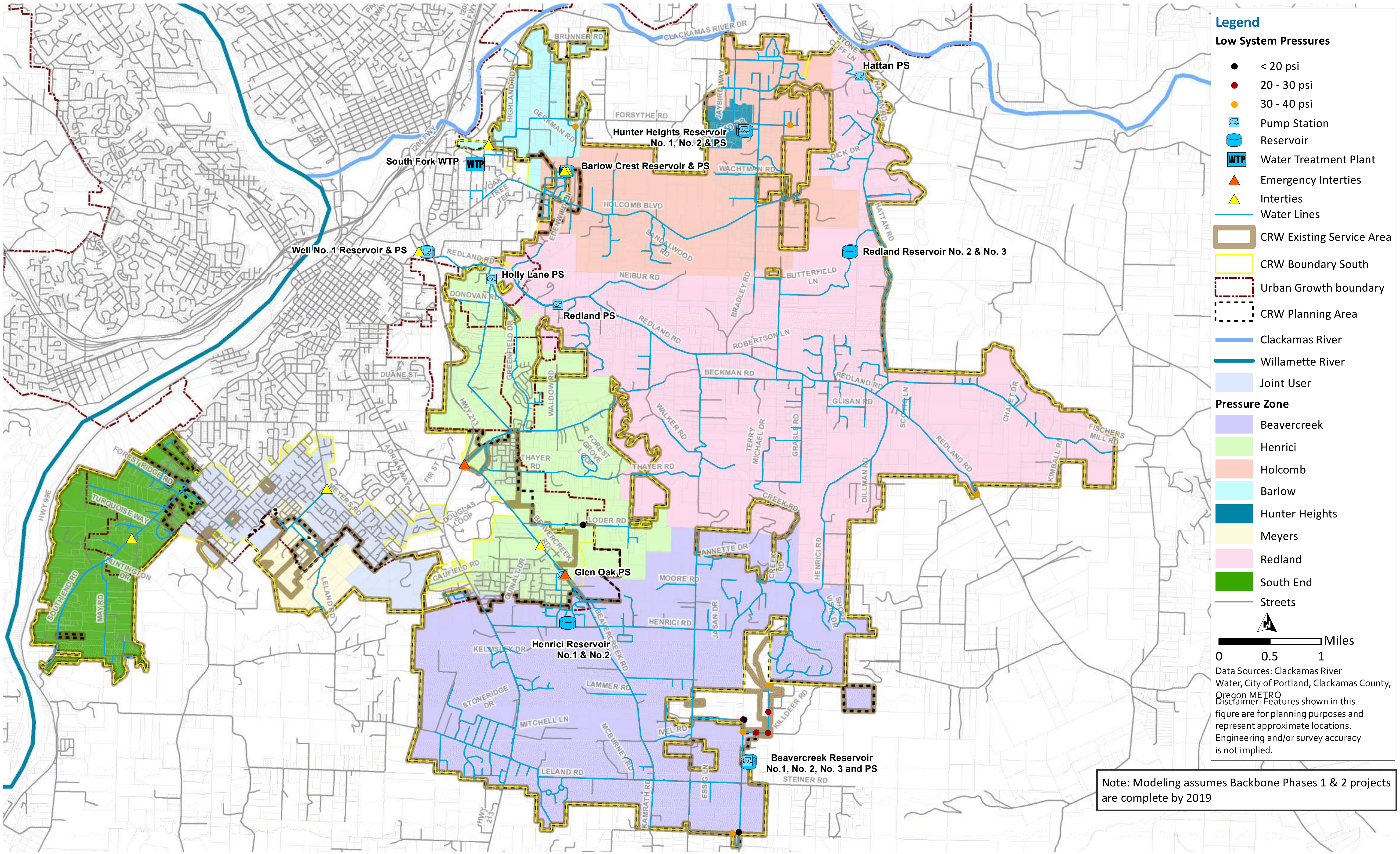

Figure 6.6 Low System Pressures Under 2019 PHD Conditions - South System

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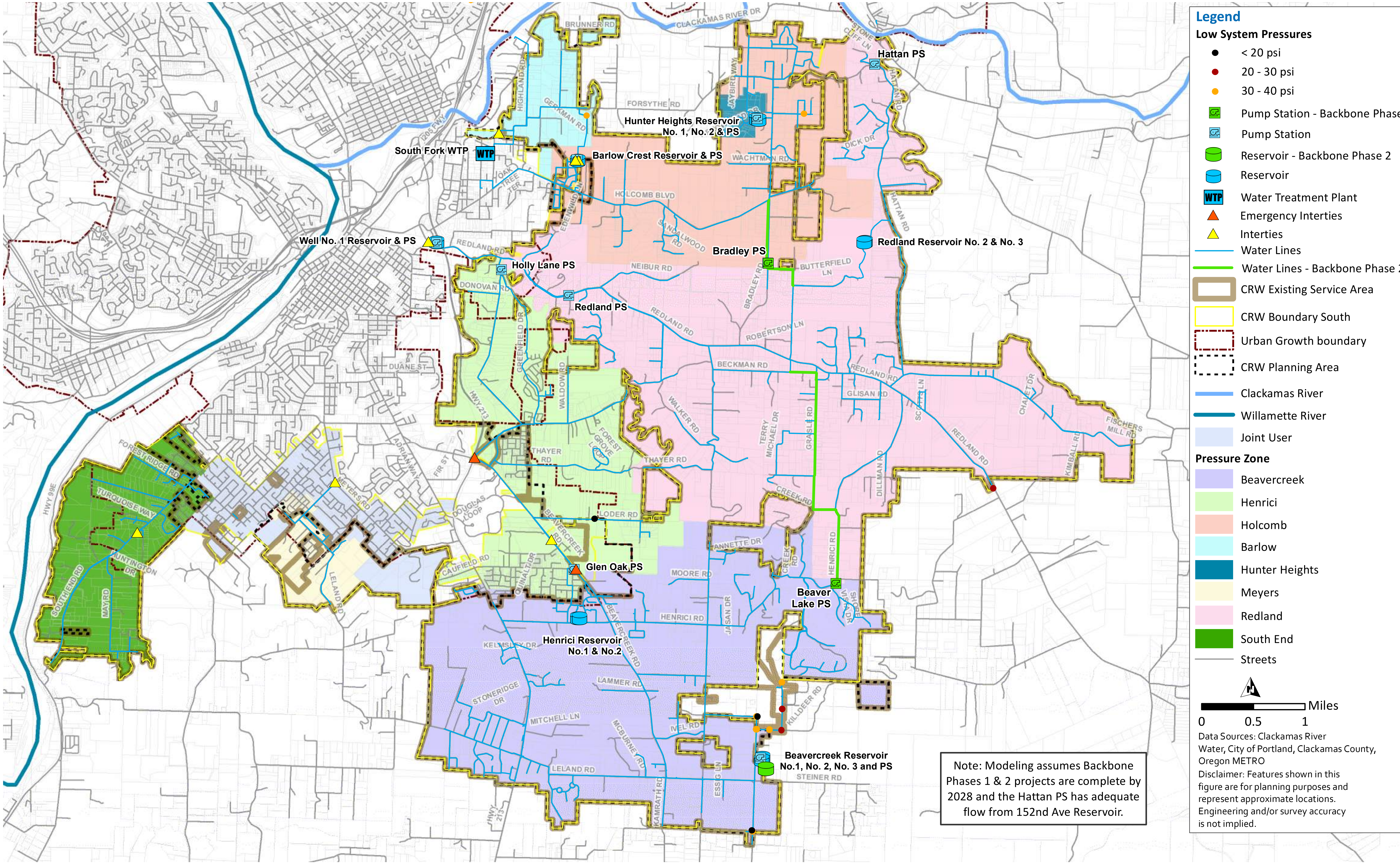

Figure 6.7 Low System Pressures Under 2028 PHD Conditions - South System

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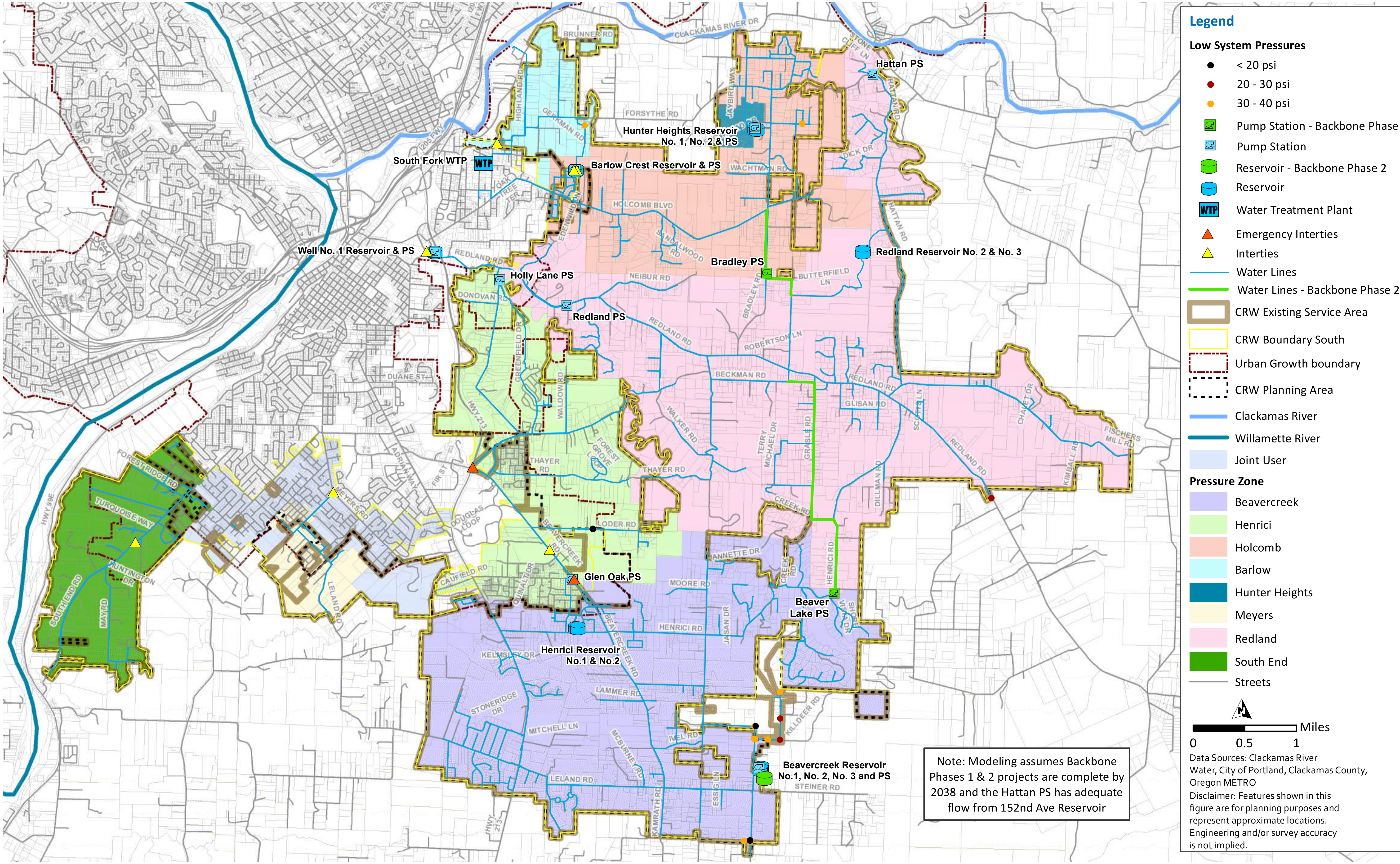

Figure 6.8 Low System Pressures Under 2038 PHD Conditions - South System

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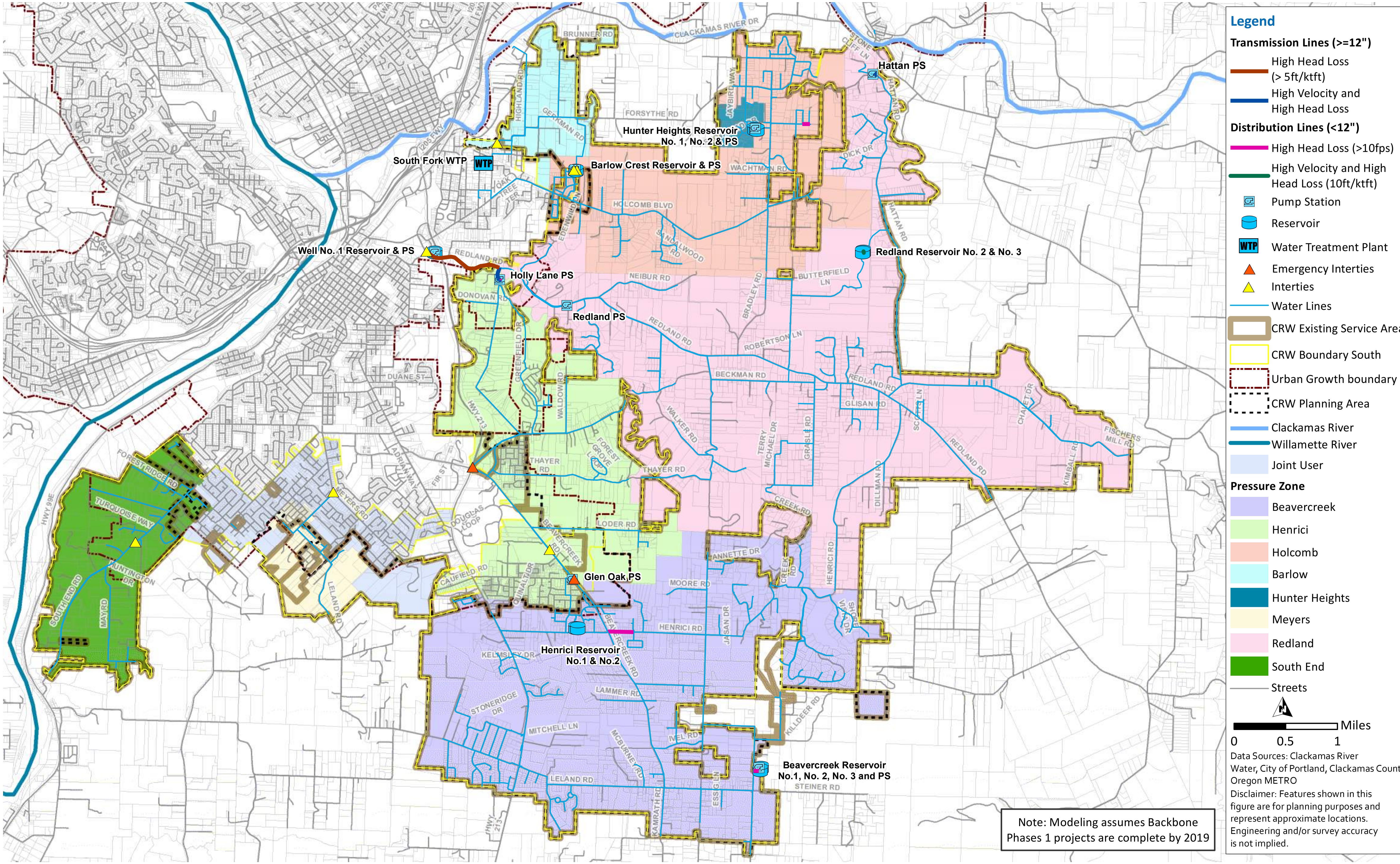

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Figure 6.9 Pipeline Velocities and Head Loss under 2019 PHD Conditions - South System

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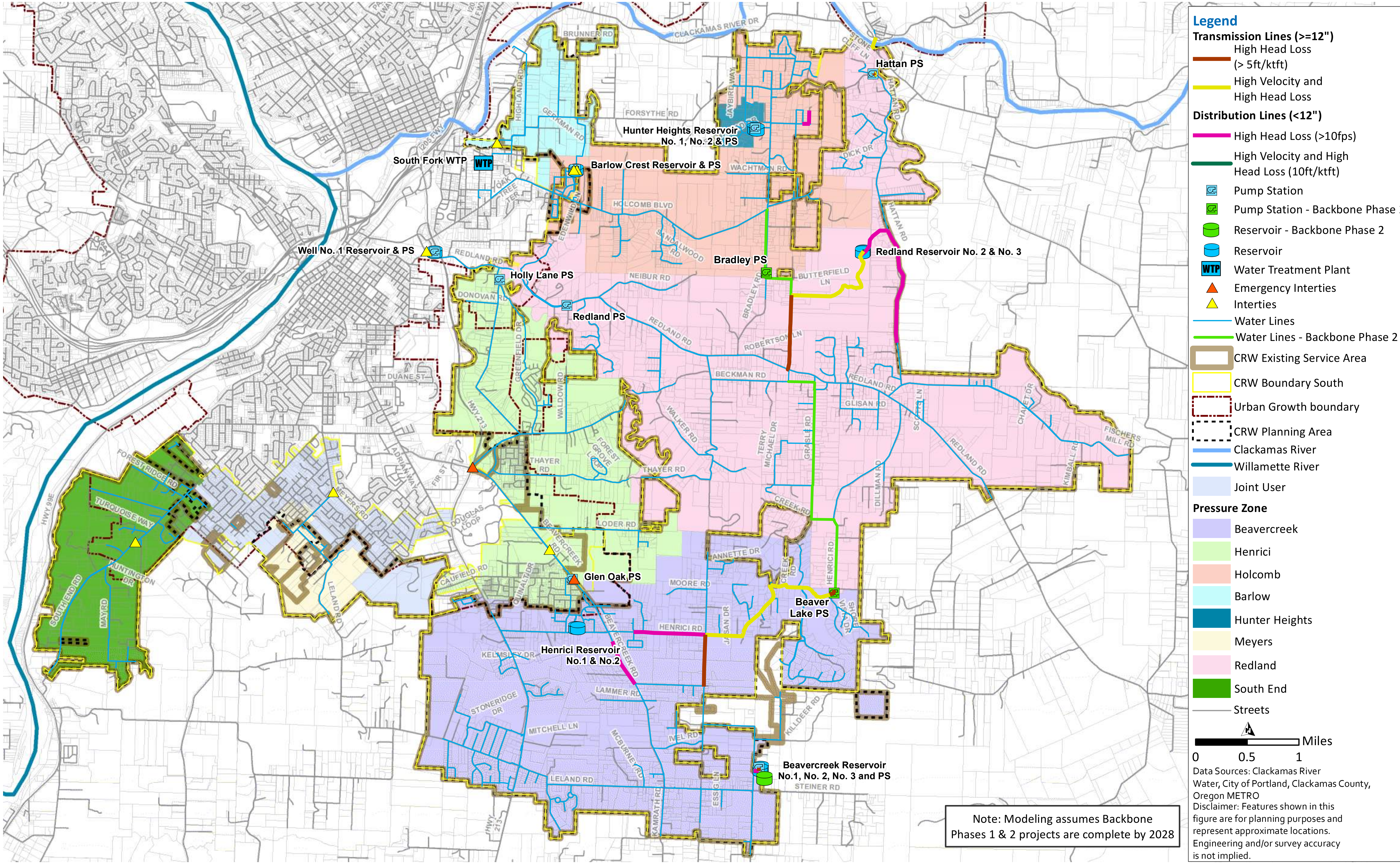

Note: Modeling assumes Backbone Phases 1 & 2 projects are complete by 2028

Figure 6.10 Pipeline Velocities and Head Loss under 2028 PHD Conditions - South System

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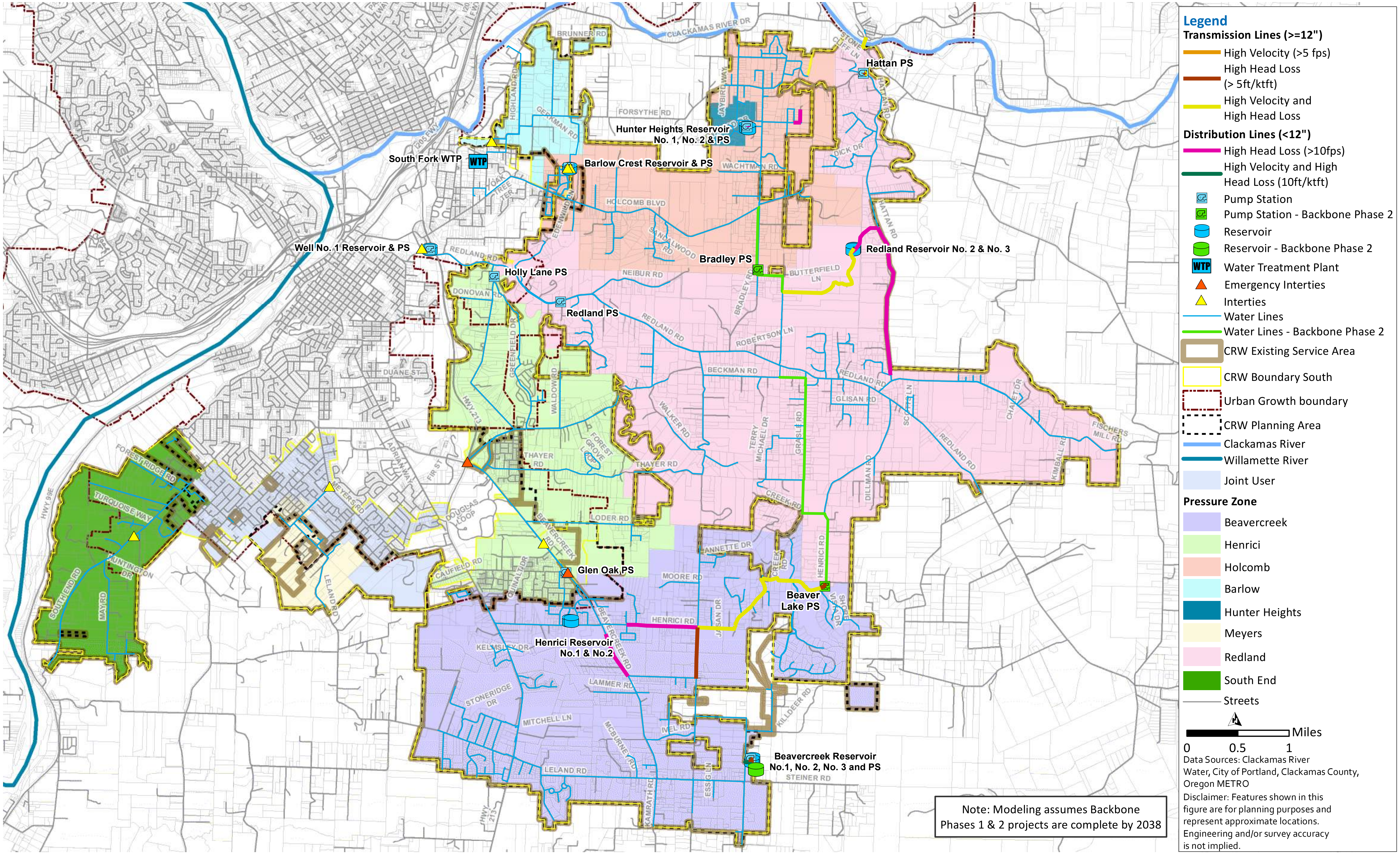

Figure 6.11 Pipeline Velocities and Head Loss under 2038 PHD Conditions - South System

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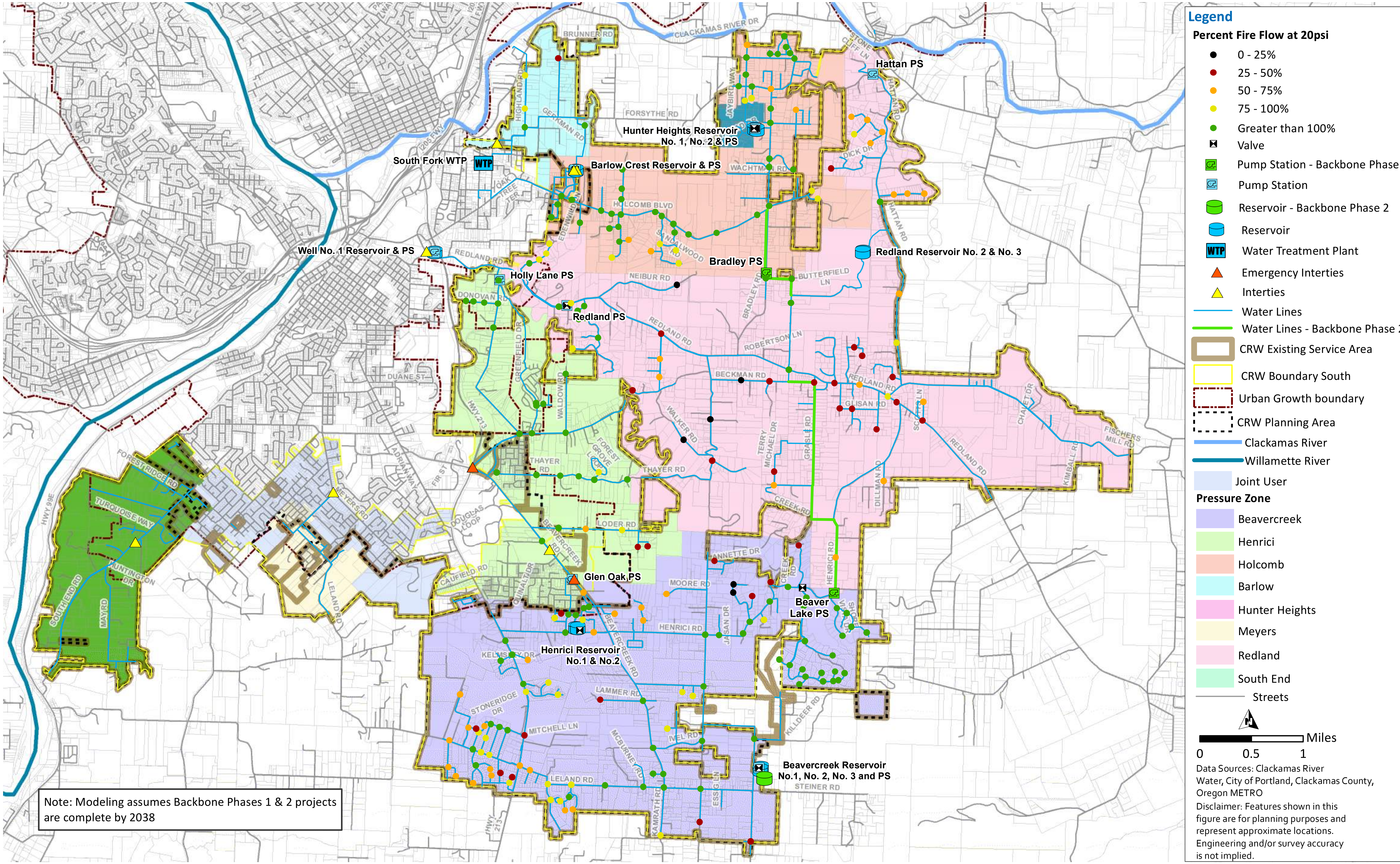

Figure 6.12 Fire Flow Deficiencies under 2038 MDD + Fire Flow Conditions - South System

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6.7.3 Recommended Improvement Projects

Improvements were recommended to meet the deficiencies identified in the previous sections. Improvements include pipe upsizing, main looping, and modifying pressure zone boundaries. The recommended projects are shown in Figure 6.13.

This section provides detailed information on each recommended pipe improvement. Individual projects are referenced based on the Project Identification shown in Figure 6.13. Each recommended project requires further site-specific and project level engineering analysis before implementation.

A summary of the recommended projects can be found in Table 6.10.

Projects are described based on their main purpose: PV stands for pressure and velocity projects, PZ stands for Pressure Zone projects, while FF stands for Fire Flow projects.

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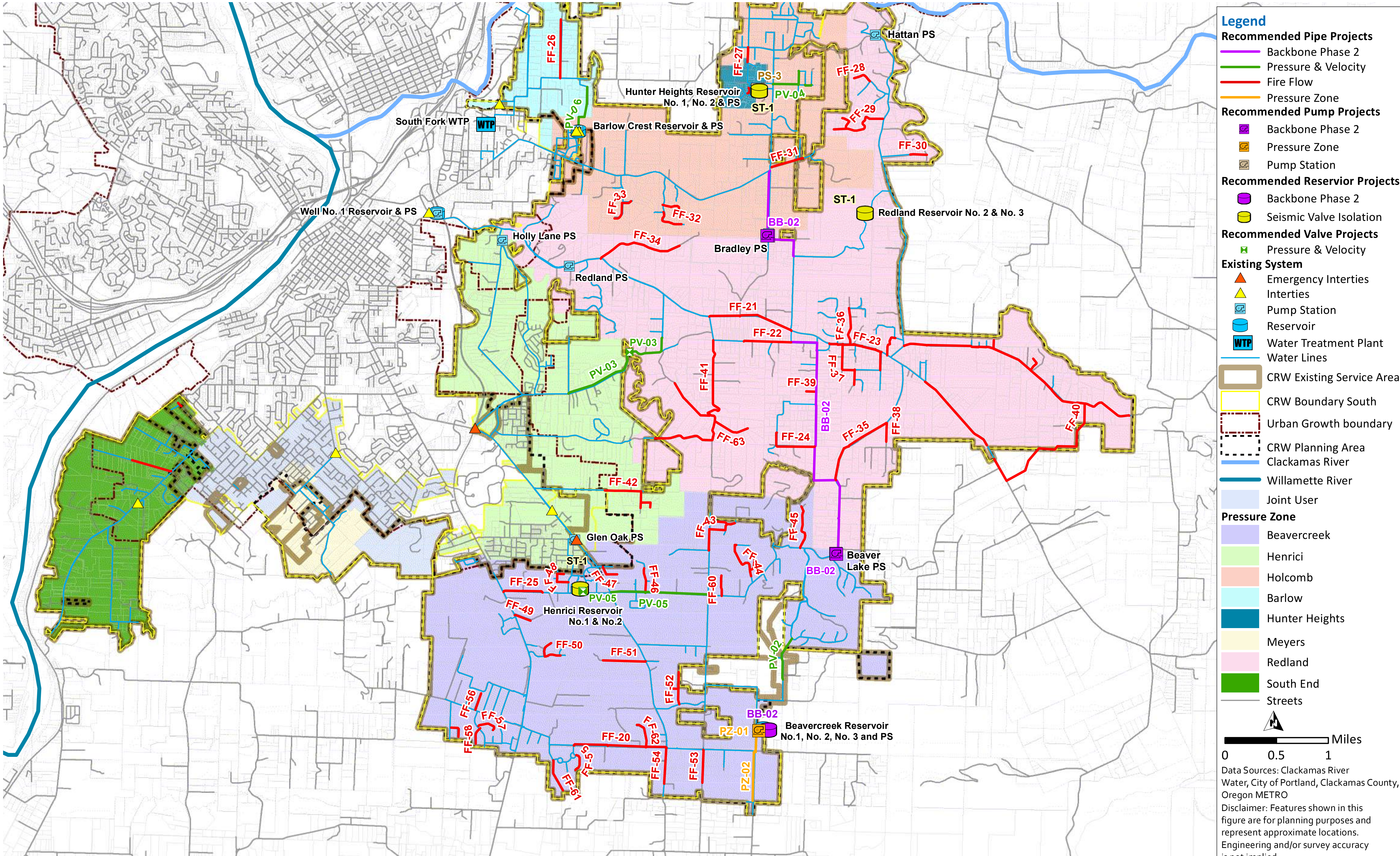

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Figure 6.13 South System Recommended Projects

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Table 6.10 Summary of Distribution System Recommended Improvement Projects

CIP ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose
PV-02	Beavercreek Loop Connection	New Pipe	2,271	n/a	12	S Mountain Meadow Rd from S Sunrise Ln to S Mompano Overlook Dr.	This project is required to fix the low pressure area in the Beavercreek Zone.
PV-03	S Maplelane Rd New Pipe, New PRV Station	PRV Station New Pipe New Pipe	n/a 3,580 2,756	n/a n/a n/a	n/a 6 8	S Maplelane Rd from S Walker Rd to S Waldow Rd.	This project is required to deliver flow from the Backbone Phase II project to the Henrici zone.
PV-04	S Overlook Rd Pipe	New Pipe New Pipe	370 2,026	6 8	6 8	S Overlook Rd from S Sky Ranch Rd east to end of pipe; S Overlook Rd from S Bradley Rd to S Outlook Terrace; North on S Outlook Terrance to connect with pipe at north end of Sky Ranch Ln.	This project is required to address low pressures in the vicinity and to provide sufficient fire flow to the surrounding area.
PV-05	Henrici Rd New Pipe; Henrici Tank PRV Station	New Pipe PRV Station	4,957 n/a	6 n/a	12 n/a	Henrici Rd from Beavercreek Rd to S Ferguson Rd.	The project is required to deliver flow from the Backbone Phase II project to the Henrici zone.
PV-06	Barlow Crest New Pipe	New Pipe	2,625	12	12	S Mason Heights Dr from Barlow Crest PS to Forsythe Rd.	This project is required to address low pressures in the vicinity.
PZ-01	New Beavercreek Pressure Zone	New Pipe New Pipe BPS	1,136 2,588 n/a	8 6 n/a	4 8 n/a	S Yeoman Rd from Beavercreek PS south to S Steiner Rd; S Beavercreek Rd from S Steiner Rd to S Williams Rd.	A new pressure zone in the Beavercreek service area is recommended due to low pressures in the southeast section of the service area.
FF-20	S Leland Rd, S Beavercreek Rd New Pipe	Upsize Pipe	4,871	8	12	S Leland Rd from S Leslie Ave to S Kamrath Rd.	This project is required to provide sufficient fire flow to the surrounding area.
FF-21	S Redland Rd New Pipe	New Pipe	4,418	8	12	S Redland Rd from S Ferguson Rd to S Potter Rd.	This project is required to provide sufficient fire flow to the surrounding area.
FF-22	SE Beckman Rd New Pipe	Upsize Pipe	2,435	6	8	SE Beckman Rd east and west of S Matthew Ct.	This project is required to provide sufficient fire flow to the surrounding area.
FF-23	S Redland School Rd, S Redland Rd New Pipe	New Pipe New Pipe	2,903 1,196	8 n/a	12 8	S Redland School Rd from S Redland Rd to Redland Elementary School; S Redland Rd from S Norman Rd to S Marklund Dr.	This project is required to provide sufficient fire flow to the surrounding area.
FF-24	S North End Rd, S Terry Michael Dr New Pipe	Upsize Pipe	2,680	4	8	S North Ed Rd from S Grasle Rd to S Terry Michael Dr; S Terry Michael Dr from S North End Rd north.	This project is required to provide sufficient fire flow to the surrounding area.
FF-25	Beavercreek - Henrici Rd	Upsize Pipe	2,107	8	12	Henrici Rd from Cascade Hwy S to S Reeder Rd.	This project is required to provide sufficient fire flow to the surrounding area.
FF-26	S Brunner Rd Pipe Upsize	Upsize Pipe	2,998	4	8	S Brunner Rd from S Forsythe Rd north to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.
FF-27	S Burkstrom Rd Pipe Upsize	Upsize Pipe	747	6	8	S Burkstrom Rd from S Forsythe Rd south to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-28	S Edgewood St Pipe Upsize	Upsize Pipe	967	6	8	S Edgewood St from S Edgewood Ln west to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-29	S Dick Dr and S Lucky Ln Pipe Upsize	Upsize Pipe	3,086	6	8	S Dick Dr from S Hattan Rd west to end of street; S Lucky Ln from S Dick Dr to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-30	S Clear Acres Dr Pipe Upsize	Upsize Pipe	865	6	8	S Clear Acres Dr.	This project is required to provide sufficient fire flow to the surrounding area.
FF-31	S Holcomb Blvd Pipe Upsize	Upsize Pipe	1,678	6	8	S Holcomb Blvd from S Bradley Rd to S Keplea.	This project is required to provide sufficient fire flow to the surrounding area.
FF-32	S Sandalwood Rd and S Brook Ct Pipe Upsize	Upsize Pipe	2,540	6	8	S Sandwood Rd from S Lora Ct south to end of street; S Brook Ct from S Sandalwood Rd to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-33	S Wildflower Ln and S Pam Dr Pipe Upsize	Upsize Pipe	1,540	6	8	S Pam Dr from S Wildflower Ln south to end of street; S Wildflower Ln from S Pan Dr to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.
FF-34	S Neibur Rd Pipe Upsize	Upsize Pipe	4,443	4	8	S Neibur Rd from S Redland Rd east to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.

Table 6.10 Summary of Distribution System Recommended Improvement Projects (Continued)

CIP ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose
FF-35	S Henrici Rd (south of S Dillman Rd) Pipe Upsize	Upsize Pipe	4,256	4	8	S Henrici Rd from intersection with Backbone Phase 2 pipe north to S Dillman Rd.	This project is required to provide sufficient fire flow to the surrounding area.
FF-36	S Canter Ln Pipe Upsize	Upsize Pipe	1,845	6	8	S Canter Ln from S Redland Rd to S Nestle Ln.	This project is required to provide sufficient fire flow to the surrounding area.
FF-37	S Norman Rd, S Elida Rd/S Glisan Rd New Pipe	New Pipe	2,926	4/6	8	S Norman Rd from S Redland Rd to S Glisan Rd ; S Elida Rd from S Redland Rd to S Glisan Rd and S Glisan Rd to S Cadle Rd.	This project is required to provide sufficient fire flow to the surrounding area.
FF-38	S Dillman Rd Pipe Upsize	Upsize Pipe	968	6	8	S Dillman Rd south from S Henrici Rd.	This project is required to provide sufficient fire flow to the surrounding area.
FF-39	S Grasle Rd south of Team Ct Pipe Upsize	Upsize Pipe	495	6	8	S Grasle Rd south of Team Ct.	This project is required to provide sufficient fire flow to the surrounding area.
FF-40	Fischers Mill Rd Upsize; S Hinkle Rd/S Kimball Rd New Pipe	Upsize Pipe Upsize Pipe New Pipe Upsize Pipe	10,374 2,623 8,050 6,076	6 4 n/a 4 & 6	12 8 8 8	Fischers Mill Rd from S Kimball Rd to end of street; Fischers Mill Rd from S Redland Rd to S Kimball Rd; S Hinkle Rd/S Kimball Rd from S Redland Rd to S Fischers Mill Rd.	This project is required to provide sufficient fire flow to the surrounding area.
FF-41	S Thayer Rd, S Walker Rd, S Ferguson Rd Pipe Upsize	Upsize Pipe	11,785	4 & 6	8	S Ferguson Rd from SE Beckman Rd continuing onto S Thayer Rd; S Walker Rd from S Ferguson Rd north; S Coplet Ct from S Ferguson Rd to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-42	S Loder Rd, Thimble Creek Dr Pipe Upsize	Upsize Pipe	3,428	6	8	S Loder Rd, S Thimble Creek Dr, and S Merry Lane Dr.	This project is required to provide sufficient fire flow to the surrounding area.
FF-43	S Ferguson Rd, S Heidi St Pipe Upsize	Upsize Pipe	3,200	4 & 6	8	S Ferguson Rd from S Moore Rd to S Heidi St; S Heidi St to S Annette Dr; S Annette Dr; S Rachel Ct.	This project is required to provide sufficient fire flow to the surrounding area.
FF-44	S Athens Rd, S Olympus Rd Pipe Upsize	Upsize Pipe	2,996	4 & 6	8	S Athens Rd from S Henrici Rd to end of street; S Olympus Rd from S Athens Rd to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-45	S Creek Rd Pipe Upsize	Upsize Pipe	2,315	4	8	S Creek Rd from S Henrici Rd north.	This project is required to provide sufficient fire flow to the surrounding area.
FF-46	Danny Ln Pipe Upsize	Upsize Pipe	1,270	6	8	S Danny Ct from S Henrici Rd north to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.
FF-47	S Saddle Ln Pipe Upsize	Upsize Pipe	976	6	8	S Saddle Ln from S Old Acres Ln south to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-48	Woodglen Way, Crystal Ct Pipe Upsize	Upsize Pipe	1,331	6	8	S Woodglen Way from S Homestead Dr to S Crystal Ct; S Crystal Ct from S Woodglen Way east to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-49	S Quail Crest Ln Pipe Upsize	Upsize Pipe	854	6	8	S Quail Crest Ln to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.
FF-50	S Mossy Rock Ct Pipe Upsize	Upsize Pipe	847	6	8	S Mossy Rock Ct from S Green Tree Dr north to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-51	S Lammer Rd Pipe Upsize	Upsize Pipe	2,201	6	8	S Lammer Rd from S Beavercreek Rd west to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-52	S Levi Ct, S Levi Rd Pipe Upsize	Upsize Pipe	1,315	6	8	S Levi Rd from S Levi Ct to end of pipe; S Levi Ct from S Levi Rd to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.
FF-53	S Ferguson Rd Pipe Upsize	Upsize Pipe	1,690	6	8	S Ferguson Rd from S Beavercreek Rd to S Williams Rd.	This project is required to provide sufficient fire flow to the surrounding area.
FF-54	S Kamrath Rd Pipe Upsize	Upsize Pipe	1,825	6	8	S Kamrath Rd from S Beavercreek Rd to S Creek Haven Ln.	This project is required to provide sufficient fire flow to the surrounding area.
FF-55	S Leslie Ave Pipe Upsize	Upsize Pipe	950	6	8	S Leslie Ave from S Dales Ave south to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-56	S Clear View Ct Pipe Upsize	Upsize Pipe	870	6	8	S Clear View Ct from Leland Rd north to end of street.	This project is required to provide sufficient fire flow to the surrounding area.

Table 6.10 Summary of Distribution System Recommended Improvement Projects (Continued)

CIP ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose
FF-57	S Hawthorne Ct, S Firethorne Ct Pipe Upsize	Upsize Pipe	1,934	6	8	S Hawthorne Ct from S Larkspur Ave to end of street; S Firethorne Ct from S Larkspur Ave to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-58	S Farm Pond Ct Pipe Upsize	Upsize Pipe	819	6	8	S Farm Pond Ct from S Foothills Ave to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-59	S Archer Dr Pipe Upsize	Upsize Pipe	333	6	8	S Archer Dr from S Fawn Dr north to S Outlook Rd.	This project is required to provide sufficient fire flow to the surrounding area.
FF-60	S Jason Dr Pipe Upsize	Upsize Pipe	650	6	8	S Jason Dr from S Henrici Rd north to first FH.	This project is required to provide sufficient fire flow to the surrounding area.
FF-61	S Dans Ct Pipe Upsize	Upsize Pipe	1,656	6	8	S Dans Ct from S Dales Ave south to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-62	S Lance Ct Pipe Upsize	Upsize Pipe	1,401	6	8	S Lance Ct from S Leland Rd north to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-63	S Copley Ct Pipe Upsize	Upsize Pipe	1,871	6	8	S Copley Ct from S Ferguson Rd east to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.

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6.7.3.1 Redland Zone Recommended Improvements

Fire Flow Deficiencies Improvement Projects

The recommended improvements to address fire flow deficiencies are as follows:

- FF-21: S Redland Rd New Pipe - Install a new 12-inch diameter pipe parallel to the existing 8-inch diameter pipe on S Redland Rd from S Ferguson Rd to S Potter Rd. This project is required to provide sufficient fire flow to the surrounding area.
- FF-22: SE Beckman Rd New Pipe - Replace the existing 6-inch diameter pipe with 8-inch diameter pipe on SE Beckman Rd east to connect at the intersection of the Butterfield Ln 16-in transmission main (Backbone Phase 1 project) and Grasle Rd 12-in transmission main (Backbone Phase 2 project) with Backbone Phase 2 and west to approximately 16744 S Beckman Rd. This project is required to provide sufficient fire flow to the surrounding area.
- FF-23: S Redland School Rd, S Redland Rd - New Pipe Install new 8-inch diameter pipe on S Redland School Rd from S Redland Rd to Redland Elementary School. Install new 12-inch diameter pipe on S Redland Rd from S Norman Rd to S Marklund Dr. This project is required to provide sufficient fire flow to Redland Elementary School.
- FF-24: S North End Rd, S Terry Michael Rd New Pipe - Replace the existing 4-inch diameter pipe with 8-inch diameter pipe on S North Ed Rd from S Grasle Rd to S Terry Michael Dr and S Terry Michael Dr from S North End Rd north. This project is required to provide sufficient fire flow to the surrounding area.
- FF-28: S Edgewood St Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Edgewood St from S Edgewood Ln west to end of street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-29: S Dick Dr and S Lucky Ln Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Dick Dr from S Hattan Rd west to end of the street and S Lucky Ln from S Dick Dr to end of street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-30: S Clear Acres Dr Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe. This project is required to provide sufficient fire flow to the surrounding area.
- FF-34: S Neibur Rd Pipe Upsize - Replace the existing dead end 4-inch diameter pipe with 8-inch diameter pipe on S Neibur Rd from S Redland Rd east to the end of the pipe. This project is required to provide sufficient fire flow to the surrounding area.
- FF-35: S Henrici Rd (south of S Dillman Rd) Pipe Upsize - Replace the existing 4-inch diameter pipe with 8-inch diameter pipe on S Henrici Rd from intersection with Backbone Phase 2 pipe north to S Dillman Rd. This project is required to provide sufficient fire flow to the surrounding area.
- FF-36: S Canter Ln Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Canter Ln from S Redland Rd to S Nestle Ln. This project is required to provide sufficient fire flow to the surrounding area.
- FF-37: S Norman Rd, S Elida Rd/S Glisan Rd New Pipe - Install new 8-inch diameter pipe parallel to the existing 4-inch diameter pipe on S Norman Rd from S Redland Rd to S Glisan Rd. Install new 8-inch diameter pipe on S Elida Rd from S Redland Rd to S Glisan Rd and S Glisan Rd to S Cadle Rd. This project is required to provide sufficient fire flow to the surrounding area.

- FF-38: S Dillman Rd Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Dillman Rd south from S Henrici Rd. This project is required to provide sufficient fire flow to the surrounding area.
- FF-39: S Grasle Rd south of Team Ct Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe. This project is required to provide sufficient fire flow to the surrounding area.
- FF-41: S Thayer Rd, S Walker Rd, S Ferguson Rd Pipe Upsize - Replace the existing dead end 4-inch diameter and 6-inch diameter pipe with 8-inch diameter pipe on S Ferguson Rd from SE Beckman Rd continuing onto S Thayer Rd; S Walker Rd from S Ferguson Rd north; and S Copley Ct from S Ferguson Rd to end of street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-40: Fischers Mill Rd Upsize; S Hinkle Rd/S Kimball Rd New Pipe includes the following project elements:
  - Replace existing 4-inch diameter pipe with new 8-inch diameter pipe on Fischers Mill Rd from S Kimball Rd to the end of the street.
  - Replace existing 6- inch diameter pipe with new 12-inch diameter pipe on Fischers Mill Rd from S Redland Rd to S Kimball Rd.
  - Install new 8-inch diameter pipe on S Hinkle Rd/S Kimball Rd from S Redland Rd to S Fischers Mill Rd.
  - Upsize dead end pipe.

  This project is required to provide sufficient fire flow to the surrounding area.
- FF-63: S Copley Ct Pipe Upsize - Replace existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Copley Ct from S Ferguson Rd east to the end of the pipe. This project is required to provide sufficient fire flow to the surrounding area.

6.7.3.2 Beavercreek Zone Recommended Improvements

Pressure and Velocity Improvement Projects

PV-02: Beavercreek Loop Connection Project is a recommended improvement. This project will be to create a loop by installing new 12-inch diameter pipe along S Mountain Meadow Rd from S Sunrise Ln to S Mompano Overlook Dr. This project is required to fix the low pressure area in the Beavercreek Zone.

Pressure Zone Improvement Projects

PZ-02: The creation of a new Beavercreek Pressure Zone is a recommended improvement. The project includes the following elements:

- Install new Beavercreek BPS to serve new Beavercreek Pressure Zone south of S Steiner Rd. A new pressure zone in the Beavercreek service area is recommended due to low pressures south of S Steiner Rd.
- Install a new 4-inch diameter pipe parallel to the existing 8-inch diameter pipe on S Yeoman Rd from the Beavercreek PS south to S Steiner Rd. A new pressure zone in the Beavercreek service area is recommended due to low pressures south of S Steiner Rd.
- Install a new 8-inch diameter pipe parallel to the existing 6-inch diameter pipe on S Beavercreek Rd from S Steiner Rd to S Williams Rd. This project is required to provide sufficient fire flow to the surrounding area.

Fire Flow Deficiencies Improvement Projects

The recommended improvements to address fire flow deficiencies are as follows:

- FF-20: S Leland Rd, S Beavercreek Rd New Pipe - Replace the existing 8-inch diameter pipe with 12-inch diameter pipe on S Leland Rd from S Leslie Ave to S Kamrath Rd. This project is required to provide sufficient fire flow to the surrounding area.
- FF-25: Beavercreek – Henrici Rd - Replace the existing 8-inch diameter pipe with 12-inch diameter pipe on Henrici Rd from Cascade Hwy S to S Reeder Rd. This project is required to provide sufficient fire flow to the surrounding area.
- FF-43: S Ferguson Rd, S Heidi St Pipe Upsize - Replace the existing dead end 4-inch diameter and 6-inch diameter pipes with 8-in diameter pipe S Ferguson Rd from S Moore Rd to S Heidi St, S Heidi St to S Annette Dr, S Annette Dr, and S Rachel Ct. This project is required to provide sufficient fire flow to the surrounding area.
- FF-44: S Athens Rd, S Olympus Rd Pipe Upsize - Replace the existing dead end 4-inch diameter and 6-inch diameter pipes with 8-inch diameter pipe on S Athens Rd from S Henrici Rd to the end of the street, and S Olympus Rd from S Athens Rd to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-45: S Creek Rd Pipe Upsize - Replace the existing dead end 4-inch diameter pipe with 8-inch diameter pipe on S Creek Rd from S Henrici Rd north. This project is required to provide sufficient fire flow to the surrounding area.
- FF-46: Danny Ln Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Danny Ct from S Henrici Rd north to end of pipe. This project is required to provide sufficient fire flow to the surrounding area.
- FF-47: S Saddle Ln Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Saddle Ln from S Old Acres Ln south to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-48: Woodglen Way, Crystal Ct Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Woodglen Way from S Homestead Dr to S Crystal Ct and S Crystal Ct from S Woodglen Way east to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-49: S Quail Ln Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Quail Crest Ln to the end of the pipe. This project is required to provide sufficient fire flow to the surrounding area.
- FF-50: S Mossy Rock Ct Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Mossy Rock Ct from S Green Tree Dr north to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-51: S Lammer Rd Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Lammer Rd from S Beavercreek Rd west to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-52: S Levi Ct, S Levi Rd Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe S Levi Rd from S Levi Ct to the end of the pipe and S Levi Ct from S Levi Rd to the end of the pipe. This project is required to provide sufficient fire flow to the surrounding area.

- FF-53: S Ferguson Rd Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Ferguson Rd from S Beavercreek Rd to S Williams Rd. This project is required to provide sufficient fire flow to the surrounding area.
- FF-54: S Kamrath Rd Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Kamrath Rd from S Beavercreek Rd to S Creek Haven Ln. This project is required to provide sufficient fire flow to the surrounding area.
- FF-55: S Leslie Ave Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-in diameter pipe on S Leslie Ave from S Dales Ave south to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-56: S Clear View Ct Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Clear View Ct from Leland Rd north to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-57: S Hawthorne Ct, S Firethorne Ct Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Hawthorne Ct from S Larkspur Ave to end of street and S Firethorne Ct from S Larkspur Ave to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-58: S Farm Pond Ct Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Farm Pond Ct from S Foothills Ave to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-60: S Jason Dr Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Jason Dr from S Henrici Rd north to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-61: S Dans Ct Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Dans Ct from S Dales Ave south to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-62: S Lance Ct Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Lance Ct from S Leland Rd north to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.

6.7.3.3 Henrici Zone Recommended Improvements

Pressure and Velocity Improvement Projects

PV-05: The Henrici Rd New Pipe, Henrici Tank PRV Station Project is a recommended improvement for the Henrici Zone. The project has two elements:

- Install a new 12-inch diameter pipe parallel to the existing 6-inch diameter pipe on Henrici Rd from Beavercreek Rd to S Ferguson Rd.
- Install a new PRV station at Henrici Reservoir with new 12-inch diameter pipe.

This project is required to deliver flow from the Phase II Backbone system to the Henrici zone.

PV-03: The S Maplelane Rd New Pipe, New PRV Station Project is a recommended improvement for the Redland and Henrici Zones. This project will convey water from the Redland zone to the Henrici zone via a PRV as a supplement to the proposed PRV station from the Redland to the Henrici zone. It will have the follow elements:

- Install new pipe on S Maplelane Rd to connect the existing pipes from S Walker Rd to S Waldow Rd. Portions of the pipe will be installed parallel to the existing pipe, and portions of the pipe will include a new river crossing.

- Install a new PRV station between the Redland and Henrici Zones.

This project is required to address pipeline velocities resulting from constructing the Henrici Reservoir PRV. An alternate corridor for this pipeline could be on Thayer Road or Wadlow Road.

Fire Flow Deficiencies Improvement Projects

The recommended improvement identified to address fire flow deficiencies is outlined below:

- FF-42: S Loder Rd, Thimble Creek Dr Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe S Loder Rd, S Thimble Creek Dr, and S Merry Lane Dr. This project is required to provide sufficient fire flow to the surrounding area.

6.7.3.4 Holcomb Zone Recommended Improvements

Pressure and Velocity Improvement Projects

PV-04: The S Overlook Rd Pipe Project is a recommended improvement for the Holcomb Zone. This project has two elements:

- Install a new 6-inch diameter pipe parallel to the existing 2-inch diameter pipe on S Overlook Rd from S Sky Ranch Rd east to the end of the pipe. This project is required to address low pressures nearby.
- Install a new 8-inch diameter pipe on S Overlook Rd from S Bradley Rd to S Outlook Terrace, and north on S Outlook Terrance to connect with pipe at the north end of Sky Ranch Ln. This project is required to provide sufficient fire flow to the surrounding area.

Fire Flow Deficiencies Improvement Projects

The improvements recommended to address fire flow deficiencies are as follows:

- FF-27: S Bradley Rd Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe S Bradley Rd from S Forsythe Rd south to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-31: S Holcomb Blvd Pipe Upsize - Replace the existing dead end 6-in diameter pipe with 8-inch diameter pipe on S Holcomb Blvd from S Bradley Rd to S Timberdark Ln. This project is required to provide sufficient fire flow to the surrounding area.
- FF-32: S Sandalwood Rd, S Brook Ct Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Sandwood Rd from S Lora Ct south to end of street and S Brook St from S Sandalwood Rd to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-33: S Wildflower Ln, S Pam Dr Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Pam Dr from S Wildflower Ln south to the end of the street and S Wildflower Ln from S Pan Dr to the end of the pipe. This project is required to provide sufficient fire flow to the surrounding area.

6.7.3.5 Hunter Heights Zone Recommended Improvements

Fire Flow Deficiencies Improvement Projects

The improvement recommended to address fire flow deficiencies is as follows:

- FF-59: S Archer Dr Pipe Upsize - Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on S Archer Dr from S Fawn Dr north to S Outlook Rd. This project is required to provide sufficient fire flow to the surrounding area.

6.7.3.6 Barlow Zone Recommended Improvements

Pressure and Velocity Improvement Projects

PV-06: The Barlow Crest New Pipe Project is a recommended improvement for the Holcomb and Barlow Zones. The project will install a new 12-inch diameter pipe on S Mason Heights Dr, parallel to the existing 12-inch diameter pipe, from the Barlow Crest PS to Forsythe Rd. This project is required to address low pressures nearby.

Fire Flow Deficiencies Improvement Projects

The improvement recommended to address fire flow deficiencies is as follows:

- FF-26: S Brunner Rd Pipe Upsize - Replace the existing dead end 4-inch diameter pipe with 8-inch diameter pipe on S Brunner Rd from S Forsythe Rd north to the end of the pipe. This project is required to provide sufficient fire flow to the surrounding area.

6.7.3.7 South End Rd. and Meyers Zones Recommendations Improvements

The following improvements were identified and provided by CRW for addition in this Plan. These projects are illustrated in Figure 6.14. No modeling analysis was performed as part of this Plan. It is recommended that projects in the South End Rd. Zone area be confirmed when the opportunity arises. The following improvements are not included in Chapter 8 – CIP.

Fire Flow deficiencies Improvement Projects

The recommended improvements to address fire flow deficiencies are as follows:

- FF-64 South Beutel Road – Install new 12-inch diameter pipe to replace the dated existing 6-inch diameter steel water main on S. Beutel Road from South End Road westerly to approximate lot 10927 S. Beutel Rd. This project is required to replace a dated waterline and provide sufficient fire flow to the surrounding area.
- FF-65 South Beutel Road - Install new 8-inch diameter pipe (a continuation of FF-64) to replace the dated existing 4-inch diameter steel water main on S. Beutel Road from lot 10927 S. Beutel Rd west to the end of the road. This project is required to replace a dated waterline and provide sufficient fire flow to the surrounding area.
- FF-66 South Forest Ridge Road – Install new 8-inch diameter pipe to replace the dated existing 6-inch diameter AC water main for the entire length of S. Forest Ridge Road. This project is required to replace a dated waterline and provide sufficient fire flow to the surrounding area.
- FF-67 South Allen Court - Install new 8-inch diameter pipe to replace the dated existing 4-inch diameter cast iron water main for the entire length of S. Allen Court. This project is required to replace a dated waterline and provide sufficient fire flow to the surrounding area.
- FF-68 South Sunnyridge Court - Install new 8-inch diameter pipe to replace the dated existing 4/6-inch diameter steel water main for the entire length of S. Sunnyridge Court. This project is required to replace a dated waterline and provide sufficient fire flow to the surrounding area.
- FF-69 South End Court - Install new 8-inch diameter pipe to replace the dated existing 4-inch diameter steel water main for the entire length of S. End Court. This project is required to replace a dated waterline and provide sufficient fire flow to the surrounding area.
- FF-70 South Deer Land and Rose Lane - Install new 8-inch diameter pipe to replace the dated existing 4-inch diameter ac/steel water main for the westerly end of S. Rose lane and all of Deer Court. This project is required to replace a dated waterline and provide sufficient fire flow to the surrounding area.

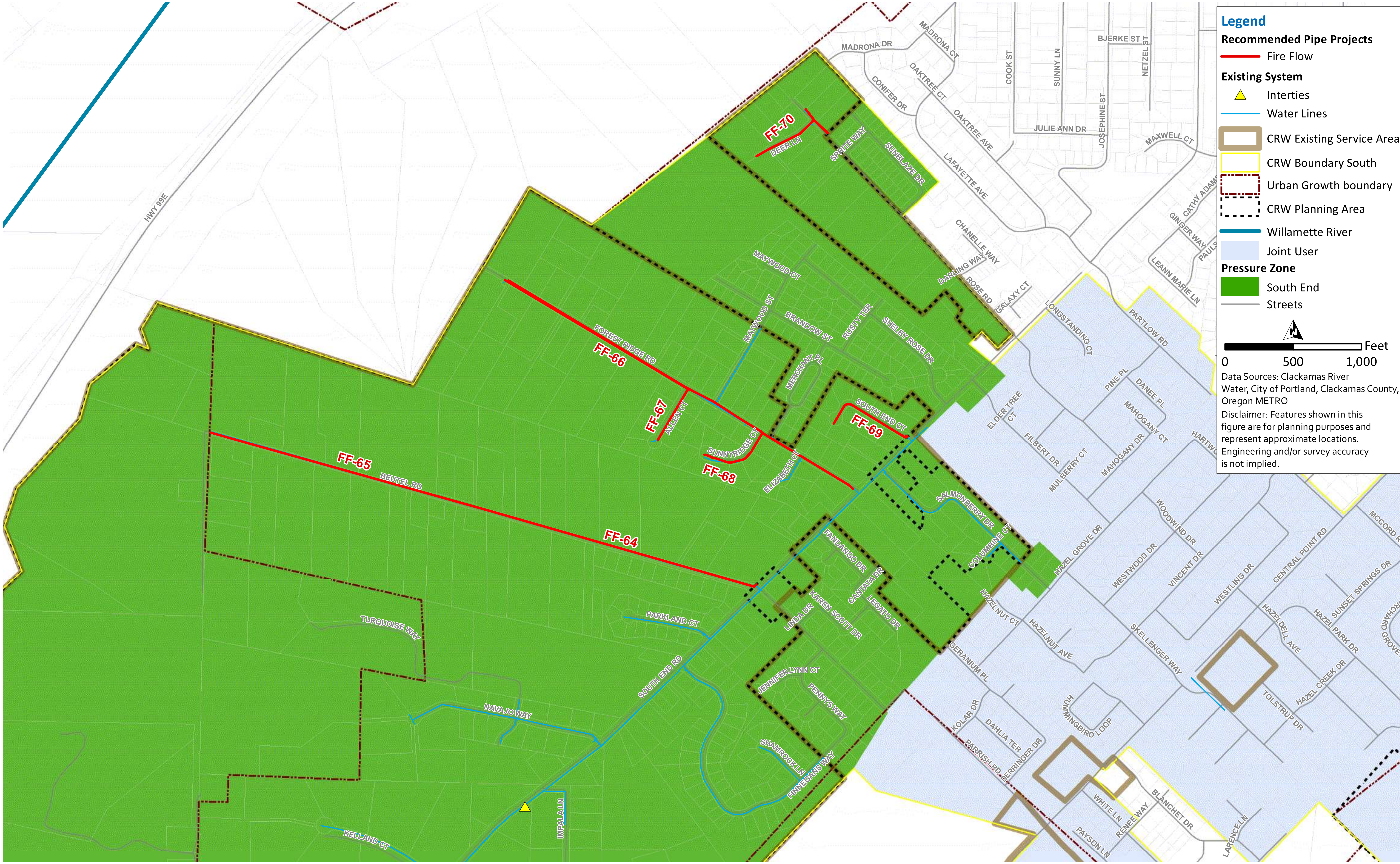

Figure 6.14 South System Recommended Pipeline Projects - South End and Meyers

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Chapter 7

SEISMIC ASSESSMENT RESULTS – SOUTH SYSTEM

7.1 Introduction

As part of the Water System Plan (Plan), the Oregon Health Authority Drinking Water Services (OHA) requires water systems with over 300 connections to prepare a seismic risk assessment and mitigation plan, using the 2013 Oregon Resilience Plan as a road map for earthquake preparedness. This seismic assessment and mitigation plan has two goals:

1. Identify critical infrastructure needed to supply water during an emergency.
2. Identify improvements to supply, pumping, storage, and distribution so customers are still provided with water following a Cascade subduction zone earthquake.

This chapter identifies seismic hazards within Clackamas River Water's (CRW) South system and defines the water system's seismic system, including critical facilities and components that will need to continue to supply water to the community's essential needs. This chapter also presents the results of the performance evaluation of the system's pipes and makes recommendations for seismic resilience, which will be integrated into a 50-year Mitigation Plan.

7.2 Seismic Hazard Identification

Seismic hazards include strong ground shaking, liquefaction settlement, lateral spreading, and seismically induced landslides. These hazards can damage facilities such as pipelines or above-ground structures through either ground deformation or intense shaking.

To identify seismic hazards within CRW's South system for a magnitude 9.0 Cascadia Subduction Zone (CSZ) scenario, McMillan Jacobs Associates (MJA) performed a seismic hazards assessment using data sets published by the Oregon Department of Geology and Mineral Industries (DOGAMI) and historic boring records and site reconnaissance.

The following sections summarize this assessment. For further details on the development on this data, refer to TM 1 – Seismic Hazard Evaluation (Appendix M).

7.2.1 Definitions

- Peak ground acceleration (PGA): PGA measures an earthquake's shaking intensity. DOGAMI's available seismic hazard data suggests that, throughout CRW's South system, the anticipated PGA is approximately 0.2g.
- Peak ground velocity (PGV): PGV also measures shaking intensity during an earthquake, but it focuses on longer period movements.
- Permanent ground deformation (PGD): Large PGD is the maximum predicted ground displacement caused by soil liquefaction and landslides.

- Liquefaction hazard: Liquefaction is a phenomenon in which cyclic, rapid shearing from an earthquake causes saturated, granular soils to drastically lose shear strength and transform into a heavy, viscous fluid mass. Soil liquefaction leads to loss of shear strength, loss of soil materials through sand boils, flotation of buried chambers/pipes, and post-liquefaction settlement.
- Lateral spreading hazard: Liquefaction leads to progressive deformation of the ground, known as lateral spreading. The lateral movement of liquefied soil breaks the non-liquefied soil crust into blocks that progressively move downslope or toward a free face. As earthquake-generated ground accelerations overcome the strength of the liquefied soil column, seismic movement incrementally pushes these blocks downslope.
- Landslide hazard: When inertial force from an earthquake adds load to a slope, earthquake-induced landslides occur. This ground movement can be extremely large and damaging to pipelines and other structures.

7.2.2 Methodology

To develop the seismic hazard assessment of CRW's South system, the following steps were taken:

1. The DOGAMI's seismic hazard maps for a magnitude 9.0 CSZ event were reviewed.
2. Available geological information was reviewed.
3. Available geotechnical boring information provided by CRW was reviewed to verify it against the DOGAMI's seismic hazard maps.
4. Site reconnaissance was conducted to address key geological and geotechnical assumptions and to examine areas that are potentially prone to failures from lateral spreading and seismic landslide hazards.
5. Estimates were developed for strong ground shaking, liquefaction-induced settlement, PGD from lateral spreading, and seismic landslide slope instability.

7.2.3 Results

The following sections detail the results of the seismic hazard evaluation. TM 1 – Seismic Hazard Evaluation details the results and provide maps of these results.

7.2.3.1 Peak Ground Velocity

PGV estimates depend on the subsurface material available. Typically, thick soil units will intensify ground shaking near the surface. In general, the estimated PGV values are estimated to range from 7 to 16 inches per second throughout CRW's South system.

7.2.3.2 Liquefaction Settlement

DOGAMI published hazard maps for the Portland metro area in the event of a M9 CSZ earthquake. These maps were reviewed to evaluate the hazard potential of soil liquefaction in CRW's service area. Where geotechnical data on subsurface conditions was available, site-specific analyses were also completed.

Based on the evaluation, the primary zones of liquefaction hazard in the South System are around Abernathy Creek and the Clackamas River. In these locations, PGD caused by liquefaction-induced settlement is expected to reach 8 inches.

7.2.3.3 Lateral Spreading

As mentioned above, the DOGAMI M9 CSZ maps were also reviewed to assess lateral spreading hazards within CRW's service area. The primary zones of lateral spreading hazard in the South System are along the Clackamas River and Abernathy Creek, where this hazard is anticipated to range from 6 to 24 inches.

7.2.3.4 Seismic Landslide

Using the same DOGAMI M9 CSZ maps and general topography and site visits to visually assess key slopes, the potential for seismic landslide hazards was evaluated for pipelines, pump stations, and reservoirs. Landslide hazards are generally more prevalent in the South System, particularly on steep slopes near Oregon City, but all existing facilities are generally located on relatively flat or gently sloped ground.

7.2.4 Allocation of Seismic Hazards to Pipelines

Overlaying is a spatial analysis tool in GIS that integrates the attributes of a target layer (CRW's pipes) and an overlay layer (any of the seismic hazard maps) that occupy the same spatial location. The result is an output layer (in this case, CRW's pipes) that retains the attributes of both input layers.

The seismic hazards of the CSZ scenario identified in TM 1 were overlaid with CRW's GIS pipeline data using an overlay tool. The tool was used to assign individual seismic hazard parameters for PGV, liquefaction probability, liquefaction-induced spreading PGD, liquefaction-induced settlement PGD, seismic landslide probability, and seismic landslide PGD.

Some pipes overlap from a high-hazard area to a low-hazard area. For this reason, each pipe segment was assigned the length-weighted average of the underlying hazard data, since it derives a more realistic probability of damage to pipelines than values at midpoint would.

7.3 CRW Seismic System

7.3.1 Seismic System Development

In compliance with OAR 333-061-0060, the seismic risk assessment must identify critical facilities needed to supply water to key community needs during a seismic event (fire suppression, health care, first aid emergency, drinking water). With input from the CRW staff, the assessment identified the seismic system and its infrastructure, which include key supply, treatment, distribution, and storage elements required to continue supplying water to the community after a Cascadia subduction zone earthquake.

CRW is following recommendations outlined in the 2013 Oregon Resilience Plan (ORP), which defines the seismic backbone system's function as follows: "The backbone water system would be capable of supplying key community needs, including fire suppression, health and emergency response, and community drinking water distribution points, while damage to the larger (non-backbone) system is being addressed."

The ORP presents target states of recovery after a magnitude 9.0 Cascadia subduction zone earthquake for critical public services, including water supply systems, for regions in the state. Figure 7.1 shows the target states of recovery for domestic water supply in the "Valley" region, where CRW is located. These guidelines were used to help create the seismic system.

TARGET STATES OF RECOVERY: WATER & WASTEWATER SECTOR (VALLEY)	Event occurs	0–24 hours	1–3 days	3–7 days	1–2 weeks	2 weeks–1 month	1–3 months	3–6 months	6 months –1 year	1–3 years	3 + years
Domestic Water Supply											
Potable water available at supply source (WTP, wells, impoundment)		R	Y		G			X			
Main transmission facilities, pipes, pump stations, and reservoirs (backbone) operational		G					X				
Water supply to critical facilities available		Y	G				X				
Water for fire suppression—at key supply points		G		X							
Water for fire suppression—at fire hydrants				R	Y	G			X		
Water available at community distribution centers/points			Y	G	X						
Distribution system operational			R	Y	G				X		

80 – 90% Operational	G
50 – 60% Operational	Y
20 – 30% Operational	R
Current State/90% Operational	×

Figure 7.1 ORP Target States of Recovery for Domestic Water Supply

7.3.2 Seismic System Result

As seen in Figure 7.1, the ORP recommends the seismic system's main transmission facilities, pipes, pump stations, and reservoirs to be 80 to 90 percent operational within 24 hours after the M9.0 CSZ event. This means that the seismic system must be able to withstand an earthquake with little to no damage and remain pressurized. Thus, to provide realistic goals in water resilience planning, the ORP recommends a phased improvement plan that focuses efforts first on developing the seismic system so it serves its function.

CRW identified a critical seismic system for the South System that connects the following critical facilities that are highlighted in Figure 7.2 to the 152nd Ave Reservoir and Sunrise Water pump station in the South System.

- Hattan Rd pump station
- Hunter Heights Reservoir 1 & 2 and Hunter Heights pump station.
- Hunter Avenue pump station.
- Barlow Crest Reservoir and Pump Station.
- Well No. 1 pump station.
- Holly Lane pump station.
- Redland pump station.
- Oregon City/CRW Emergency Intertie.
- Glen Oak pump station.
- Henrici Reservoir No. 1 and 2.
- Beaver Lake pump station (future).
- Beavercreek pump station.
- Beavercreek Reservoir No. 1 and 2.

CRW selected the following facilities in the system to serve as emergency shelters where potable water may be distributed in the South System:

- Ogden Jr. High.
- Ogden Middle.
- Redland Elementary.
- Beavercreek Elementary

Coordination with Clackamas County Disaster Management is recommended to confirm the suitability of these sites and their expectations from CRW. CRW's remaining critical facilities, which include fire and police stations, are all connected by the seismic system.

A planned backbone system (Phase 1 and Phase 2) will connect the North and South systems beginning at the 152nd Ave Reservoir and ending at the planned Beaver Lake pump station, located in the South System, where it will tie into an existing 12-inch diameter transmission main. Since the backbone system will be a critical piece of the distribution system, it will be part of the seismic system.

Community water distribution points and firefighting supply locations were not specifically identified for this assessment. However, we recommend locating these facilities along the seismic system and identifying additional piping to serve them.

The seismic system shown in Figure 7.2 should be revised as CRW continues to coordinate with internal departments and regional emergency planning services, such as fire and police. Other factors that will drive revision of the seismic system include accommodating new critical facilities, emergency shelter locations, and opportunity projects with road improvements, such as the construction of resilient bridges.

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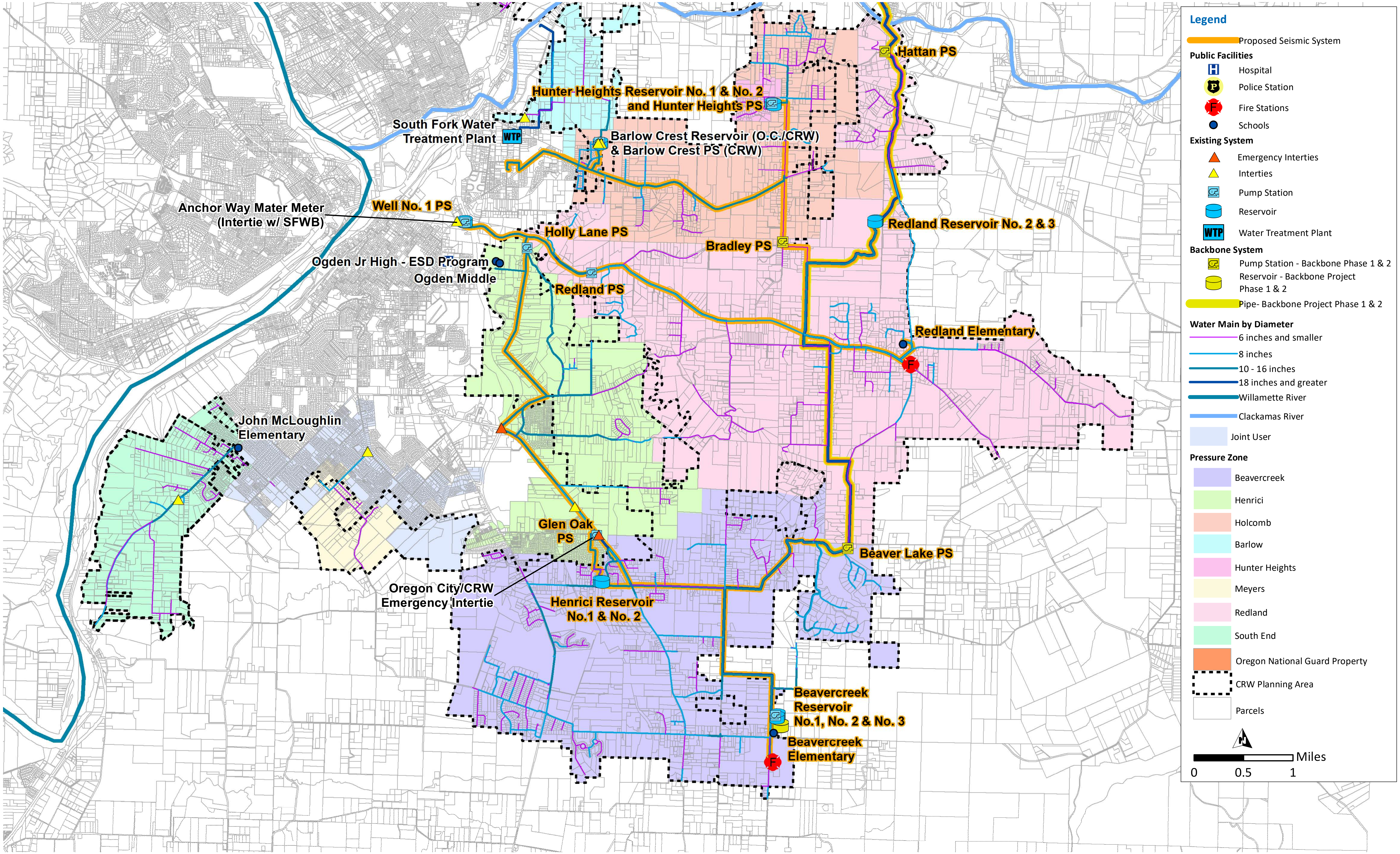

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Figure 7.2 CRW South Seismic System

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7.4 Anticipated Performance of Existing Pipelines

Using the American Lifelines Association (ALA) approach, CRW's distribution system was assessed for seismic vulnerability. Of utmost concern are the anticipated magnitude of repairs needed to return the system to service following the earthquake.

As described in Section 7.2.4, the overlay tool assigned seismic hazards were assigned to each pipe segment. The first step in determining the seismic vulnerability of CRW's pipelines is to assign fragility constants based on pipe material and joint type. These fragility constants, K1 and K2, are used in three equations (presented below) to estimate repair rates. K1 represents the strength of the pipe to withstand damage during high ground velocities. K2 represents the joint strength and flexibility to withstand separation caused by ground deformation. The larger the K value, the more vulnerable the pipe material or joint type is.

Most of CRW's GIS pipe data contains information on pipe material, year of installation, diameter, and length. Table 7.1 lists typical material constants and the assumptions used in this evaluation.

Table 7.1 Pipeline Fragility Assumptions

Pipe Material	Typical Range: K1	Assumed: K1	Typical Range: K2	Assumed: K2
Ductile Iron, non-restrained	0.15 - 0.5	0.5	0.15 - 0.5	0.5
Ductile Iron, restrained	0.15 - 0.5	0.25	0.15 - 0.5	0.25
Cast Iron & Galvanized Iron	0.7 – 1.4	0.8	0.7 – 1.0	0.8
Steel	0.15 – 1.3	0.7	0.6 – 1.0	0.7
Concrete Cylinder Pipe	0.7 – 1.0	0.8	0.6 – 1.0	0.7
Unknown	N/A	1.0	N/A	1.0
Asbestos Cement	0.5 – 1.0	0.5	0.8 – 1.0	0.8
PVC	0.15 – 0.5	0.5	0.8	0.8

Following the ALA approach, failure rates for each pipe segment were calculated given each pipe segment's assigned fragility constants and seismic hazards. The failure rates are calculated as "repairs per thousand feet" as shown in equations 1 through 3:

Equation 1: *Repair Rate/1000 feet = K1*0.00187*PGV*

Equation 2: *Repair Rate/1000 feet = K2*1.06*Liquefaction-PGD0.319*Liquefaction-Probability*

Equation 3: *Repair Rate/1000 feet = K2*1.06*Landslide-PGD0.319*Landslide-Probability*

Note that the estimated repairs are high-level planning estimates. Actual repairs could be 50 percent less or 100 percent higher.

Once the repair rate for each pipe segment was calculated, the expected number of repairs was calculated based on the length of the segment. Of the repairs required because of PGV, 80 percent are anticipated to be minor repairs (for leaks) and 20 percent are anticipated to be major repairs (for breaks). Of the repairs required because of PGD, 20 percent are expected to be minor repairs while 80 percent are expected to be major.

Many of the pipe segments within CRW's GIS database are much shorter than 1,000 feet; thus, the vast majority of pipes were predicted to have only small fractional repairs. Because the seismic hazard data is fairly coarse, the fractional repairs should be aggregated throughout the distribution system to estimate the likely number of repairs needed.

A summary of expected repairs is shown in Table 7.2.

Table 7.2 Summary of Expected Repairs – South System

	Total Length (LF)	Estimated Repairs	Estimated Leaks	Estimated Breaks
Non-Seismic System	**659,600**	**58**	**15**	**43**
Diameter < 12-inches	499,600	43	11	32
Diameter ≥ 12-inches	160,000	15	4	11
Seismic System(1,2)	**117,800**	**17**	**4**	**13**
Diameter < 12-inches	43,200	7	2	5
Diameter ≥ 12-inches	74,600	10	2	8
South System Total	**777,400**	**75**	**19**	**56**

Notes:
(1) Backbone pipes connecting the North and South Systems were not included in this evaluation. These pipelines have been designed (Phase 1), or will be designed (Phase 2), as critical infrastructure with consideration for seismic resiliency and are anticipated to be minimally disrupted by the M9 CSZ earthquake.
(2) Seismic system pipelines were evaluated assuming that the existing system is in place during the M9 CSZ earthquake.

After the M9 CSZ earthquake, the South System is anticipated to experience damage that causes approximately 75 repairs. Approximately 15 of these repairs are anticipated to be fairly small leaks, while 43 may be larger main breaks. Figure 7.3 shows a more comprehensive map of repair rates for all pipes in the South System.

Liquefaction and landslide-induced PGD will cause the majority of expected leaks and breaks, which are anticipated to occur on piping with smaller diameters. Specifically, pipelines along Redland Road and Beavercreek Road are anticipated to have the highest risk of failure in the South System.

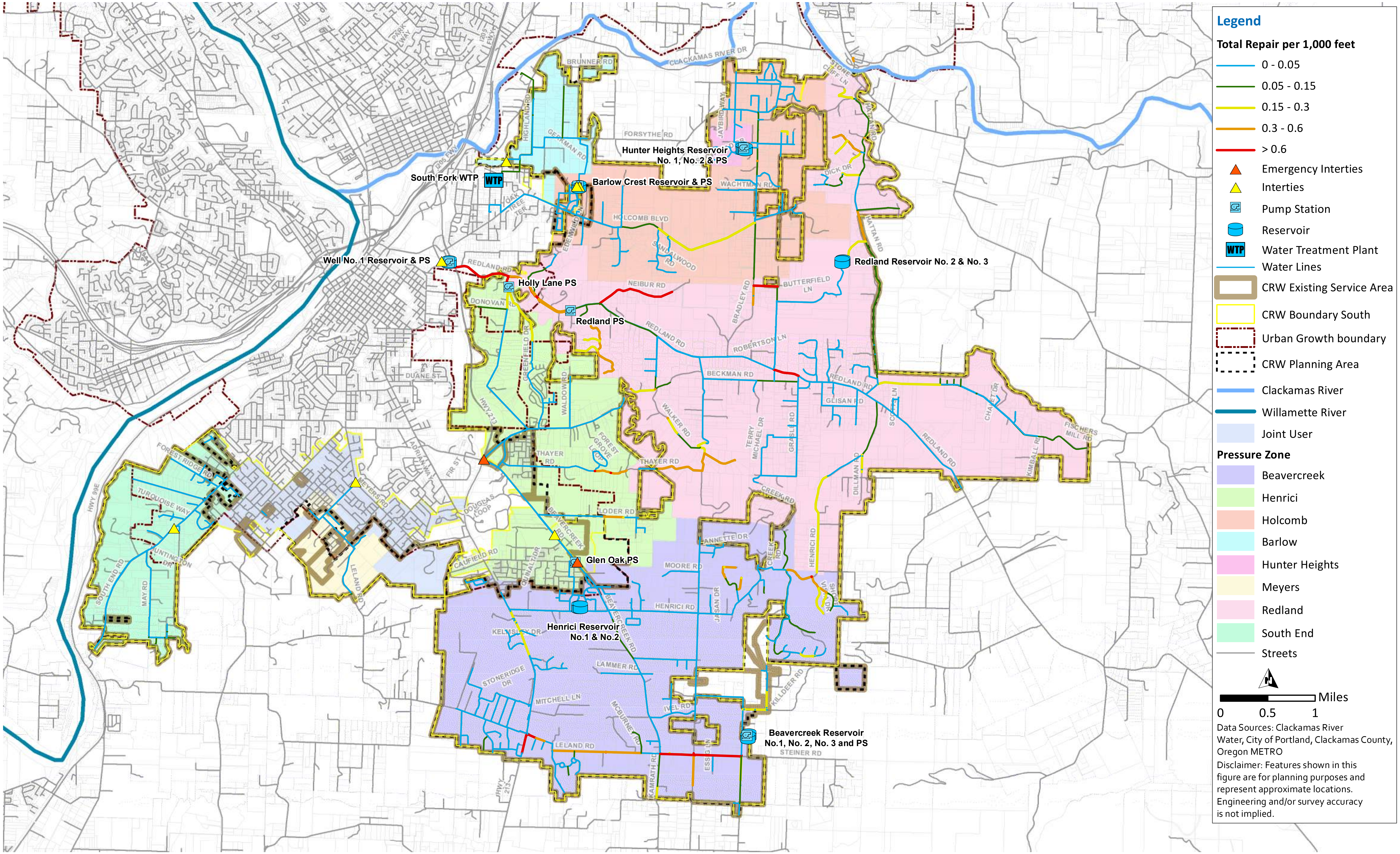

Figure 7.3 Potential Repair Rates per 1,000 LF - South System

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7.5 Seismic Resilience Recommendations

To adequately prepare for the M9 CSZ earthquake, every major component of CRW's water distribution system must be evaluated and improved as necessary. The following sections offer recommendations to improve the seismic resiliency of CRW's pipelines and above-ground facilities.

7.5.1 Seismic System Design Standard Recommendations

A seismically resilient segmented pipeline is usually designed according to subsurface conditions and criticality. Because no two installments are exactly alike, no well-vetted design standards exist within the industry for resilient segmented pipes. CRW's current design standards for thrust restraint applications call for cement mortar-lined ductile iron pipes (DIP) with a minimum thickness class of 52, with mechanically restrained joints. Applying this standard to all pipes in the distribution system would improve overall resiliency.

The critical factors in a resilient pipe design can be grouped into joint design and material selection. The joint must have sufficient flexibility to allow for some elongation, compression, and rotation, but it must also be restrained enough to keep it from pulling apart. The material must be able to withstand shear and compression forces without local buckling. Lastly, the overall system (pipe segments and joints) must accommodate approximately one percent strain.

In general, the design standards recommend that any replacements with DIP use a mechanically-restrained joint. However, resilient pipe design will be unique for each pipe replacement project and design engineers may recommend a different pipe material for a particular project. Alternate materials include steel with double-welded joints and fused-joint HDPE pipes, which are considered seismically resistant because of the pipe materials' ductility. An additional alternate pipe material, particularly for projects near active cathodic protection systems, is molecularly oriented PVC (AWWA C-909) with seismic joints.

7.5.1.1 Backbone Seismic System Pipes

Once the Phase 1 and Phase 2 backbone pipelines are complete in 2024, they will form a critical link between CRW's North System and South System. Phase 1, a backbone system designed to be seismically resilient, is currently being constructed and is anticipated to be completed by 2020. Phase 2 will be designed with similar performance criteria. Given the design focus on seismic resilience, these new pipelines are anticipated to experience minimal damage from the M9 CSZ earthquake.

7.5.1.2 Low-Risk Seismic System Pipes

For planning purposes, seismic system pipelines with a repair rate less than 0.15 repairs per 1,000 feet are considered "low risk." This means there is less than a 15 percent chance of failure somewhere along a 1,000 foot segment of pipe. Approximately 79 percent of the South System's planned seismic system pipes falls within the low-risk category.

Pipelines in low-risk areas are recommended for replacement when they reach the end of their useful life (which depends on the material they're made of), when there is a hydraulic deficiency, or when an opportunity project presents itself. Replacing existing cast iron pipes with new restrained-joint DIP is recommended over time. Depending on their current conditions, existing ductile iron and welded steel pipelines may be able to survive the CSZ earthquake. If a segment of ductile iron or steel pipe must be replaced, restrained-joint DIP is once again recommended instead.

Other pipe options, including double-welded steel and HDPE, can be used if the design engineer deems them appropriate and CRW approves.

7.5.1.3 High-Risk Seismic System Pipes

Seismic system pipelines with a repair rate greater than or equal to 0.15 repairs per 1,000 feet are considered "high risk." In the pipeline resilience evaluation, approximately 21 percent, or about 24,400 linear feet, of the South System's non-backbone seismic system pipes were deemed high risk.

Seismic system pipelines in high-risk areas must be replaced with seismic-resistant pipe systems, which can be DIP with seismic joints. Alternate materials include steel with double-welded joints or HDPE with fused joints. These piping systems must include flexible joints and joint restraints, and must be able to accommodate one percent strain. The strain accommodation can be achieved with the pipe ductility or special seismic joints. Where the pipe alignments are subject to significant corrosion, either molecular-oriented PVC (AWWA C-909) or HDPE (AWWA C-906) PVC piping is recommended.

Special design requirements are necessary for seismic-resistant piping systems. Segmented pipes like ductile iron or PVC must be designed to accommodate thrust. All pipes must allow movement to provide adequate flexibility at hard points (e.g., connections to structures, tees, crosses and elbows, and valves) and to account for the design of service connections. Low-strength concrete backfill is not recommended when installing seismically resistant pipes since this prevents or limits their expected movement. If this type of backfill is required for specific installations, such as County road crossings, the design engineer will need to allow for additional movement on either side.

7.5.2 Distribution System Design Standard Recommendations

The distribution system can become even more resilient by hardening the non-seismic system pipelines during the scheduled pipe replacement. These pipelines were deemed non-critical; however, water loss due to leaks or major breaks may potentially drain the backbone system. Replacing pipes that have reached the end of useful life with restrained-joint DIP will improve the distribution system's overall resiliency.

7.5.3 Isolation Valve Recommendations

CRW may also consider installing seismically actuated isolation valves (referred to as "seismic valves" in this report) on storage reservoirs, particularly for pressure zones with vulnerable pipes. These isolation valves have closures that are triggered by ground shaking, preventing the tank from draining, even if a pipe breaks downstream. They also isolate areas of the distribution system that are vulnerable to landslide or extensive liquefaction.

In general, for pressure zones with more than one existing reservoir, seismic valves should be installed on the reservoir that is more seismically resilient and should be incorporated into the design of all new storage reservoirs. Nonetheless, one reservoir per pressure zone can be allowed to continue supplying the system with no seismic valve. Table 7.3 summarizes these recommendation.

Table 7.3 Preliminary Seismic Valve Location Recommendations – South System

Pressure Zone	No Seismic Valve	Install Seismic Valve(1)
Holcomb	Hunter Heights (small)	Hunter Heights (large)
Redland	Redland No. 2	Redland No. 3
Beavercreek	Beavercreek No. 2 Standpipe (if destroyed, proposed elevated tank)	Proposed elevated tank (if standpipe kept)
Henrici	None (to be served by Beavercreek Zone)	Henrici

Notes:
(1) Final recommendations on the seismic valves' location will depend on the results of the recommended Storage Reservoir seismic resilience evaluations.

Note that these installations could shut down service to portions of the system, limiting the ability to suppress fires. Thus, isolation valves must be evaluated under a future study that considers full system operation after an earthquake event.

In the meantime, the following are recommended to monitor and control the valves:

- A ground motion instrument that measures PGA.
- A flow meter or pressure monitor to determine significant downstream pipe damage.
- A programmable logic controller (PLC) tied to the SCADA system to assess the need for valve closure and allow manual override. The PLC must have a battery backup.

Finally, butterfly valves are recommended for new installations. However, pneumatic actuators with a nitrogen-bottle air supply provide the simplest installation and maintenance, and existing globe valves pilot systems can also be modified to operate as valves.

7.5.4 Recommendations for Additional Evaluations

The evaluations described in this chapter focused on the anticipated performance of CRW's pipelines during the M9 CSZ earthquake. The next step in understanding the overall system's seismic resilience is to perform detailed structural, nonstructural, and geotechnical evaluations of CRW's facilities. These facilities include raw water intake structures, the water treatment plant (including piping between process units), storage reservoirs, pump stations, office buildings, and maintenance buildings. These evaluations will include several key components:

- Building and treatment process structures.
- Mechanical and electrical equipment within the structures.
- Piping and conduit within structures.
- Connections of pipes and conduits where they enter or exit structures.
- Functional and post-event recovery dependencies of the facilities.

We recommend including these evaluations in CRW's upcoming Facility Plan, which is scheduled for 2019.

7.6 Mitigation Plan

Up to this point, this chapter:

- Identified the seismic hazards within CRW's South system.
- Detailed the seismic system that will supply water after the CSZ earthquake.
- Evaluated the anticipated performance of existing pipelines during the seismic event.

- Recommended actions for CRW to begin planning for mitigating expected damage.

The scope of these improvements is vast, and they are intended to be accomplished over the next 50 years. Table 7.4 shows a schedule for conducting additional evaluations and implementing improvement recommendations. Chapter 8 – Capital Improvements Plan offer cost estimates for these projects.

Table 7.4 Preliminary Mitigation Plan Schedule

Improvement Project	2019-2023	2024-2028	2029-2033	2034-2038	2039-2048	2049-2058	2059-2068
Seismic System Pipe Improvements							
Phase 1 Backbone Pipes							
Phase 2 Backbone Pipes							
Non-Backbone Seismic System Pipes, High-Risk							
Non-Backbone Seismic System Pipes, Low-Risk							
Non-Seismic System Pipe Replacement							
Storage Reservoir Improvements							
Seismic Resiliency Evaluations							
Seismic Valve Installations							
Recommended Seismic Improvements							
Pump Station Improvements							
Seismic Resiliency Evaluations							
Recommended Seismic Improvements							
Office and Maintenance Building Improvements							
Seismic Resiliency Evaluations							
Recommended Seismic Improvements							

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Chapter 8

CAPITAL IMPROVEMENT PLAN – SOUTH SYSTEM

8.1 Introduction

This chapter combines the various projects recommended in the Water System Plan (Plan) for Clackamas River Water's (CRW) water system and presents a comprehensive Capital Improvement Plan (CIP). With the CIP, CRW will have a guideline for planning and budgeting its water system over the next 20 years. It will also have the recommended timing and cost estimates for each identified project. Project phasing is described as either short term (2019-2028) or long-term (2029-2038).

Appendix N details each project with cost estimates and implementation timing. It also includes a summary table listing CIP costs for each year through 2028.

8.1.1 Capital Project Categories

The Plan's capital projects are categorized by the infrastructure involved, which are as follows:

- General (G).
- Programmatic (P).
- Pressure Zone (PZ).
- Storage (ST).
- Pump Station (PS).
- Distribution Pipeline (D).
- Backbone (BB).

The abbreviations presented above were used during project identification to delineate each project category.

General projects (G) are currently identified for both North and South systems, however, as the system becomes one, these should be combined. For the purpose of this Plan, general projects costs are split between the North and South systems' CIP.

Programmatic projects (P) represent the repair and replacement program and the seismic system program. The programmatic projects include capital pipelines replacement programs that do not specify individual projects by location but rather a length of pipe replacement each year. These include pipes reaching their remaining useful life within the planning period that are not included in any of the specific projects identified in the distribution pipelines (D) presented below. The seismic system program includes pipes that are part of the proposed seismic system that are not already included in any of the specific projects identified in the distribution pipelines (D) presented below.

Pressure zone (PZ), storage (ST), pumping (PS) and projects are included in their respective categories.

Distribution pipeline projects (D) contain new or parallel pipe, pipe upsizing projects, and pipelines from the repair and replacement study identified specifically.

The backbone (BB) category includes projects that CRW developed to connect the North and South systems. This Plan assumes that Backbone Phase I projects will all be implemented by 2019; therefore, only Phase II projects are included in the CIP. Note, all backbone projects Phase II are located in the South system.

8.1.2 Capital Project Types

To support CRW's financial evaluation, projects were allocated into three types:

1. Improvement: Projects that increase level-of-service (e.g., redundant pumping, backup power, pipe upsizing, fire flow, system reliability, etc.) of existing infrastructure. These projects are typically funded with rates and will be needed whether demand increases or stays the same.
2. Capacity: Projects that provide additional system capacity to meet future demand growth. These projects are typically funded with connection fees. These projects were recommended to meet the analysis criteria in Chapter 6.
3. Repair & Replacement: Non-capacity-related projects that involve replacing or maintaining existing infrastructure without increasing capacity or level-of-service. These projects are typically funded with reserves. As explained in Chapter 2, these projects are meant to renew infrastructure in poor condition.

Projects may include elements of multiple capital project types. Each project was defined as one or more of the three project types and assigned a percentage of the total project cost to each project type. The allocations between multiple types were made based on professional judgment.

8.2 Cost Estimating Assumptions

8.2.1 Cost Estimate Level

The CIP cost estimates in this chapter are Class 4 estimates, or budget-level estimates. Actual costs may vary from these estimates by -15 percent to +30 percent. These costs were determined based on the team's understanding of project locations and current conditions.

All costs are in 2018 dollars. The Engineering News Report (ENR) U.S. 20-City Construction Cost Index for August 2018 is 11124. As previously stated, the estimates are subject to change as the project design matures and because costs for labor, materials, and equipment may vary in the future.

8.2.2 Cost Estimate Overview

Baseline construction costs are estimated based on the assumptions presented below using unit costs. Unless otherwise stated, the unit cost does not include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for planning contingency that will be added to determine the total project cost.

8.2.3 Pipeline Unit Costs

Table 8.1 shows cost assumptions for pipeline units. These costs were developed from recent construction costs of various water pipelines and were rounded to the nearest tenth. To be conservative, these unit costs assume open-trench construction in improved areas. If trenchless construction is possible for some projects, the cost estimates may need to be modified.

Costs include pavement-cutting, excavation, hauling, shoring, pipe materials and installation, backfill material and installation, and pavement replacement. The unit costs are for "typical" field conditions for construction in stable soil at a depth ranging between 3 to 5 feet.

Table 8.1 Pipeline Unit Costs

Pipe Size (Inches)	Pipeline Unit Cost(1) ($/LF)
4	$190
6	$200
8	$230
10	$250
12	$260
16	$330
18	$370
20	$430
24	$490
30	$620
8/24 Casing(2)	$1,140

Notes:
(1) The unit cost does not include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for project contingency that will be added to determine the total project cost.
(2) This unit cost includes additional material cost and installation associated with a pipeline river or highway crossing.

The construction costs for high-risk pipelines within the seismic system will be 30 percent higher than the pipeline unit cost to account for additional material cost and the difficulty of installation, as shown in Table 8.2. Low-risk pipelines within the seismic system are anticipated to have the same unit cost as outlined in Table 8.1

Table 8.2 High-Risk Seismic System Pipeline Unit Costs

Pipe Size (Inches)	Pipeline Unit Cost(1) ($/LF)
8	$300
12	$340
14	$400
18	$480
24	$640

Notes:
(1) The unit cost does not include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for project contingency that will be added to determine the total project cost.

8.2.4 Pump Station Costs

Costs for a new pump station were developed using typical costs from past projects. The cost for a pump unit varies with pump size. Accordingly, cost estimates were calculated based on pump size (greater or less than 1.0 mgd), as shown in Table 8.3.

Table 8.3 Pump Station Unit Costs

Pump Size (mgd)	Pump Unit Cost(1) ($/HP)
>1.0	$5,200
<1.0	$6,000

Notes:
(1) The unit cost does not include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for project contingency that will be added to determine the total project cost.

The cost estimate for adding a single redundant fire flow pump at an existing pump station was based on the pump size. For this CIP, the estimated cost for a 700 gpm capacity pump, presented as lump sum, was $200,000.

The total project costs included an additional 30 percent for construction contingency, 25 percent for engineering, legal, and administrative, and 20 percent for project contingency.

8.2.5 Storage Costs

Project costs for new storage were developed based on typical costs from past projects. Conceptual costs for reservoirs vary by type (ground, standpipe, or elevated) and are estimated based on reservoir volume in gallons (gal), as presented in Table 8.4. Storage costs are sensitive to site-specific geotechnical and seismic considerations; therefore, we recommend conducting a reservoir siting study at the start of a new storage project.

Table 8.4 Reservoir Unit Costs

Reservoir Type	Cost per gallon(1) ($/gal)
Ground	$1.5
Standpipe	$2
Elevated	$4

Note:
(1) The unit cost does not include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for project contingency that will be added to determine the total project cost.

8.2.6 Valve Costs

Other costs for the CIP include the pressure reducing valve (PRV) station and the seismic isolation valve. Conceptual costs were estimated based on past projects, as presented in Table 8.5.

Table 8.5 Valve Costs

	Cost(1) (Lump Sum)
Pressure Reducing Valve Station	$200,000
Seismic Isolation Valve	$200,000

Notes:
(1) The lump sum cost does not include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for project contingency that will be added to determine the total project cost.

8.3 CIP Development and Implementation

As discussed in Chapter 2 – Existing System and Condition Assessment, Chapter 6 – System Analysis, and Chapter 7 – Seismic System, the recommended projects are combined and prioritized according to their urgency in mitigating projected deficiencies and servicing anticipated growth. To develop project priorities, CIP projects with multiple project purposes were noted. In addition, all pipe projects were reviewed to avoid duplicate projects for the same pipeline, if more than one type of deficiency is proposed.

The capital improvement implementation phases are separated into two phases:

- Short-term (2019 – 2028), and
- Long-term (2029-2038) priority.

Short-term projects (2019-2028) have already started (or are committed to start within the short-term timeframe) and include high-priority projects, such as:

- Projects necessary to operate the backbone;
- Projects necessary to provide 10 mgd of wholesale water;
- Repair and replacement projects for pipes past their remaining useful life and history of excessive leakage.

All other CIP projects are long-term projects. These are recommended to be completed within the planning period (2029-2038) and include the following project categories:

- Other improvement projects;
- Capacity projects;
- Continued repair and replacement projects.

When capital projects overlap between different project types, the highest-priority phase between the two was selected. For instance, if a pipe upsize is recommended in the long-term to mitigate fire flow deficiencies, but the same pipe is recommended to be replaced or repaired in the short-term, it will be prioritized in the short-term phase.

The following sections summarize recommended projects identified in previous chapters and incorporated in Section 8.4's comprehensive CIP.

8.3.1 Recommended General Projects

General projects include developing the Water Treatment Plant and Seismic Facility Plan (G-01) and the 10- and 20-year update to the Water System Master Plan (G-02).

8.3.2 Recommended Programmatic Projects

Two types of programmatic projects are recommended: Repair and Replacement Pipeline and Seismic System Pipeline Programs.

8.3.2.1 Repair and Replacement Pipeline Projects

The pipe condition analysis incorporated three types of data:

- Remaining Useful Life (RUL),
- Leakage records, and
- Historically identified projects.

As outlined in Chapter 2, the RUL analysis examined the pipe's material, installation year, and material's useful life to determine the year in which each pipe would reach its RUL. Any pipes that reach the RUL by 2019 were categorized as short-term projects, and those that reach the RUL between 2020 and 2038 were categorized as long-term projects. Pipes that reach the RUL beyond the planning period were not included in the CIP. The Repair and Replacement Pipeline Program (P-01) summarizes each of these pipes.

In addition, to prioritize pipe replacement projects, CRW's leakage was overlaid on the pipes that will reach their RUL within the planning period. The dataset showed that almost all pipe that reached their RUL by 2019 have leakage records. It is recommended that CRW prioritize these pipeline replacement projects in the short-term. Table 8.6 summarizes the RUL analysis and indicates the pipe length, costs, and phasing for pipe replacement. Note, pipes identified in the RUL analysis that were also identified in specific projects in other sections of the CIP, such as improvement projects, are not included in the repair and replacement program project P-01.

Table 8.6 Repair and Replacement Analysis Summary

Pipe Diameter	Short-Term (2019-2028)		Long-Term (2029-2038)	
	Length (LF)	Cost(1)	Length (LF)	Cost(1)
4-inch (and smaller) replaced with 8-inch(1)	--	--	2,500	$990,000
6-inch to 8-inch (1)	14,800	$5,947,000	3,400	$1,349,000
8-inch	22,100	$8,892,000	5,800	$2,350,000
12-inch	12,700	$5,795,000	--	--
14-inch	4,100	$2,200,000	--	--
Total	**53,700**	**$22,830,000**	**11,700**	**$4,689,000**
Annual Length/Cost	**5,370**	**$2,283,000**	**1,170**	**$468,900**

Notes:
(1) Both 4-inch and 6-inch existing diameters will be replaced with 8-inch diameter pipes.
(2) The cost includes 30 percent construction contingency, 25 percent Engineer/Legal/Admin contingency, and 20 percent project contingency

8.3.2.2 Recommended Seismic System Pipeline Program

The seismic hazard assessment in Chapter 7 recommended a seismic system identifying the major infrastructure that would be part of the seismic system after an earthquake. All pipes identified in the seismic system are included in the CIP. The Seismic System Pipe Program (P-02) summarizes the seismic pipe system. Project P-02 only includes the pipes that were not identified in any other projects in the CIP.

8.3.3 Recommended Pressure Zone Projects

The pressure zone project, New Beavercreek Pressure Zone (PZ-02), was developed based on hydraulic modeling results. The purpose of this project is to address low pressure in the southeast region of the Beavercreek Service area by creating a new pressure zone in the service area.

8.3.4 Recommended Storage Projects

8.3.4.1 Storage Seismic Valves

As outlined in Chapter 7, it is recommended that seismic isolation valves are installed at the Mather Reservoir and two of the Otty Reservoirs. This storage project is captured in the CIP as the Seismic Isolation Valves at Existing Tanks Project (ST-01).

8.3.4.2 Storage Condition Analysis

Carollo also recommends that CRW perform a condition evaluation of their existing storage reservoirs. It is anticipated that existing reservoirs constructed before 1975 may need to be replaced or repaired within the planning period. Reservoirs might need repairs or new coating. The Storage Condition Evaluation (ST-02) summarizes the condition evaluation project, and the Storage Repair & Rehabilitation Project (ST-03) is included as a capital project for potential costs and necessary repairs resulting from the storage evaluation.

8.3.5 Recommended Pump Station Projects

8.3.5.1 Pump Station Improvement Projects

A redundant fire flow pump n the Hunter Heights pressure zone (PS-03) is recommended to increase the firm capacity of the Hunter Heights PS.

8.3.5.2 Pump Station Condition Projects

Carollo recommends that CRW perform a condition evaluation of their existing pump stations. It is anticipated that any pump stations constructed before 1985 may need to be replaced or repaired within the planning period. The Pump Station Condition Evaluation (PS-04) summarizes the condition evaluation project, while the Pump Station Repair & Rehabilitation Project (PS-05) is included as a capital project for potential costs and necessary repairs resulting from the evaluation.

Electrical and Arc-Flash upgrades were performed in 2018-19, and the estimates do not include electrical costs. At the time the condition evaluation is performed, there may be electrical improvements needed for code compliance.

8.3.6 Recommended Distribution Pipeline Projects

Distribution pipeline projects were developed using the hydraulic modeling detailed in Chapter 6, and projects historically identified by CRW.

8.3.6.1 Pressure and Velocity Projects

Based on the results of the hydraulic modeling in Chapter 6, pipeline projects were developed to address areas of low pressure and high velocity. The recommended projects to address pressure and velocity concerns are summarized in Table 8.7. Further details can be found in Section 8.4.

Table 8.7 Pressure and Velocity Projects Summary

Pipe Diameter	Short-Term (2019-2028)		Long-Term (2029-2038)	
	Length (LF)	Cost(1)	Length (LF)	Cost(1)
4-inch	--	--	1,100	$382,000
6-inch	3,900	$1,253,000	400	$130,000
8-inch	2,800	$1,110,000	11,100	$4,464,000
12-inch	7,500	$3,421,000	2,600	$1,195,000

Notes:
(1) The cost includes 30 percent construction contingency, 25 percent Engineer/Legal/Admin contingency, and 20 percent project contingency.

8.3.6.2 Fire Flow Projects

Pipeline projects were developed to address fire flow deficiencies and are summarized in Table 8.8. The fire flow project addressing fire flow deficiencies to the Redland Elementary School (D-79) will be completed in the short-term planning period, but all other fire flow projects are recommended to be completed in the long-term planning period.

Table 8.8 Fire Flow Projects Summary

Pipe Diameter	Short-Term (2019-2028)		Long-Term (2029-2038)	
	Length (LF)	Cost(1)	Length (LF)	Cost(1)
8-inch	19,100	$7,688,000	82,600	$33,247,000
12-inch		--	21,800	$9,905,000

Notes:
(1) The cost includes 30 percent construction contingency, 25 percent Engineer/Legal/Admin contingency, and 20 percent project contingency.

8.3.7 Recommended Backbone Projects

The Backbone Phase 2 projects are included in the CIP for the South System, as outlined in Chapter 6. Backbone Phase 2 (BB-02) includes the following project elements:

- Grasle Rd – 16-inch pipe
- Beaver Lake PS – 3 MGD
- Bradley Rd – 12-inch pipe.
- Bradley Rd PS – 1.25 MGD.
- 2.5-MG Beavercreek Reservoir (5 MG is recommended in the future, however, for the 20-year planning period, a 2.5 MG appears sufficient, per the storage analysis in Chapter 6).

8.4 Capital Improvement Program

8.4.1 Capital Improvement Program Overview

This section summarizes the CIP program and cost, and illustrates the locations of recommended projects, both specific projects such as distribution pipelines, and programmatic projects. Tables 8.9 and 8.10 summarize the CIP projects by project category and type, respectively. Figures 8.1 and 8.2 summarize the percent of each project identified by project category, and project type, respectively.

The total South System CIP cost over the next 20 years is approximately $174 million, which equates to approximately $8.7 million annually. Of the total cost, $70 million is budgeted for the short-term phase and approximately $104 million is budgeted for the long-term phase.

When considering CIP costs by project category, as shown in Table 8.9 and Figure 8.1, the majority of CIP costs (50.5 percent) occur from distribution pipelines projects. The Backbone Phase II projects comprise the other high cost category, at 21.8 percent of the CIP.

When considering CIP costs by project type (shown in Table 8.10 and Figure 8.2), approximately 31.9 percent of the CIP costs are repair and replacement projects, the majority of which are anticipated to be completed in the long-term. Improvement projects comprise approximately 67.3 percent of the CIP costs, with a majority also expected to be completed in long-term. Capacity projects make up only about 0.8 percent of the CIP costs, and most are expected to be completed in the short-term.

Table 8.9 CIP Summary by Project Category

Project Category	Short-Term (2019-2028)	Long-Term (2029-2038)	Total CIP	Percentage
General	$450,000	$200,000	$650,000	0.4%
Programmatic	$22,830,000	$46,665,000	$69,495,000	39.8%
Pressure Zone	--	$1,879,000	$1,879,000	1.1%
Storage	$700,000	$5,250,000	$5,950,000	3.4%
Pump Station	--	$600,000	$600,000	0.3%
Distribution Pipeline	$16,972,000	$49,835,000	$66,807,000	38.3%
Backbone	$29,058,000	--	$29,058,000	16.7%
Total Cost	**$70,010,000**	**$104,429,000**	**$174,439,000**	
Annual Cost	**$7,001,000**	**$10,443,000**	**$8,722,000**	

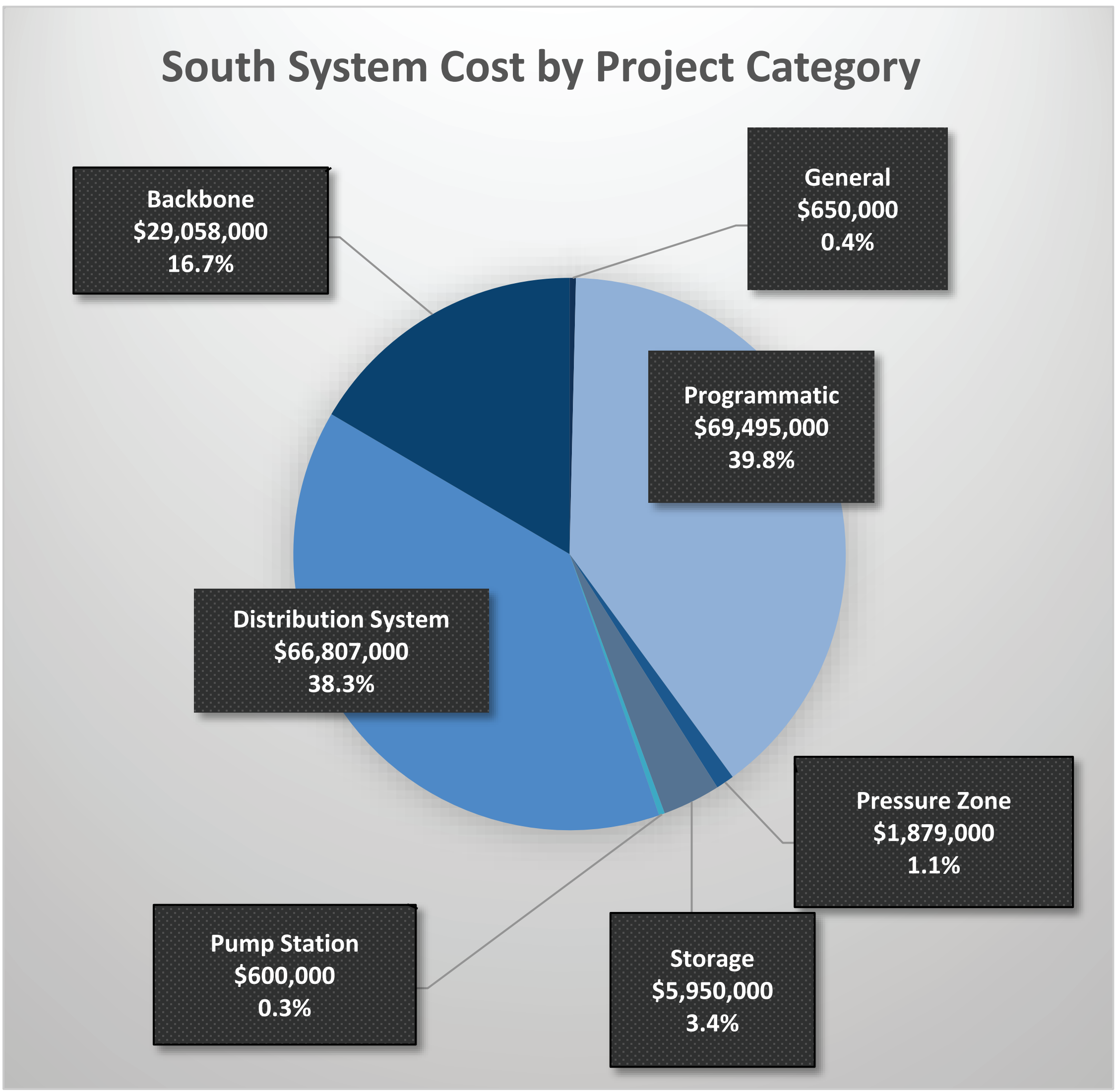

Figure 8.1 CIP Summary by Project Category

Table 8.10 CIP Summary by Project Type

Project Type	Short-Term (2019-2028)	Long-Term (2029-2038)	Total CIP
Improvement	$40,629,000	$47,964,000	$88,593,000
Capacity	$1,033,000	--	$1,033,000
Repair and Replacement	$28,348,000	$56,465,000	$84,813,000
Total Cost	**$70,010,000**	**$104,429,000**	**$174,439,000**
Annual Cost	**$7,001,000**	**$10,443,000**	**$8,722,000**

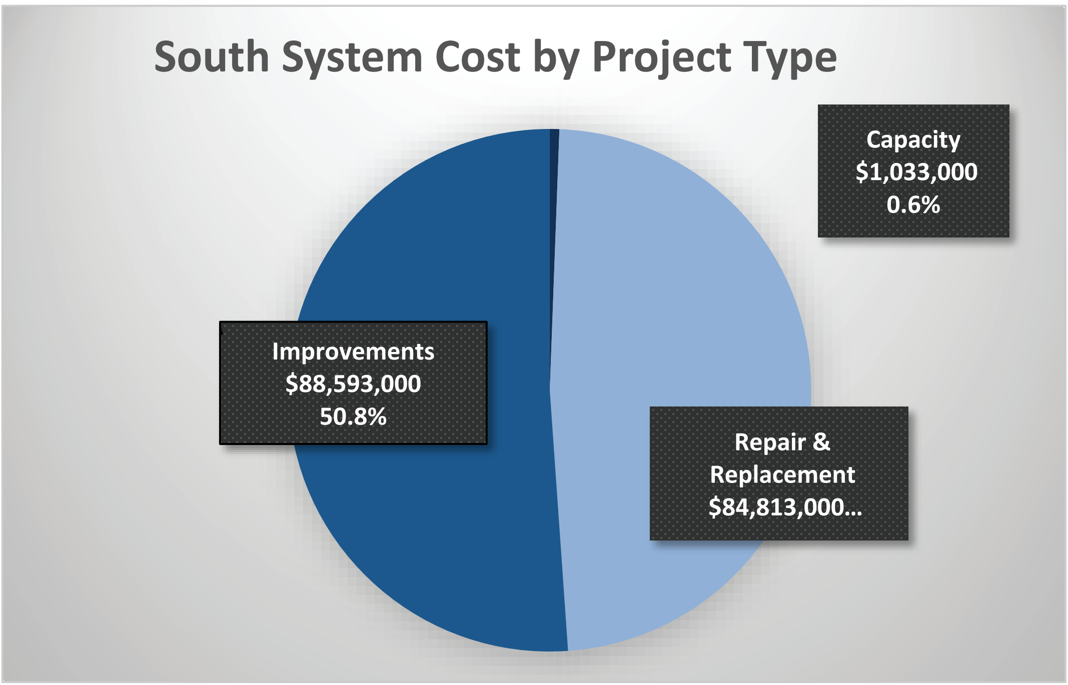

Figure 8.2 CIP Summary by Project Type

8.4.2 Detailed CIP Program

Table 8.11 summarizes the South System CIP projects and labels them Improvement, Capacity, or Repair and Replacement projects. It also states whether the pipeline is part of the seismic system. Each project is assigned a CIP ID, which is different from the System Analysis ID from Chapter 6. Note, one project can be triggered for different reasons and can be associated with multiple project types. For these cases, the capital costs are equally split between the project types.

Table 8.10 identifies the planning period (Short-Term vs Long-Term) determined for each project and each project type. The combined project phasing in the last column of this table shows the priority used for each project in the CIP. For instance, if a project was identified in the long-term as an improvement project and short-term as a condition project, the CIP combined phasing was identified as short-term.

Figure 8.3 illustrates the locations of the specific projected identified, while Figure 8.4 illustrates these projects phased between short and long-term. Figure 8.5 illustrates the location of the projects included in the programmatic CIP, not included in any of the specific projects.

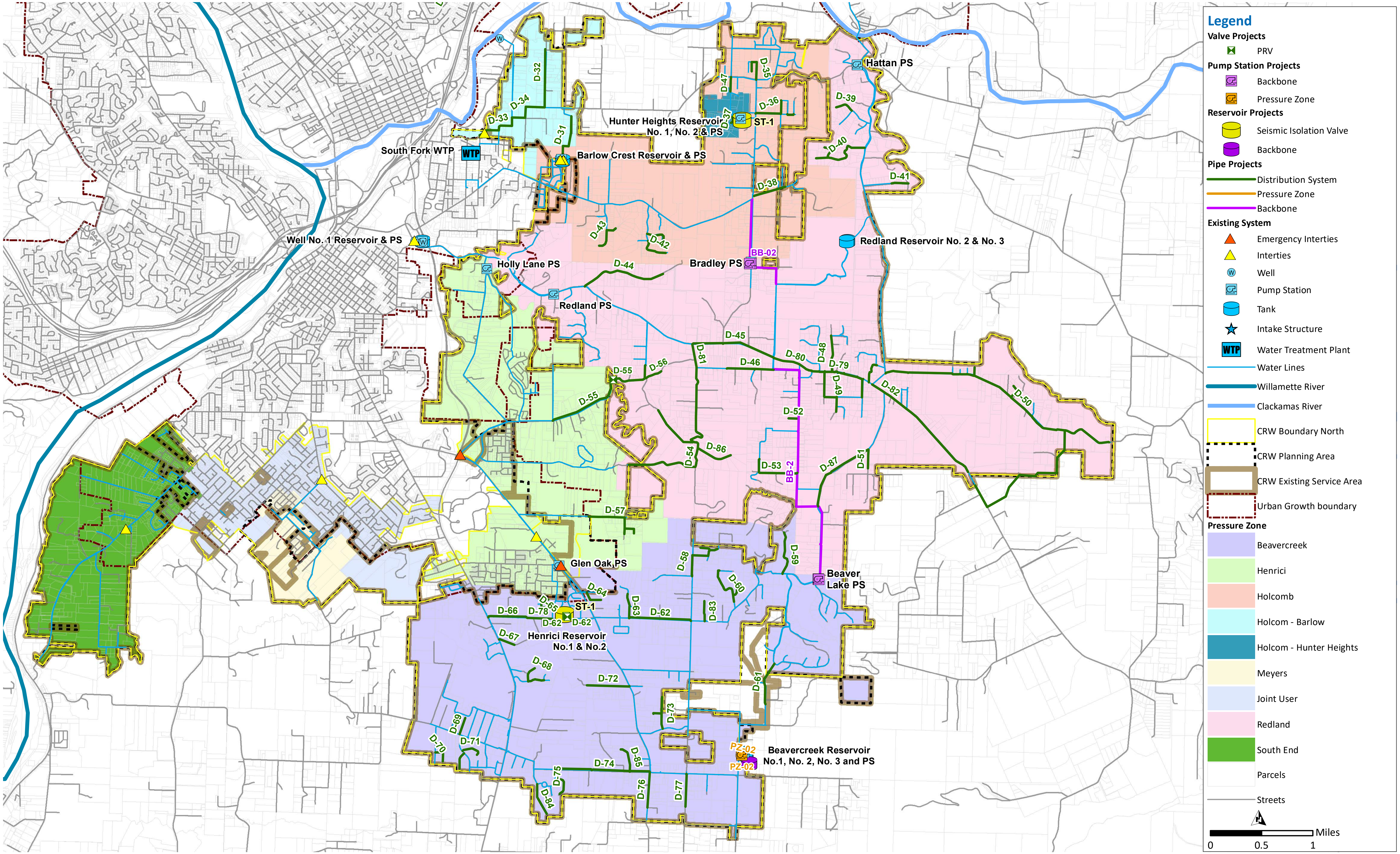

Figure 8.3 CIP Specific Projects - South System

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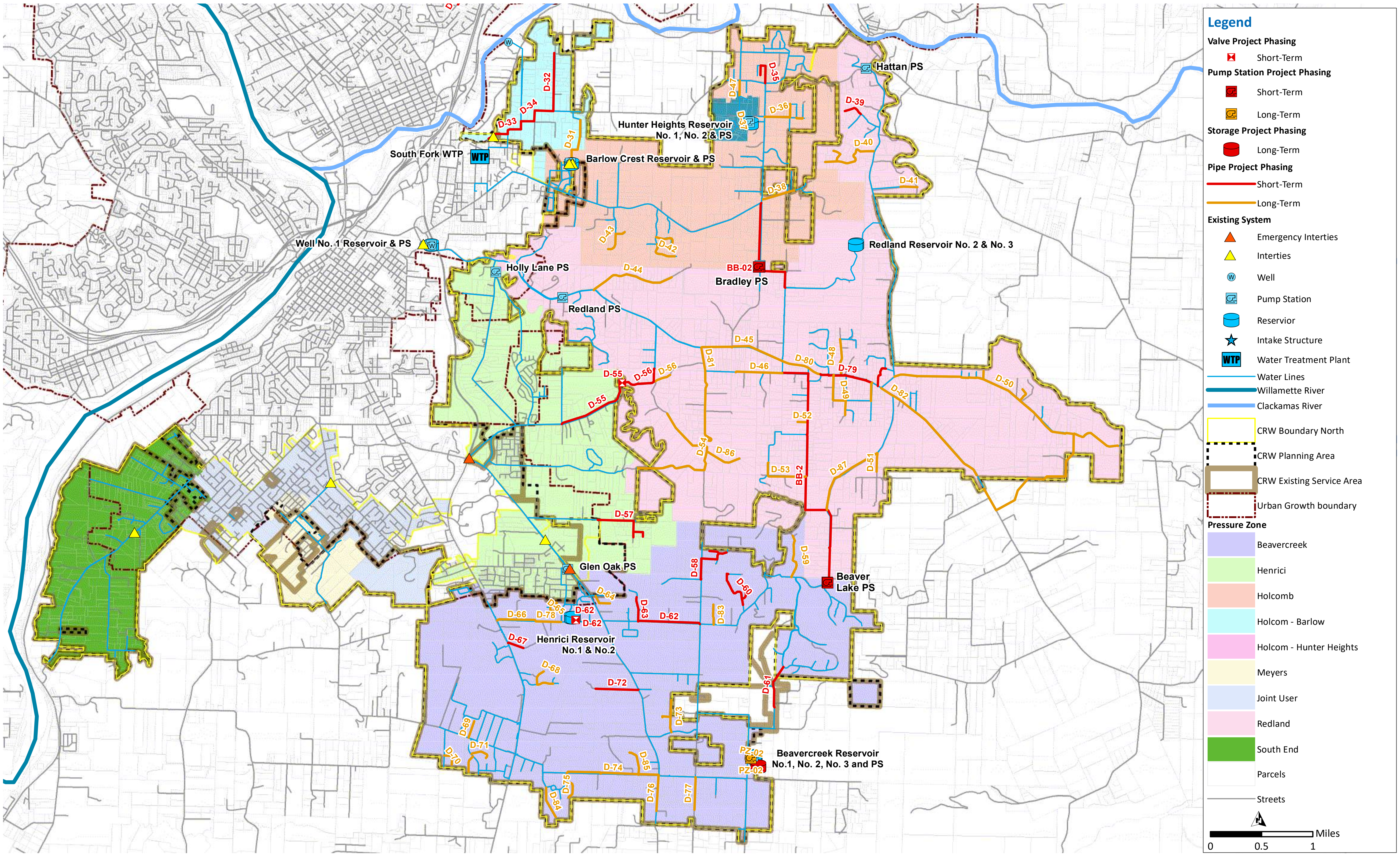

Figure 8.4 CIP Specific Project Phasing - South System

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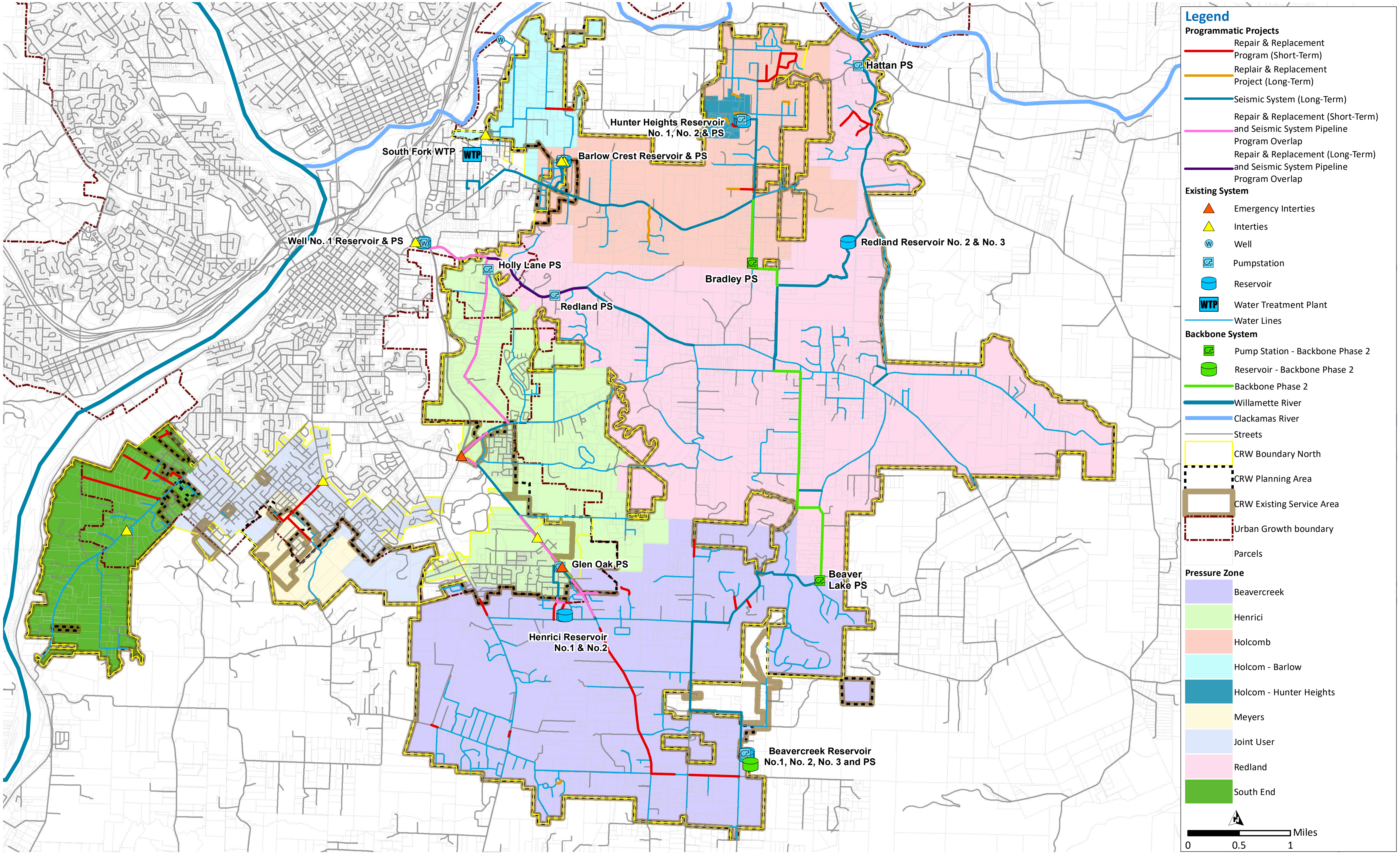

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Figure 8.5 CIP Programmatic Projects - South System

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Table 8.11 CIP Recommended Projects

CIP ID	System Analysis ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose	Improvement Project		Capacity Project		Repair and Replacement Project			Seismic System		Project Phasing
									Yes/No	Year	Yes/No	Year	Reach RUL?	Year	Leakage?	Yes/No	Length (ft)	
General (G)																		
G-01	n/a	Water Treatment Plant and Seismic Facility Plan	Program	n/a	n/a	n/a	System-wide	Develop a Water Treatment Plant and Seismic Facility Plan	Yes	Short-Term	No		No			Yes		Short-Term
G-02	n/a	2028 Water System Master Plan	Program	n/a	n/a	n/a	System-wide	Develop an updated Water System Master Plan	Yes	Short-Term	No		No			No		Short-Term
G-03	n/a	2038 Water System Master Plan	Program	n/a	n/a	n/a	System-wide	Develop an updated Water System Master Plan	Yes	Long-term	No		No			No		Long-Term
Programmatic (P)																		
P-01	n/a	Remaining Useful Life Pipeline Program	Replace Pipe / Upsize Pipe	65,305	Varies	Varies	System-wide	Replace pipelines that are past their useful life based on pipe material and pipe installation year.	No		No		Yes	Short-Term & Long-Term		No		Short-Term & Long-Term
P-02	n/a	Seismic System Pipe Program	Replace Pipe	80,619	Varies	Varies	System-wide	This project is required to complete CRW's planned seismic system.	Yes	Long-term	No		No			Yes		Long-Term
Pressure Zone (PZ)																		
PZ-02	PZ-02	New Beavercreek Pressure Zone	New Pipe New Pipe BPS	1,136 2,588 n/a	n/a n/a n/a	4 8 n/a	S Yeoman Rd from the PS south to S Steiner Rd; S Beavercreek Rd from S Seiner Rd to S Williams Rd	A new pressure zone in the Beavercreek service area is recommended due to low pressures in locations south of S Steiner Rd. New pipe on S Beavercreek Rd is required to provide fire flow.	Yes	Long-Term	No		No			No		Long-Term
Storage (ST)																		
ST-01	ST-01	Seismic Isolation Valves at Existing Tanks	Seismic Valves	n/a	n/a	n/a	Hunter Heights Reservoir and Henrici Reservoir	Seismic isolation valves are required to provide seismic resiliency to the reservoirs	Yes	2028	No		No			Yes	n/a	Short-Term
ST-02	n/a	Storage Condition Evaluation	Condition Evaluation	n/a	n/a	n/a	Storage Reservoirs System-Wide	This project is recommended due to age of storage reservoirs.	No		No		Yes	Long-Term	n/a	No		Long-Term

Table 8.11 CIP Recommended Projects (Continued)

CIP ID	System Analysis ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose	Improvement Project		Capacity Project		Repair and Replacement Project			Seismic System		Project Phasing
									Yes/No	Year	Yes/No	Year	Reach RUL?	Year	Leakage?	Yes/No	Length (ft)	
ST-03	n/a	Storage Repair & Rehabilitation	Repair & Replacement	n/a	n/a	n/a	Storage Reservoirs System-Wide	Repair and rehabilitation of the existing storage reservoirs. The project includes potential coating, repair, and rehabilitation of the existing reservoirs.	No		No		Yes	Long-Term	n/a	No		Long-Term
Pump Station (PS)																		
PS-03	PS-03	Hunter Heights Pump Station	PS	n/a	n/a	n/a	Hunter Heights Pump Station	Increase the firm capacity of the Hunter Heights Pump Station	Yes	Long-Term	No		No			No		Long-Term
PS-04	n/a	Pump Station Condition Evaluation	Condition Evaluation	n/a	n/a	n/a	Pump Stations System-Wide	This project is recommended due to age of the pump stations.	No		No		Yes	Long-Term	n/a	No		Long-Term
PS-05	n/a	Pump Station Repair & Rehabilitation	Repair & Replacement	n/a	n/a	n/a	Pump Stations System-Wide	This project is recommended due to age of pump stations. The project includes evaluation, repair, and rehabilitation of the existing pump stations.	No		No		Yes	Long-Term	n/a	No		Long-Term
Distribution Pipeline (D)																		
D-31	PV-06	Barlow Crest New Pipe	New Pipe	2,625	n/a	12	S Mason Heights Dr from Barlow Crest PS to Forsythe Rd.	This project is required to address low pressures in the vicinity.	No		No		No			No		Long-Term
D-32	FF-26	S Brunner Rd Pipe Upsize	Upsize Pipe	2,998	4	8	S Brunner Rd from S Forsythe Rd north to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-Term	No		Yes	2019	Yes	No		Short-Term
D-33	CRW-100	Forsythe Road (1)	Upsize Pipe	2,400	6	8	Forsythe Road (Hunter Avenue to Highland Road)	This pipeline will reach its remaining useful life by the year 2019. This pipeline has been flagged by CRW as a pipeline with reported leakage.	No		No		Yes	2019	Yes	No		Short-Term
D-34	CRW-101	Forsythe Road (2)	Upsize Pipe	2,200	6	8	Forsythe Road (Highland Road to Brunner Road)	This pipeline will reach its remaining useful life by the year 2019.This pipeline has been flagged by CRW as a pipeline with reported leakage.	No		No		Yes	2019	Yes	No		Short-Term

Table 8.11 CIP Recommended Projects (Continued)

CIP ID	System Analysis ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose	Improvement Project		Capacity Project		Repair and Replacement Project			Seismic System		Project Phasing
									Yes/No	Year	Yes/No	Year	Reach RUL?	Year	Leakage?	Yes/No	Length (ft)	
D-35	CRW-102	Bradley Road	Upsize Pipe Upsize Pipe Upsize Pipe	500 25 900	2 4 6	8 8 8	Bradley Road (North from Forsythe Road)	This pipeline will reach its remaining useful life by the year 2020. This pipeline has been flagged by CRW as a pipeline with reported leakage. Portions of this pipeline are undersized.	No		No		Yes	2020	Yes	No		Short-Term
D-36	PV-04	S Overlook Rd Pipe	New Pipe (parallel to 2") Upsize Pipe	370 2,026	n/a 6	6 8	S Overlook Rd from S Sky Ranch Rd east to end of pipe; S Overlook Rd from S Bradley Rd to S Outlook Terrace; North on S Outlook Terrace to connect with pipe at north end of Sky Ranch Ln.	This project is required to address low pressures in the vicinity and to provide sufficient fire flow to the surrounding area.	Yes	Long-Term	No		Yes	2037		No		Long-Term
D-37	FF-59	S Archer Dr Pipe Upsize	Upsize Pipe	333	6	8	S Archer Dr from S Fawn Dr north to S Outlook Rd.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-38	FF-31	S Holcomb Blvd Pipe Upsize	Upsize Pipe	1,678	6	8	S Holcomb Blvd from S Bradley Rd to S Timberdark Ln.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-39	FF-28	S Edgewood St Pipe Upsize	Upsize Pipe	967	6	8	S Edgewood St from S Edgewood Ln west to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-Term	No		Yes	2019	Yes	No		Short-Term
D-40	FF-29	S Dick Dr and S Lucky Ln Pipe Upsize	Upsize Pipe	3,978	6	8	S Dick Dr from S Hattan Rd west to end of street; S Lucky Ln from S Dick Dr to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-Term	No		No		Yes	No		Long-Term
D-41	FF-30	S Clear Acres Dr Pipe Upsize	Upsize Pipe	865	6	8	S Clear Acres Dr.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term

Table 8.11 CIP Recommended Projects (Continued)

CIP ID	System Analysis ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose	Improvement Project		Capacity Project		Repair and Replacement Project			Seismic System		Project Phasing
									Yes/No	Year	Yes/No	Year	Reach RUL?	Year	Leakage?	Yes/No	Length (ft)	
D-42	FF-32	S Sandalwood Rd and S Brook Ct Pipe Upsize	Upsize Pipe	2,540	6	8	S Sandalwood Rd from S Lora Ct south to end of street; S Brook St from S Sandalwood Rd to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-Term	No		No		Yes	No		Long-Term
D-43	FF-33	S Wildflower Ln and S Pam Dr Pipe Upsize	Upsize Pipe	1,540	6	8	S Pam Dr from S Wildflower Ln south to end of street; S Wildflower Ln from S Pan Dr to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-44	FF-34	S Neibur Rd Pipe Upsize	Upsize Pipe	4,443	4	8	S Neibur Rd from S Redland Rd east to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-45	FF-21	S Redland Rd New Pipe	New Pipe	4,418	n/a	12	S Redland Rd from S Ferguson Rd to S Potter Rd.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			Yes	4,418	Long-Term
D-46	FF-22	SE Beckman Rd New Pipe	Upsize Pipe	2,435	6	8	SE Beckman Rd east and west of S Matthew Ct.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-Term	No		No		Yes	No		Long-Term
D-47	FF-27	S Burkstrom Rd Pipe Upsize	Upsize Pipe	747	6	8	S Burkstrom Rd from S Forsythe Rd south to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-Term	No		No		Yes	No		Long-Term
D-48	FF-36	S Canter Ln Pipe Upsize	Upsize Pipe	1,845	6	8	S Canter Ln from S Redland Rd to S Nestle Ln.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-Term	No		No		Yes	No		Long-Term
D-49	FF-37	S Norman Rd, S Elida Rd/S Glisan Rd New Pipe	New Pipe	2,926	n/a	8	S Norman Rd from S Redland Rd to S Glisan Rd ; S Elida Rd from S Redland Rd to S Glisan Rd and S Glisan Rd to S Cadle Rd.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term

Table 8.11 CIP Recommended Projects (Continued)

CIP ID	System Analysis ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose	Improvement Project		Capacity Project		Repair and Replacement Project			Seismic System		Project Phasing
									Yes/No	Year	Yes/No	Year	Reach RUL?	Year	Leakage ?	Yes/No	Length (ft)	
D-50	FF-40	Fischers Mill Rd Upsize; S Hinkle Rd/S Kimball Rd New Pipe	Upsize Pipe Upsize Pipe New Pipe Upsize Pipe	10,374 2,623 8,050 5,697	6 4 n/a 4 & 6	12 8 8 8	Fischers Mill Rd from S Kimball Rd to end of street; Fischers Mill Rd from S Redland Rd to S Kimball Rd; S Hinkle Rd/S Kimball Rd from S Redland Rd to S Fischers Mill Rd.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No		Yes	No		Long-Term
D-51	FF-38	S Dillman Rd Pipe Upsize	Upsize Pipe	968	6	8	S Dillman Rd south from S Henrici Rd.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-52	FF-39	S Grasle Rd south of Team Ct Pipe Upsize	Upsize Pipe	495	6	8	S Grasle Rd south of Team Ct.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-53	FF-24; CRW-109; PZ-02	S North End Rd, S Terry Michael Dr New Pipe	Upsize Pipe	2,680	4	8	S North Ed Rd from S Grasle Rd to S Terry Michael Dr; S Terry Michael Dr from S North End Rd north.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			Yes	2,588	Long-Term
D-54	FF-41; CRW-104; CRW-105; CRW-107	S Thayer Rd, S Walker Rd, S Ferguson Rd Pipe Upsize	Upsize Pipe	11,785	4 & 6	8	S Ferguson Rd from SE Beckman Rd continuing onto S Thayer Rd; S Walker Rd from S Ferguson Rd north; S Coplet Ct from S Ferguson Rd to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No		Yes	No		Long-Term
D-55	PV-03	S Maplelane Rd New Pipe, New PRV Station	PRV Station New Pipe New Pipe	n/a 3,580 2,756	n/a n/a n/a	n/a 6 8	S Maplelane Rd from S Walker Rd to S Waldow Rd.	This project is required to deliver flow from the Backbone Phase II project to the Henrici zone.	Yes	Short-Term	No		No		Yes	No		Short-Term
D-56	CRW-108	S Maple Lane Road	Upsize Pipe	862	6	8	S Maple Lane Rd to Anderson	Replace 4" and 6" CI (approx.. 3,150')	Yes	Long-Term	No		No		Yes	No		Long-Term
D-57	FF-42	S Loder Rd, Thimble Creek Dr Pipe Upsize	Upsize Pipe	3,428	6	8	S Loder Rd, S Thimble Creek Dr, and S Merry Lane Dr.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-Term	No		Yes	2019		No		Short-Term

Table 8.11 CIP Recommended Projects (Continued)

CIP ID	System Analysis ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose	Improvement Project		Capacity Project		Repair and Replacement Project			Seismic System		Project Phasing
									Yes/No	Year	Yes/No	Year	Reach RUL?	Year	Leakage?	Yes/No	Length (ft)	
D-58	FF-43	S Ferguson Rd, S Heidi St Pipe Upsize	Upsize Pipe	3,200	4 & 6	8	S Ferguson Rd from S Moore Rd to S Heidi St; S Heidi St to S Annette Dr; S Annette Dr; S Rachel Ct.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-Term	No		Yes	2019		No		Short-Term
D-59	FF-45	S Creek Rd Pipe Upsize	Upsize Pipe	2,315	4	8	S Creek Rd from S Henrici Rd north.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-60	FF-44	S Athens Rd, S Olympus Rd Pipe Upsize	Upsize Pipe	2,996	4 & 6	8	S Athens Rd from S Henrici Rd to end of street; S Olympus Rd from S Athens Rd to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-Term	No		Yes	2019	Yes	No		Short-Term
D-61	PV-02	Beavercreek Loop Connection	New Pipe	2,271	n/a	12	S Mountain Meadow Rd from S Sunrise Ln to S Mompano Overlook Dr.	This project is required to fix the low pressure area in the Beavercreek Zone.	No		Yes	Short - Term	No			No		Short-Term
D-62	PV-05	Henrici Rd New Pipe; Henrici Tank PRV Station	New Pipe PRV Station	4,957 n/a	n/a n/a	12 n/a	Henrici Rd from Beavercreek Rd to S Ferguson Rd.	The project is required to deliver flow from the Backbone Phase II project to the Henrici zone.	Yes	Short-Term	No		Yes	2017	Yes	Yes	3,230	Short-Term
D-63	FF-46	Danny Ln Pipe Upsize	Upsize Pipe	1,270	6	8	S Danny Ct from S Henrici Rd north to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		Yes	2019	Yes	No		Short-Term
D-64	FF-47	S Saddle Ln Pipe Upsize	Upsize Pipe	976	6	8	S Saddle Ln from S Old Acres Ln south to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		No			No		Long-Term
D-65	FF-48	Woodglen Way, Crystal Ct Pipe Upsize	Upsize Pipe	1,331	6	8	S Woodglen Way from S Homestead Dr to S Crystal Ct; S Crystal Ct from S Woodglen Way east to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		No			No		Long-Term
D-66	FF-25	Beavercreek - Henrici Rd	Upsize Pipe	2,107	8	12	Henrici Rd from Cascade Hwy S to S Reeder Rd.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		No			No		Long-Term
D-67	FF-49	S Quail Crest Ln Pipe Upsize	Upsize Pipe	854	6	8	S Quail Crest Ln to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		Yes	2020		No		Short-Term

Table 8.11 CIP Recommended Projects (Continued)

CIP ID	System Analysis ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose	Improvement Project		Capacity Project		Repair and Replacement Project			Seismic System		Project Phasing
									Yes/No	Year	Yes/No	Year	Reach RUL?	Year	Leakage?	Yes/No	Length (ft)	
D-68	FF-50	S Mossy Rock Ct, S Greentree Dr Pipe Upsize	Upsize Pipe	1,680	6	8	S Mossy Rock Ct from S Greentree Dr north to end of street; S Greentree Dr from S Mossy Rock Ct to S Casca Berry Ct.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		No		Yes	No		Long-Term
D-69	FF-56	S Clear View Ct Pipe Upsize	Upsize Pipe	870	6	8	S Clear View Ct from Leland Rd north to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		No			No		Long-Term
D-70	FF-58	S Farm Pond Ct Pipe Upsize	Upsize Pipe	819	6	8	S Farm Pond Ct from S Foothills Ave to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		No			No		Long-Term
D-71	FF-57	S Hawthorne Ct, S Firethorne Ct Pipe Upsize	Upsize Pipe	1,934	6	8	S Hawthorne Ct from S Larkspur Ave to end of street; S Firethorne Ct from S Larkspur Ave to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		No		Yes	No		Long-Term
D-72	FF-51	S Lammer Rd Pipe Upsize	Upsize Pipe	2,201	6	8	S Lammer Rd from S Beavercreek Rd west to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-Term	No		Yes	2019	Yes	No		Short-Term
D-73	FF-52	S Levi Ct, S Levi Rd Pipe Upsize	Upsize Pipe	2,112	6	8	S Levi Rd from S Ivel Rd to end of pipe; S Levi Ct from S Levi Rd to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		No			No		Long-Term
D-74	FF-20	S Leland Rd, S Beavercreek Rd New Pipe	Upsize Pipe	4,871	8	12	S Leland Rd from S Leslie Ave to S Kamrath Rd.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		No			No		Long-Term
D-75	FF-55	S Leslie Ave Pipe Upsize	Upsize Pipe	950	6	8	S Leslie Ave from S Dales Ave south to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		No			No		Long-Term
D-76	FF-54	S Kamrath Rd Pipe Upsize	Upsize Pipe	1,825	6	8	S Kamrath Rd from S Beavercreek Rd to S Creek Haven Ln.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		No			No		Long-Term
D-77	FF-53	S Ferguson Rd Pipe Upsize	Upsize Pipe	1,690	6	8	S Ferguson Rd from S Beavercreek Rd to S Williams Rd.	This project is required to provide sufficient fire flow to the surrounding area.	No		No		No			No		Long-Term
D-78	CRW-106	Henrici Rd	Replace Pipe	1,293	8	8	Henrici Road (HWY 213 east to RR Right-of-Way)	Model for FF - Increase capacity (approx. 3,400')	Yes	Long-Term	No		No			No		Long-Term

Table 8.11 CIP Recommended Projects (Continued)

CIP ID	System Analysis ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose	Improvement Project		Capacity Project		Repair and Replacement Project			Seismic System		Project Phasing
									Yes/No	Year	Yes/No	Year	Reach RUL?	Year	Leakage?	Yes/No	Length (ft)	
D-79	FF-23	S Redland School Rd, S Redland Rd New Pipe	New pipe (parallel to 8") New Pipe	2,903 1,196	n/a n/a	12 8	S Redland School Rd from S Redland Rd to Redland Elementary School; S Redland Rd from S Norman Rd to S Marklund Dr.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Short-Term	No		No			Yes	2,903	Short-Term
D-80	CRW-110	Redland Road	Replace Pipe	2,063	8	8	Redland Road (Potter Road to Fieldson Road)	Model to determine future main size - (approx 2,500')	Yes	Long-Term	No		No			Yes	2,500	Long-Term
D-81	CRW-103	Ferguson Road (1)	Upsize Pipe	1,300	6	8	Ferguson Road (Redland Road to Beckman Road)	"Replace current 6" with 8" pipe.	Yes	Long-Term	No		No			No		Long-Term
D-82	CRW-115	Redland Road	Upsize Pipe	1,821	6	8	Redland Rd – Fischer Mills to Scotts Lane	Replace undersize 6" CI main. (approx. 2,200')	Yes	Long-Term	No		No			Yes	538	Long-Term
D-83	FF-60	S Jason Dr Pipe Upsize	Upsize Pipe	1,041	6	8	S Jason Dr from S Henrici Rd north to first hydrant at 20252 S. Jason Dr.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-84	FF-61	S Dans Ct Pipe Upsize	Upsize Pipe	1,656	6	8	S Dans Ct from S Dales Ave south to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-85	FF-62	S Lance Ct Pipe Upsize	Upsize Pipe	1,401	6	8	S Lance Ct from S Leland Rd north to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-86	FF-63	S Copley Ct Pipe Upsize	Upsize Pipe	1,871	6	8	S Copley Ct from S Ferguson Rd east to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-87	FF-64	S Henrici Rd (south of S Dillman Rd) Pipe Upsize	Upsize Pipe	4,256	4	8	S Henrici Rd from intersection with Backbone Phase 2 pipe north to S Dillman Rd.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-Term	No		No			Yes	900	Long-Term

CIP projects were identified based on the analyses presented in previous sections. Table 8.12 shows the detailed costs for both short- and long-term CIP projects in 2018 dollars. Costs were not escalated.

Table 8.12 also allocates projects between the capital project types (i.e., Improvement, Capacity, and Repair and Replacement). It provides a total cost and average annual cost for all CIP items as well.

An individual project sheet was generated for each CIP project and includes project identifier, description, costs, project type, timeline, and comments to help with future implementation. To help identify individual projects, project sheets are separated by project category. The project sheets are included in Appendix N.

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Table 8.12 CIP Project Summary Table

Capital Improvements Program Summary																	
Project		Total CIP Cost Estimate(2)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Short-term (2019-2028)	Long-term (2029-2036)	Project Type		
															Capacity	Repair & Replacement	Improvements
General (G)		**$650,000**	**$250,000**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$200,000**	**$450,000**	**$200,000**			
G-01	Water Treatment Plant and Seismic Facility Plan(1)	$250,000	$ 250,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$250,000	$ –	0%	0%	1000%
G-02	2028 Water System Master Plan(1)	$200,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$200,000	$ 200,000	$ –	0%	0%	100%
G-03	2038 Water System Master Plan(1)	$200,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 200,000	0%	0%	100%
Programmatic (P)		**$69,495,000**	**$2,283,000**	**$2,283,000**	**$2,283,000**	**$2,283,000**	**$2,283,000**	**$2,283,000**	**$2,283,000**	**$2,283,000**	**$2,283,000**	**$2,283,000**	**$22,830,000**	**$46,665,000**			
P-01	Remaining Useful Life Pipeline Program	$27,519,000	$2,283,000	$2,283,000	$2,283,000	$2,283,000	$2,283,000	$2,283,000	$2,283,000	$2,283,000	$2,283,000	$2,283,000	$22,830,000	$ 4,689,000	0%	100%	0%
P-02	Seismic System Pipe Program	$41,976,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$41,976,000	0%	100%	0%
Pressure Zone (PZ)		**$ 1,879,000**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$1,879,000**			
PZ-02	New Beavercreek Pressure Zone	$1,879,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$1,879,000	0%	0%	100%
Storage (ST)		**$5,950,000**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$700,000**	**$1,050,000**	**$5,250,000**			
ST-01	Seismic Isolation Valves at Existing Tanks	$700,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$700,000	$1,050,000	$ –	0%	0%	100%
ST-02	Storage Condition Evaluation	$250,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$250,000	0%	100%	0%
ST-03	Storage Repair & Rehabilitation	$5,000,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$5,000,000	0%	100%	0%
Pump Station (PS)		**$600,000**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$600,000**			
PS-03	Hunter Heights Pump Station	$350,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$350,000	0%	0%	100%
PS-04	Pump Station Condition Evaluation	$250,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 250,000	0%	100%	0%
PS-05	Pump Station Repair & Rehabilitation	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	0%	100%	0%
Distribution Pipeline (D)		**$66,807,000**	**$2,313,000**	**$ –**	**$ –**	**$4,967,000**	**$650,000**	**$4,111,000**	**$1,380,000**	**$2,021,000**	**$1,530,000**	**$ –**	**$16,972,000**	**$49,835,000**			
D-31	Barlow Crest New Pipe	$1,194,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$1,194,000	0%	0%	100%
D-32	S Brunner Rd Pipe Upsize	$1,207,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$1,207,000	0%	50%	50%
D-33	Forsythe Road (1)	$966,000	$ –	$ –	$ –	$ –	$ –	$966,000	$ –	$ –	$ –	$ –	$966,000	$ –	0%	1000%	0%
D-34	Forsythe Road (2)	$886,000	$ –	$ –	$ –	$ –	$ –	$886,000	$ –	$ –	$ –	$ –	$886,000	$ –	0%	100%	0%
D-35	Bradley Road	$664,000	$ –	$ –	$ –	$ –	$ –	$664,000	$ –	$ –	$ –	$ –	$664,000	$ –	0%	100%	0%
D-36	S Overlook Rd Pipe	$945,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$945,000	0%	50%	50%
D-37	S Archer Dr Pipe Upsize	$134,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$134,000	0%	0%	100%
D-38	S Holcomb Blvd Pipe Upsize	$675,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$675,000	0%	0%	100%
D-39	S Edgewood St Pipe Upsize	$389,000	$ –	$ –	$ –	$ –	$ –	$389,000	$ –	$ –	$ –	$ –	$389,000	$ –	0%	50%	50%
D-40	S Dick Dr and S Lucky Ln Pipe Upsize	$1,601,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$1,601,000	0%	50%	50%
D-41	S Clear Acres Dr Pipe Upsize	$348,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 348,000	0%	0%	100%
D-42	S Sandalwood Rd and S Brook Ct Pipe Upsize	$1,022,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$1,022,000	0%	50%	50%
D-43	S Wildflower Ln and S Pam Dr Pipe Upsize	$620,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$620,000	0%	0%	100%
D-44	S Neibur Rd Pipe Upsize	$1,788,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$1,788,000	0%	0%	100%
D-45	S Redland Rd New Pipe	$2,010,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$2,010,000	0%	0%	100%

Table 8.12 CIP Project Summary Table (Continued)

Capital Improvements Program Summary																	
Project		Total CIP Cost Estimate	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Short-term (2019-2028)	Long-term (2029-2036)	Project Type		
															Capacity	Repair & Replacement	Improvements
D-46	SE Beckman Rd New Pipe	$980,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$980,000	0%	50%	50%
D-47	S Burkstrom Rd Pipe Upsize	$301,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$301,000	0%	50%	50%
D-48	S Canter Ln Pipe Upsize	$ 743,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$743,000	0%	50%	50%
D-49	S Norman Rd, S Elida Rd/S Glisan Rd New Pipe	$1,178,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$1,178,000	0%	0%	100%
D-50	Fischers Mill Rd Upsize; S Hinkle Rd/S Kimball Rd New Pipe	$11,309,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$11,309,000	0%	0%	100%
D-51	S Dillman Rd Pipe Upsize	$390,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 390,000	0%	0%	100%
D-52	S Grasle Rd south of Team Ct Pipe Upsize	$199,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$199,000	0%	0%	100%
D-53	S North End Rd, S Terry Michael Dr New Pipe	$1,079,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$1,079,000	0%	0%	100%
D-54	S Thayer Rd, S Walker Rd, S Ferguson Rd Pipe Upsize	$4,743,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$4,743,000	0%	0%	100%
D-55	S Maplelane Rd New Pipe, New PRV Station	$3,012,000	$ –	$ –	$ –	$2,362,000	$ 650,000	$ –	$ –	$ –	$ –	$ –	$3,012,000	$ –	0%	0%	100%
D-56	S Maplelane Road	$347,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$347,000	0%	50%	50%
D-57	S Loder Rd, Thimble Creek Dr Pipe Upsize	$1,380,000	$ –	$ –	$ –	$ –	$ –	$ –	$1,380,000	$ –	$ –	$ –	$1,380,000	$ –	0%	50%	50%
D-58	S Ferguson Rd, S Heidi St Pipe Upsize	$1,288,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$644,000	$644,000	$ –	$1,288,000	$ –	0%	50%	50%
D-59	S Creek Rd Pipe Upsize	$932,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 932,000	0%	0%	100%
D-60	S Athens Rd, S Olympus Rd Pipe Upsize	$1,206,000	$ –	$ –	$ –	$ –	$ –	$1,206,000	$ –	$ –	$ –	$ –	$ 1,206,000	$ –	0%	50%	50%
D-61	Beavercreek Loop Connection	$1,033,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$1,033,000	$ –	$ –	$ 1,033,000	$ –	100%	0%	0%
D-62	Henrici Rd New Pipe; Henrici Tank PRV Station	$2,605,000	$ –	$ –	$ –	$2,605,000	$ –	$ –	$ –	$ –	$ –	$ –	$2,605,000	$ –	0%	0%	100%
D-63	Danny Ln Pipe Upsize	$ 511,000	$ 511,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 511,000	$ –	0%	50%	50%
D-64	S Saddle Ln Pipe Upsize	$393,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$393,000	0%	0%	100%
D-65	Woodglen Way, Crystal Ct Pipe Upsize	$ 536,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$536,000	0%	0%	100%
D-66	Beavercreek - Henrici Rd	$959,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 959,000	0%	0%	100%
D-67	S Quail Crest Ln Pipe Upsize	$ 344,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$344,000	$ –	$ –	$344,000	$ –	0%	50%	50%
D-68	S Mossy Rock Ct, S Greentree Dr Pipe Upsize	$ 676,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$676,000	0%	50%	50%
D-69	S Clear View Ct Pipe Upsize	$350,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 350,000	0%	0%	100%
D-70	S Farm Pond Ct Pipe Upsize	$ 330,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$330,000	0%	0%	100%
D-71	S Hawthorne Ct, S Firethorne Ct Pipe Upsize	$778,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$778,000	0%	50%	50%
D-72	S Lammer Rd Pipe Upsize	$ 886,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 886,000	$ –	$886,000	$ –	0%	50%	50%
D-73	S Levi Ct, S Levi Rd Pipe Upsize	$850,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 850,000	0%	0%	100%
D-74	S Leland Rd, S Beavercreek Rd Pipe Upsize	$ 2,216,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$2,216,000	0%	0%	100%
D-75	S Leslie Ave Pipe Upsize	$ 382,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 382,000	0%	0%	100%
D-76	S Kamrath Rd Pipe Upsize	$ 735,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 735,000	0%	0%	100%
D-77	S Ferguson Rd Pipe Upsize	$ 680,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$680,000	0%	0%	100%

Table 8.12 CIP Project Summary Table (Continued)

Capital Improvements Program Summary																
Project		Total CIP Cost Estimate	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Short-term (2019-2028)	Long-term (2029-2036)	Project Type		
															Capacity	Repair & Replacement	Improvements
D-78	Henrici	$520,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$520,000	0%	0%	100%
D-79	S Redland School Rd, S Redland Rd New Pipe	$ 1,802,000	$ 1,802,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 1,802,000	$ –	0%	0%	100%
D-80	Redland Road	$830,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 830,000	0%	0%	100%
D-81	Ferguson Road (1)	$ 1,006,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 1,006,000	0%	0%	100%
D-82	Redland Road	$ 733,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 733,000	0%	0%	100%
D-83	S Jason Dr Pipe Upsize	$419,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 419,000	0%	0%	100%
D-84	S Dans Ct Pipe Upsize	$ 667,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 667,000	0%	0%	100%
D-85	S Lance Ct Pipe Upsize	$ 564,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 564,000	0%	0%	100%
D-86	S Copley Ct Pipe Upsize	$ 753,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ 753,000	0%	0%	100%
D-87	S Henrici Rd (between Redland Rd and S Bogynski Rd) Pipe Upsize	$ 1,713,000	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$ –	$1,713,000	0%	0%	100%
Backbone (BB)		**$ 29,058,000**	**$ –**	**$5,833,000**	**$8,688,000**	**$8,704,000**	**$5,833,000**	**$ –**	**$ –**	**$ –**	**$ –**	**$ –**	**$29,058,000**	**$ –**			
BB-02	Backbone Phase 2	$ 29,058,000	$ –	$5,833,000	$8,688,000	$8,704,000	$5,833,000	$ –	$ –	$ –	$ –	$ –	$29,058,000	$ –	0%	0%	100%
CIP Total		**$174,439,000**	**$4,846,000**	**$8,116,000**	**$10,971,000**	**$15,954,000**	**$8,766,000**	**$6,394,000**	**$3,663,000**	**$4,304,000**	**$3,813,000**	**$3,183,000**	**$70,010,000**	**$104,429,000**	**$1,033,000**	**$84,813,000**	**$87,943,000**
Annual Cost		$ 8,722,000	$4,846,000	$8,116,000	$10,971,000	$15,954,000	$8,766,000	$6,394,000	$3,663,000	$4,304,000	$3,813,000	$3,183,000	$7,010,000	$10,443,000	$52,000	$4,241,000	$4,397,000

Notes:

(1) General project costs from recommended Plans and Studies were allocated between the North System and South System.

(2) The Total Project cost in this table include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for planning contingency added over the Baseline Construction Costs from the unit costs.

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8.4.3 Short-Term Recommended CIP Projects

The South System projects expected to be completed in the short-term are as follows:

- G-01: Water Treatment Plant and Seismic Facility Plan:
  - Description: Develop a Water Treatment Plant and Seismic Facility Plan.
  - Purpose: Review status of aging water treatment plant, identify improvements, and help prepare CRW for seismic events and increase the system's seismic resiliency.
  - Timing: 2019
  - Note: This project is split between the North System and South System
- G-02: 2028 Water System Master Plan:
  - Description: Develop an updated Water System Master Plan.
  - Purpose: Complete a 10-year master plan update.
  - Timing: 2028.
  - Note: This project is split between the North System and South System.
- P-01 – Remaining Useful Life Pipeline Program:
  - Replace pipelines past their useful life based on pipe material and pipe installation year. Pipes listed in this program will reach their remaining useful life within the planning horizon (2019-2038).
  - Timing: 2019-2028.
- ST-01 – Seismic Isolation Valves at Existing Tanks:
  - Description: Install seismic isolation valves at the Hunter Heights Reservoir (large) and the Henrici reservoir.
  - Purpose: Provide seismic resiliency to the reservoirs.
  - Timing: 2028.
  - Project Type: Improvement.
- D-33 – Forsythe Road (1):
  - Description: Forsythe Road (Hunter Avenue to Highland Road) upsizing current 6-inch pipe to 8-inch Pipe.
  - Purpose: Pipe has reached its remaining useful life.
  - Timing: 2024.
  - Project Type: Repair & Replacement.
- D-34 – Forsythe Road (2):
  - Description: Upsize current 6-inch pipe on Forsythe Road (Highland Road to Brunner Road) to 8 inch.
  - Purpose: Pipe has reached its remaining useful life.
  - Timing: 2024.
  - Project Type: Repair & Replacement.
- D-35 – Bradley Road:
  - Description: Upsize current 2-inch, 4-inch, and 6-inch pipe to 8-inch pipe on Bradley Road (North from Forsythe Road).
  - Purpose: Pipe has reached its remaining useful life.
  - Timing: 2024.
  - Project Type: Repair & Replacement.
- D-39 – S Edgewood St Pipe Upsize:
  - Description: Replace existing 6-inch pipe with 8-inch pipe on S Edgewood St from S Edgewood Ln west to end of street.

  - Purpose: Pipe has reached its remaining useful life. Project is also recommended to provide fire flow.
  - Timing: 2024
  - Project Type: Repair & Replacement and Improvement
- D-55 – S Maplelane Rd New Pipe, New PRV Station:
  - Description: Install new pipe on S Maplelane Rd to connect existing pipes from S Walker Rd to S Waldow Rd. Portions of the pipe will be installed parallel to existing pipe, and portions of the pipe will include a new river crossing. Approximately 2,100 feet of 8-inch pipe will be parallel to the existing 4-inch pipe. The 6-inch pipe will be parallel to the existing 6-inch pipe. Install a new PRV station between the Redland and Henrici pressure zone. Alternatively, this project could be placed on Ferguson Rd and Thayer Rd.
  - Purpose: Address low pressures in the vicinity and convey water from the Redland zone to the Henrici zone via a PRV; this project supplements the proposed PRV station from the Redland to the Henrici Zone.
  - Timing: 2022-2023.
  - Project Type: Improvement.
- D-57 – S Loder Rd, Thimble Creek Dr Pipe Upsize:
  - Description: Replace existing 6-inch pipe with 8-inch pipe on S Loder Rd, S Thimble Creek Dr, and S Merry Lane Dr.
  - Purpose: Pipe has reached its remaining useful life. Project is also recommended to provide fire flow.
  - Timing: 2025.
  - Project Type: Repair & Replacement and Improvement.
- D-58 – S Ferguson Rd, S Heidi St Pipe Upsize:
  - Description: Replace existing 4-inch and 6-inch pipe with 8-inch pipe on S Ferguson Rd from S Moore Rd to S Heidi St, S Heidi St to S Annette Dr, S Annette Dr, and S Rachel Ct.
  - Purpose: Pipe has reached its remaining useful life. Project is also recommended to provide fire flow.
  - Timing: 2026-2027.
  - Project Type: Repair & Replacement and Improvement.
- D-60 – S Athens Rd, S Olympus Rd Pipe Upsize:
  - Description: Replace existing 4-inch and 6-inch pipe with 8-inch pipe on S Athens Rd from S Henrici Rd to end of street, and S Olympus Rd from S Athens Rd to the end of street.
  - Purpose: Pipe has reached its remaining useful life and was flagged by CRW as a pipeline with reported leakage. Project is also recommended to provide fire flow.
  - Timing: 2024.
  - Project Type: Repair & Replacement and Improvement.
- D-61 – Beavercreek Loop Connection:
  - Description: Create a loop by installing new 12-inch pipe along S Mountain Meadow Rd from S Sunrise Ln to S Mompano Overlook Dr.
  - Purpose: Fix the low pressure area in the Beavercreek Pressure Zone.
  - Timing: 2026.
  - Project Type: Capacity.

- D-62 – Henrici Rd New Pipe; Henrici Tank PRV Station:
  - Description: Install 12-inch pipe parallel to existing 6-inch pipe on Henrici Rd from Beavercreek Rd to S Ferguson Rd; install new PRV station at Henrici Reservoir with new 12-inch pipe.
  - Purpose: Address low pressures nearby.
  - Timing: 2022.
  - Project Type: Improvement.
- D-63 – Danny Ln Pipe Upsize:
  - Description: Replace existing 6-inch pipe with 8-inch pipe on S Danny Ct from S Henrici Rd north to end of pipe.
  - Purpose: Pipe has reached its remaining useful life and was flagged by CRW as a pipeline with reported leakage. Project is also recommended to provide fire flow requirements.
  - Timing: 2019.
  - Project Type: Repair & Replacement and Improvement.
- D-67 – S Quail Crest Ln Pipe Upsize:
  - Description: Replace existing 6-inch pipe with 8-inch pipe on S Quail Crest Ln to the end of the pipe.
  - Purpose: Pipe will reach its remaining useful life in 2020. Project is also recommended to provide fire flow.
  - Timing: 2026.
  - Project Type: Repair & Replacement and Improvement.
- D-72 – S Lammer Rd Pipe Upsize:
  - Description: Replace existing the 6-inch pipe with 8-inch pipe on S Lammer Rd from S Beavercreek Rd west to the end of the street.
  - Purpose: Pipe has reached its remaining useful life and was flagged by CRW as a pipeline with reported leakage. Project is also recommended to provide fire flow.
  - Timing: 2027.
  - Project Type: Repair & Replacement and Improvement.
- D-79 – S Redland School Rd, S Redland Rd New Pipe:
  - Description: Install new 8-inch pipe on S Redland School Rd from S Redland Rd to Redland Elementary; install new 12-inch pipe, parallel to the existing 8-inch pipe, on S Redland Rd from S Norman Rd to S Marklund.
  - Purpose: Provide fire flow to Redland elementary school. Additionally approximately 2,900 feet of this pipeline was established as part of the seismic system.
  - Timing: 2019.
  - Project Type: Improvement.
- BB-02 – Backbone Phase 2:
  - Description: Install new 16-inch Transmission Main on Grasle Rd; install new 3-MGD Beaver Lake Pump Station; install new 12-inch Transmission Main on Bradley Rd ; install new 1.25-MGD Bradley Rd Pump Station; install new 2.5-MG Beavercreek Elevated Reservoir.
  - Timing: 2020-2024.
  - Project Type: Improvement.

Appendix A

OHA COMMENT LETTERS AND ADOPTION RESOLUTION

Appendix B

SOUTH FORK WATER BOARD – SETTLEMENT AGREEMENT

SETTLEMENT AGREEMENT AND MUTUAL RELEASE

This Settlement Agreement and Mutual Release ("Agreement"), effective as of May 13, 2010, is entered into by and between South Fork Water Board ("South Fork"), a cooperative governmental body organized under ORS Chapter 190, and Clackamas River Water, a domestic water supply district organized under ORS Chapter 264 ("CRW").

WHEREAS, South Fork has provided wholesale water to CRW and its predecessor, Clairmont Water District, since 1960 for purposes of supplying domestic water to the residents within CRW's territory on the south side of the Clackamas River.

WHEREAS, in 1984, South Fork and Clairmont Water District entered into a long term water supply agreement ("Clairmont Agreement"), which agreement was assigned to and assumed by CRW at the time of its organization in 1995. The Clairmont Agreement either expired or was terminated as of July 1, 1998.

WHEREAS, since 1998, South Fork has continued to supply wholesale water under an implied contract and periodically increased the rate upon providing notice of such rate increases. In 2008, South Fork provided such notice to CRW with the intent of having a new wholesale water rate in the amount of $.805 per ccf go into effect as of September 1, 2008 ("2008 Rate"). CRW objected to the 2008 Rate but continued to pay for water supplied by South Fork at the previous rate. The parties were unable to agree on the issue and a dispute arose between the parties as to the utilization of the 2008 Rate.

WHEREAS, on or about May 1, 2009, South Fork filed an action against CRW in the Clackamas County Circuit Court, Case No. CV 09-050114, seeking payment from CRW at the 2008 Rate for the South Fork wholesale water supplied to CRW since September 1, 2008 (the "Action").

WHEREAS, in due course CRW filed its answer, affirmative defenses and counterclaims for discriminatory pricing and monopolization under antitrust laws. On or about April 26, 2010, CRW voluntarily dismissed, with prejudice, its counterclaims for discriminatory pricing and monopolization under the antitrust laws.

WHEREAS, on April 28, 2010 the parties engaged in the second judicial settlement conference. As a result of the settlement conference, the parties arrived at an agreement in concept relating to South Fork's claim for an increased wholesale water rate, which concepts were placed on the court record but were made subject to a final written settlement agreement to be reviewed by the boards of the respective public entity parties. Subject to the reservation of rights and defenses with respect to a claim for attorney fees, this Agreement is intended to document the parties' full and final settlement agreement and release with respect to all claims, counterclaims and defenses with respect to the Action.

NOW THEREFORE, in consideration of the promises and other good and valuable consideration, the sufficiency and receipt of which are hereby acknowledged, and intending to be legally bound, the parties to this Agreement covenant and agree as follows:

1. **Payment for Water Supplied from September 1, 2008 to March 31, 2010.** For wholesale water deliveries during the period from September 1, 2008 through March 31, 2010 , CRW shall pay South Fork for the wholesale water supplied by South Fork the amount of $33,846.70, which is based on the rate of $.74 per hundred cubic feet (ccf) . Payment by CRW of this amount to South Fork shall be made by May 15, 2010.

2. **Rate for Water Supplied April 1, 2010 to June 30, 2011.** For wholesale water supplied to CRW by South Fork for the period from April 1, 2010 through June 30, 2011, CRW shall pay South Fork at the rate of $.74 per hundred cubic feet (ccf) of

water delivered. Payments by CRW on future invoices from South Fork, shall be paid within 20 days after the date of the invoice.

3. **Future Rates.** For wholesale water supplied to CRW by South Fork beginning July 1, 2011, the rate shall be established in accordance with the procedure identified below in this Agreement and CRW shall pay in accordance with such procedure.

4. **Future Rate Establishment Process.** For the period from July 1, 2011 through June 30, 2014, and for each three year period thereafter, South Fork will perform rate analysis that sets forth the applicable rate for the applicable three year period ("Future Rates"). Such analysis shall be performed on a "utility basis" methodology using the AWWA Manual as a guideline for such rates. Future Rates' analysis shall use a rate of return on equity and determination of the peak day factors as set forth below. Future Rates shall be subject to adjustment based on the review of the rate analysis by the parties. In the event there is an issue with respect to the rate analysis, the parties shall attempt to resolve the matter initially through negotiation and agreement. In the event the parties are unable to resolve the rate through negotiation and agreement, the parties shall resolve the matter through dispute resolution. Provided that future rate analyses follows the format and include the cost factors and allocation as contained in the July 24, 2008 HDR Engineering rate analysis ("2008 Rate Analysis"), the matters that may be contested will be limited to the administrative costs charged to CRW and the cost allocation of beneficial use of the Mountain View reservoir and Division Street pump station serving CRW. CRW payments for the purchase of water from South Fork beginning in 2011/2012 will be subject to an adjustment for deviations between actual and budgeted expenditures as set forth below ("True Ups"),

5. **Future Rate Assumptions.** All Future Rates' analyses, unless otherwise mutually agreed to by the parties, shall be subject to the following assumptions and background information:

   a. South Fork shall use the same rate of return on equity that is used by CRW for the majority of its wholesale customers. The parties agree that such rate in 2009 is nine percent (9%).

   b. South Fork shall apply the peak day factor used in the 2008 Rate Analysis, provided that such peak day factor may be adjusted in the event that the demand or commodity factors used in calculating peak day factor change justifies a change in the peak day factor.

6. **True Ups.** At the conclusion of each fiscal year, commencing with the conclusion of the 2011/2012 fiscal year, there will be a "True Up". That is, South Fork will conduct a review of actual costs and revenues versus budgeted costs and revenues for the preceding fiscal year and the difference between the budgeted costs and the actual costs will be determined. In the event such review determines a difference of five percent (5%) or more between the budgeted costs and the actual costs, the True Up shall be made as follows: 1) if the budgeted costs exceeded the actual costs CRW shall receive a credit for the difference with such credit to be applied in equal amounts against future invoices for the remainder of the then current fiscal year; and 2) if the budgeted costs are less than the actual costs, CRW shall pay South Fork such difference in equal amounts with each future invoices for the remainder of the then current fiscal year. The financial information regarding actual costs and revenues and budgeted costs and revenues for the

applicable year shall be provided by South Fork to CRW at the close of each fiscal year or as soon thereafter that is practicable.

7. **Notification of Future Rates and Objections.** Prior to implementation of a Future Rate, South Fork shall provide CRW with written notice of the Future Rate, the rate analysis and supporting data or documents as soon as practicable. It is the intent that the parties identify the applicable rates as soon in the budgeting process as possible with the understanding that the rate will initially be based on costs as budgeted in an approved budget. The parties understand that this information may not be available until close to the end of the budget period which is required under the law to be completed by June 30 of each fiscal year. Upon receiving notice of a Future Rate, CRW shall have 90 days to accept or reject the Future Rate. Any objection by CRW to the Future Rate must be in writing identifying the basis or bases on which CRW is objecting. In the event CRW does not object in writing to the proposed rate within ninety (90) days after receipt of the Future Rate, CRW shall be considered to have accepted the Future Rate. If CRW timely objects to a Future Rate, the parties shall attempt in good faith to negotiate the applicable rate within thirty (30) days after the date CRW submits its written objections. South Fork shall provide any background data not submitted with the initial rate analysis that is the subject of CRW's objections. In the event that parties have not resolved the Future Rate to be charged during the thirty (30) day period, either party may request arbitration by written notice to the other party. Such arbitration shall be final and binding. The arbitration shall be conducted in accordance with the rules of the Arbitration Service of Portland, but not through the Arbitration Service of Portland, unless otherwise agreed by the parties, provided that the time frames for the arbitration shall be as provided in this Agreement. The parties shall attempt to agree on an arbitrator within ten (10) days after

the date of written notice requesting arbitration. In the event the parties cannot agree on an arbitrator within ten (10) days after the date of the letter requesting arbitration, either party may request an arbitrator to be appointed by the Presiding Judge of Clackamas County Circuit Court. Any arbitrator appointed shall meet the qualifications of the arbitrator as described herein. An arbitrator shall be someone a) independent from either of the parties and not having provided rate analysis consulting services to either of the parties for a minimum of the previous 10 years, b) having not less than 15 years of experience in wholesale water or waste water rate analysis, and c) familiar with the American Water Works Association (AWWA) Manual on setting wholesale water rates and the utility basis authorized by such Manual. The arbitrator shall be appointed not less than forty five (45) days after the date of the letter requesting arbitration. Once appointed, unless otherwise agreed by the parties, the arbitrator shall establish the briefing submittal schedule, the hearing date and other matters such that the arbitration decision is issued within 45 days after the date the arbitrator is appointed. Each party shall bear its own costs and expenses associated with the arbitration process, provided that the fee of the arbitrator shall be shared equally by the parties. Nothing stated herein shall prevent the parties from resolving the matter through agreement during the arbitration process. During any period of dispute, CRW shall continue to pay the wholesale rate previously in effect as of the date immediately prior to the written notice of the Future Rate. Any Future Rate established by negotiation or through arbitration shall be effective as of July 1 of the applicable year.

8. **Further Agreement.** Future Rates may also be subject to adjustment based on a further agreement(s) of the parties and North Clackamas County Water Commission (NCCWC) through implementation of the Intergovernmental Cooperative Agreement for

Construction of Water Transmission Line with an effective date of April 24, 2000 ("Pipeline B Agreement") and the companion Joint Operation Plan with a footer date of July 2001 ("JOP"). It is the intent of the parties that the implementation of the Pipeline B Agreement and the JOP is to provide the parties and NCCWC an opportunity to identify and implement, through the cooperative process outlined in such documents, more cost effective water delivery methods or systems to wholesale and retail customers of each entity. Any such alternative delivery methods or systems are subject to the review and agreement of the parties hereto and NCCWC ("Further Agreement") . In the event all parties agree to a Further Agreement and CRW reasonably believes would impact Future Rates, CRW may commission, at its own cost and expense a new rate analysis upon which to base Future Rates or cause an adjustment to an existing rate due to implementation of such Further Agreement. If the parties cannot reach an agreement on a Future Rate based upon a Further Agreement, such disagreement on the applicable rate shall be resolved as provided for in section 7 above regarding objections to Future Rates.

9. **Dismissal of Action.** The parties intend to submit this Agreement to the respective governing bodies for consideration at the respective public meetings to be held on May 13, 2010. In the event each governing body approves this Agreement, counsel for the respective parties shall obtain signatures from the applicable authorized representative. Within five business days after counsel for the parties receive a fully executed copy of this Agreement, the parties shall execute a stipulation of dismissal of the Action, with prejudice as to all claims, defenses and counterclaims, reserving the right to make a claim, if any, for attorney fees and any defenses or counterclaims with respect to attorney fees associated with the Action, which claim shall be filed pursuant to Oregon Rules of

Civil Procedure, Rule 68. Nothing stated herein shall be construed or implied as a right or entitlement to attorney fees as a result of this Agreement.

10. **Notice.** Any notice required or to be given pursuant to this Agreement shall be deemed valid notice if given by certified mail, return receipt requested, or by facsimile provided that the sending facsimile machine has an operating electronic confirmation printout indicating an acceptable transmission and receipt. All such notices shall be addressed as follows provided that either party may, by written notice to the other party, change the person or contact information of the individual who is to receive such notice:

If to South Fork:
Office of General Manager
15962 S. Hunter Ave.
Oregon City, OR 97045

Facsimile #: 503-656-9336

If to CRW:
Lee Moore, General Manager
16770 SE 82nd Dr.
Clackamas, OR 97015

Facsimile #: 503-656-7086

with copy to CRW's Registered Agent. As of the execution of this Agreement the Registered Agent is Dean M. Phillips, Attorney, P.O. Box 510, Eagle Creek, Oregon 97022.

11. **Release.** Except for the claims and defenses relating to attorney fees associated with the Action, as reserved in paragraph 9 above, South Fork and CRW (on behalf of themselves individually and all of their respective successors, predecessors, assigns, commissioners, directors, officers, stockholders, employees and agents) hereby release and forever discharge each other (and all of their respective successors, predecessors, assigns, commissioners, directors, officers, stockholders, employees and agents) from and for any and all claims, demands, liabilities, sums of money, losses and causes of action of

any nature whatsoever, whether or not known, suspected or claimed, which either party ever had, now has, or may have arising out of or in any way relating to the Action, whether or not such claim, demand, liability, sum of money, loss or cause of action has been or could have been previously asserted.

12. **Illegality/ Enforceability.** The illegality or unenforceability of any provisions or any part of any provisions of this Agreement shall not affect or impair the validity, legality, or enforceability of any other provision or any other part of any provision.

13. **Counterparts.** This Agreement may be signed in multiple counterparts, all of which shall be taken together as a single instrument. Signatures presented by facsimile transmission shall be deemed effective at the time of transmission and shall be replaced by original signatures as soon thereafter as possible.

14. **Authority.** Each party hereby signing this Agreement warrants that it has the full authority to act and to execute this Agreement on behalf of the applicable party.

15. **Governing Law.** This Agreement shall be construed according to the laws of the State of Oregon.

16. **Construction.** Each party acknowledges that it has read the Agreement, has participated in its negotiation, understands its contents and has obtained the assistance of legal counsel of its choice. The terms of this Agreement are contractual and not mere recitals. Any rule of law or construction wherein ambiguities would be construed against its drafter shall not apply and is affirmatively waived by the parties to this Agreement.

17. **Costs and Expenses.** Each party agrees to bear its own costs, expenses and fees, including attorney's fees with respect to the negotiation, preparation and review of this Agreement.

18. **Compromise and Settlement.** It is expressly understood that this Agreement is made in compromise of disputes and claims, and that this Agreement is not to be construed as an admission of liability on the part of any party to this Agreement.

IN WITNESS WHEREOF, the parties have executed this Agreement as shown by their respective signatures below.

SOUTH FORK WATER BOARD

By ______________________

Date: 5/24/10

PDX_DOCS:450149.1 [37877-00100]
05/5/10 5:01 PM

CLACKAMAS RIVER WATER

By ______________________

Date: 5-20-2010

Appendix C

OREGON CITY – CLACKAMAS RIVER WATER COOPERATIVE INTERGOVERNMENTAL AGREEMENT, 1998

EXPIRATION DATE: 04/22/2028
Term: 30 yrs
Date Executed: 04/22/98

ORIGINAL

INTERGOVERNMENTAL COOPERATIVE AGREEMENT

This Intergovernmental Cooperative Agreement ("Agreement") is entered into by and between the CITY OF OREGON CITY ("City"), an Oregon municipal corporation, and CLACKAMAS RIVER WATER ("CRW"), a domestic water supply district created pursuant to ORS Chapter 264, and successor to the Clairmont Water District.

RECITALS

WHEREAS, the City and Clairmont Water District first entered into an Intergovernmental Cooperative Agreement in 1989 (the "1989 Agreement") to allocate the respective rights and responsibilities of the parties with regard to the provision of domestic water service to the territory known as the Holcomb-Outlook-Park Place Health Hazard Area ("HOPP Area") more precisely described in the 1989 Agreement; and

WHEREAS, the parties renewed and modified the 1989 Agreement by mutual written consent entered into July 15, 1992 (the "1992 Renewal"); and

WHEREAS, the 1989 Agreement, as modified by the 1992 Renewal, expires on June 30, 1998, and the parties desire to terminate the 1989 Agreement and enter into this new Agreement, to, among other things, provide a specific allocation of rights and responsibilities and a schedule for construction of jointly owned infrastructure to provide urban level water service in the HOPP Area above the 200-foot elevation contour, in two Urban Reserve Areas designated by Metro north and east of the Urban Growth Boundary ("UGB") north of the HOPP Area, and to a portion of CRW's service territory north and east of the UGB, all as more specifically described in the Memorandum of Understanding between the parties (the "MOU"); and

WHEREAS, on July 1, 1995, CRW succeeded to the obligations and rights of the Clairmont Water District; and

WHEREAS, the parties intend to designate service providers in the HOPP Area, provide for orderly service delivery and annexation to the City and assure that CRW will be able to amortize and recover the costs of its system investment in urban level water improvements it makes in the HOPP Area during the term of this Agreement;

WHEREAS, based upon the foregoing, the parties sharing common boundary or other service areas, and the parties intend this Agreement to fix present and future water service delivery boundaries and designate providers of water service and conformance with ORS 195.060 through 195.085, and that this Agreement shall be adopted and submitted for acknowledgement as part of the City's periodic review of its Comprehensive Plan and Land Use Regulations; and

WHEREAS, in negotiating this Agreement, the parties have considered the factors of ORS 195.070, and that this Agreement will assure continuance of and appropriate and adequate level of water service; and

WHEREAS, the parties have the authority to enter into this Agreement pursuant to their respective Charter or principal acts and ORS 190.003 through 190.030,

NOW THEREFORE, the premises being generally stated in the foregoing Recitals, the parties Agree as follows:

1. **Exhibits.** The following exhibits, attached to this Agreement, are specifically incorporated herein by this reference:

Ex. #	Document
1	Memorandum of Understanding, HOPP Area Water Service Plan, Oregon City/Clackamas River Water, February, 1998
2	February 24, 1998 Updated Engineering Work Program Murray Smith & Associates
3	Legal description of the Barlow Crest Phase Two subdivision property, on the Preliminary Plat

2. **Termination of the 1989 Agreement.** The 1989 Agreement, as modified by the 1992 Renewal, is hereby terminated, effective upon the date this Agreement is executed. This Agreement shall be the sole Agreement of the parties effective on execution according to the terms herein.

3. **Water Service Area Identified.** This Agreement shall govern the provision of water service in the area generally identified and illustrated in Figure 1 (the "Service Area") to the MOU (Exhibit 1). The exact boundaries of the Service Area shall follow established legal lot boundaries that most closely approximate the general boundaries illustrated in Figure 1 to the MOU. Subject to paragraph 4, CRW shall provide water service to territories within the Service Area until their annexation into the City. CRW shall continue to provide service to lands identified in the MOU within its boundary that adjoin the corporate limits of the City.

4. **City as Service Provider to Areas A-2 and A-3.** CRW currently has service responsibility for water service in the areas designated as A-2 and A-3, illustrated on Figure 1 to the MOU. CRW shall continue to be the immediate water service provider within Areas A-2 and A-3 and the City agrees to wheel water through its system for these areas; provided however, that at any time during the period of this Agreement, when the City has annexed not less than 75% of the territory of Area A-2, then the City shall operate and maintain water facilities to serve all properties within Area A-2, and operate and maintain Area A-3 under separate agreement.

5. **Memorandum of Understanding-Joint Planning and Project Implementation.** The MOU (Exhibit 1) is hereby adopted as the primary description, and construction of the Basic Facilities to be designed and constructed by the parties to provide water to the Service Area. The parties agree to jointly plan for services in the Urban Reserve Areas. The City and CRW shall cooperate in the planning and implementation of the construction of six key Basic Facilities (the "Basic Facilities") described in the MOU through a single joint project in accordance with the schedule and phasing set forth in the MOU. For purposes of this Agreement, the Basic Facilities and their respective funding sources shall be:

Basic Facility	Funding
1. Hunter Avenue Pump Station (1,800 gpm expandable to 2,500 gpm and Master Meter)	City and CRW
2. Holcomb Road Transmission Piping (16-inch diameter) and Forsythe Road Master Meter	City and CRW
3. Barlow Crest Reservoir (1.75 mg) and Lower Level CRW Master Meter	City and CRW
4. Barlow Crest Pump Station (900 gpm) and Upper Level District Master Meter	CRW
5. South Fork Water Board Hunter Avenue Transmission Piping Improvements (42-inch diameter)	City and South Fork Water Board
6. Oregon City HOPP Pressure Zones 1 and 2 Intertie Facilities	City

6. **Project Funding.** The parties agree to fund the engineering and construction of the Basic Facilities described in the MOU and authorized by this Agreement. The allocation of financing responsibility for engineering and construction of the Basic Facilities shall be according to the percent allocation set forth in the MOU and the February 24, 1998 Updated Engineering Work Program (the "Work Program"), Exhibit 2. The allocations set forth in the MOU and Work Program shall be based on final project construction costs. The Basic Facilities constructed will be jointly owned in proportion to the allocation of cost for the life of the Agreement. The parties agree that joint ownership of Basic Facilities beyond the term of this Agreement shall be subject to future negotiation.

7. **City to Serve as Contract Administrator.** For purposes of the work authorized by this Agreement and described in the MOU, the City shall function as the contract administrator and shall serve as the primary contracting public agency. CRW and the City shall jointly prepare and review, design and construction documents prior to bid. CRW shall be invited to project meetings and shall be given progress reports by the City with opportunity for comment. Change orders that increase CRW's share by more than $10,000 per change or $50,000 aggregate must be approved by CRW prior to authorization by the City. The City shall receive invoices for the various project-related costs from the various responsible contractors and shall calculate the respective financial responsibility of CRW and SFWB and shall forward to these parties invoices

for payment of these amounts. The City shall transmit the Engineer's Certification for Payment and other progress payment information if requested. Payment shall be due within 30 days of invoice. At the completion of each Basic Facility, the City shall provide a final project accounting to ensure that the financial allocations set forth in the MOU and the Work Program are met with respect to final project construction costs. All performance and payment bonds and guarantees shall be for the benefit of CRW and the City.

8. Project Engineering. The parties agree that the engineering firm of Murray, Smith & Associates, Inc. ("MSA") shall serve as the project engineer for project work described in the MOU and authorized by this Agreement. The City and CRW shall share proportionately the engineering expenses billed by MSA beginning January 1, 1998. The City shall be responsible for payment of engineering expenses billed by MSA prior to January 1, 1998.

9. Site Acquisition for the Barlow Crest Reservoir and Pump Station. The City shall be responsible for acquiring sufficient real property for the location of the Barlow Crest Reservoir and Pump Station. Upon obtaining title to the property upon which is situated the Barlow Crest Pump Station, the City agrees to grant and convey to CRW a permanent easement for the pump station, piping, appurtenances and facilities, and ingress and egress so that CRW may operate, maintain, repair, and replace the facilities. The parties agree to execute and record the necessary easement documents to effectuate this purpose as soon as reasonably practical after the City is vested with fee title. CRW shall not be obligated to pay any cost for the acquisition or development of this site beyond the allocation set forth in the MOU and Work Program. These allocations establish City cost responsibility for "Basic Facilities" (buried water piping and power conduits) across the proposed Barlow Crest Phase 2 subdivision.

10. Master Meters. The work provided for in this Agreement includes the installation of four master meter stations, the locations of which are shown on Figure 1 of the MOU and are as follows:

Master Meter	Funding
1. Hunter Avenue	City and CRW split in same proportion as Hunter Avenue pump station
2. Forsythe Road	City and CRW split in same proportion as Holcomb Road transmission piping
3. Lower Level District Master Meter	City and CRW split in same proportion as Barlow Crest Reservoir
4. Upper level District Master Meter	CRW

a. Meter Operation and Maintenance Costs. Operation and maintenance costs for each master meter shall be allocated on a pro rata basis in proportion to the water flow through each meter attributable to each party. Operation and maintenance costs shall be accounted for on an annual basis.

b. Meter Station Ownership. The City shall be the owner of all of the master meters proposed in this Agreement.

c. Meter Reading and Billing. The City shall be responsible for meter reading, billing and annual accounting. The meters shall be calibrated annually and inspected. CRW shall have the right to inspect and test the meters at its cost upon seven days' written notice to the City.

d. Future Meter Relocations. Meters shall be sized, located and installed so as to minimize the need for future relocations. In the event a meter must be moved due to expanding or shifting service territories or as land is annexed, meters may only be moved after 75% of the Area (A-2) is annexed. The City shall pay the cost of moving master meters.

11. **System Development Charge Collection and Distribution.** The City will collect an SDC on behalf of CRW for all areas that are within the City's corporate limits and within CRW's service territory.

12. **Wheeling Agreement.** CRW and the City agree that the City shall wheel water through the newly constructed system to deliver water to CRW's system. The cost of wheeling the water will be based upon the pro rata share of operating, maintaining, repair and replacement of the jointly-constructed and owned facilities, and is to be accomplished by a separate agreement. CRW shall pay SFWB based upon the amount of water delivered through the master meters pursuant to a separate agreement. The City agrees to wheel water through the Basic Facilities to allow CRW to provide service to Areas A-4, A-5 and A-6, up to the design rate of the Basic Facilities (900 gpm). The parties agree to negotiate an equitable arrangement for water demand beyond this rate. It is the intent of the parties that the City continue to wheel water through the Basic Facilities to serve CRW beyond the term of this Agreement.

13. **CRW Distribution Piping.** As part of Basic Facilities outlined in the MOU, CRW will construct a distribution piping improvement extending from the Barlow Crest Reservoir northerly to existing CRW piping on Forsythe Road. This pipeline will be funded and constructed by CRW. If Area A-2 should be incorporated within Oregon City's urban growth boundary and Oregon City annexes 75% of that area, then at that time, the City may withdraw this improvement and shall pay for said improvement based upon the depreciated value over a 50 year service life.

14. **Urban Services Agreement and Service Boundary.** The parties hereby adopt and agree that the domestic water service boundary for the City for the term of this Agreement shall be subject to the withdrawal terms set forth in this Agreement. The parties agree that when annexed and withdrawn according to the terms of this Agreement, the City shall provide and be responsible for all aspects of water service including, but not limited to, source treatment, storage transmission, financing, and all other acts necessary, customary, and incidental to providing retail water service in the areas described. Area A-1 shall immediately become part of the City service territory upon construction of the Basic Facilities. Area A-2 will become the City's service territory upon meeting the 75% annexation test threshold. CRW shall charge all customary fees and charges and its retail service rate until transferred to the City in accordance with this Agreement. All improvements constructed by CRW within areas which may be annexed by the City shall be constructed in accordance with all applicable City standards.

Consistent with ORS 195.020 and coordination agreements that may be executed as part of the ORS Chapter 195 coordination process, CRW agrees to adopt capital improvement plans and public facilities plans in accordance with state-wide planning goals for use in the applicable Comprehensive Plan and Review Development Plans to provide retail water service to users and meet the requirements of the Comprehensive Plans and Land Use Regulations adopted by the City or Clackamas County, as applicable.

The parties agree that the potential transfer of area to City will not have a substantial impact upon CRW's operation or employees. Notwithstanding ORS 236.610, if the City annexes and withdraws to its service boundary as set forth above and provides direct water services in that area, then no transfer of CRW employees to the City shall occur. Similarly, the parties agree that provision by CRW will not cause any transfer of City employees to CRW.

15. Effective Date, Term and Periodic Review. This Agreement shall be effective beginning on the last below signed date, and shall terminate 30 years from the effective date, unless extended or terminated at a different date by mutual agreement. The parties shall review the terms of this Agreement every five years as part of the City's Periodic Review under ORS 197.610 and may amend the Agreement, but only by the mutual written consent of the parties. Any action by Metro or other authority with jurisdiction over matters affecting this Agreement shall trigger a review of the Agreement by the parties. No such actions, however, shall affect this Agreement unless it is so amended by mutual written consent of the parties.

16. Dispute Resolution.

a. Subject to extensions of time by mutual consent in writing, failure or unreasonable delay by any party to substantially perform any provision of this agreement shall constitute default. In the event of an alleged default or breach of any term or condition of this agreement, the party alleging such default or breach shall give the other party not less than 30 days notice in writing specifying the nature of the alleged default and the manner in which the default may be cured satisfactorily. During this 30-day period, the party in charge shall not be considered in default for purposes of termination or instituting legal proceedings.

b. The parties shall first attempt to resolve the dispute by negotiation, followed by mediation, if negotiation fails to resolve the dispute.

Step One: (Negotiation)

The City Manager and General Manager or other persons designated by each of the disputing parties will negotiate on behalf of the entities they represent. Each Manager who shall then meet and attempt to resolve the issue. If the dispute is resolved at this step, there shall be a written determination of such resolution, signed by each Manager and ratified by the governing bodies which shall be binding upon the parties.

Step Two: (Mediation)

If the dispute cannot be resolved within thirty (30) days at Step One, the parties shall submit the matter to non-binding mediation. The parties shall attempt to agree on a mediator. If they cannot agree, the parties shall request a list of five (5) mediators from an entity or firm providing mediation services. The parties will attempt to mutually agree on a mediator from the list provided, but if they cannot agree, each party shall select one (1) name. The two selected shall select a third person. The dispute shall be heard by a panel of three (3) mediators and any common costs of mediation shall be borne equally by the parties who shall each bear their own costs and fees therefor. If the issue is resolved at this step, a written determination of such resolution shall be signed by each Manager and approved by the governing bodies.

Step Three (Legal Action)

After exhaustion of the preceding processes, if the parties agree, any dispute or claim shall be settled by arbitration under the jurisdiction of the Circuit Court of the State of Oregon for Clackamas County pursuant to ORS Chapter 36 or by arbitration provided by the Department of Land Conservation and Development. In the absence of such an agreement, that same court shall have jurisdiction.

17. Applicable Law and Attorneys Fees. This agreement shall be construed and enforced in accordance with the laws of the State of Oregon. Should any legal action being brought by any party for a breach of this agreement or to enforce any provision thereof, the prevailing party shall be entitled to reasonable attorneys fees, court costs, and any other costs as may be fixed by the Court.

18. Nonwaiver. Failure by any party in time to require performance by any other party or parties of any of the provisions hereof shall in no way affect such party's rights to enforce the same, nor shall any waiver by any party or parties of the breach hereof be held to be a waiver of the succeeding breach or a waiver of this nonwaiver clause.

19. Binding Effect. The covenants, conditions, and terms of this agreement shall extend to and be binding upon and inure to the benefit of the heirs, personal representatives, successors, and assigns of the parties hereto.

20. Merger. This Agreement embodies the entire agreement and understanding between the parties hereto and supersedes all previous agreements and understandings with respect to the urban service boundary described herein.

21. Severability. In case any one or more of the provisions contained in this agreement shall be invalid, illegal, or unenforceable in any respect, the validity, legality and enforceability of the remaining provisions shall remain.

22. Notices. Any notice herein required or permitted to be given, shall be given in writing and shall be effective when actually received and may be given by hand delivery or by United States mail, first class postage prepaid, addressed to the parties as follows:

FOR OREGON CITY:

Oregon City
Attention: City Manager
320 Warner Milne Road
Oregon City, Oregon 97045

FOR CLACKAMAS RIVER WATER:

Clackamas River Water
Attention: General Manager
16770 SE 82nd Drive, Suite 100
P.O. Box 2439
Clackamas, Oregon 97015

IT IS SO AGREED:
FOR OREGON CITY by and through its officials:

By: Daniel W. Fowler
Daniel W. Fowler, Mayor

Date: 4-15-98

By: Jean K. Elliott
Jean Elliott, City Recorder

FOR CLACKAMAS RIVER WATER by or through its officials:

By: Paul E. Rogers
Paul Rogers, President

Date: 4/22/98

By: Lowell Hanna
Lowell Hanna, Secretary

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Appendix D

OREGON CITY – CLACKAMAS RIVER WATER COOPERATIVE INTERGOVERNMENTAL AGREEMENT, 2000

EXPIRATION DATE: 02/08/2020
Term: 20 yrs
Date Executed: 02/08/00

COOPERATIVE INTERGOVERNMENTAL AGREEMENT

THIS AGREEMENT is made and entered into by and between CLACKAMAS RIVER WATER, a domestic water supply district created pursuant to ORS Chapter 264 ("CRW") and the CITY OF OREGON CITY, an Oregon municipal corporation ("City").

WITNESSETH:

RECITALS.

WHEREAS, the City and CRW operate municipal water systems and are engaged in the supply of water service for domestic purposes to the residents in its respective jurisdictions; and

WHEREAS, the parties and customers will derive mutual benefit from the joint construction and operation of these pipelines in the form of water quantity and pressure from such joint usage of pipelines as well as efficiencies in construction; and

WHEREAS, the parties share a common boundary or other service areas, and the parties intend this Agreement to fix present and future water service delivery boundaries and designate providers of water service in conformance with ORS 195.060 through 195.085, and that this Agreement shall be adopted and submitted for acknowledgement as part of the City's next periodic review of its Comprehensive Plan and Land Use Regulations; and

WHEREAS, in negotiating this Agreement, the parties have considered the factors of ORS 195.070, and that this Agreement will assure continuance of an appropriate and adequate level of water service; and

WHEREAS, the parties desire to designate service providers within the South End Road area and deliver water service in an orderly, efficient, non-duplicative manner as provided for within the City's public facility plan and CRW's master plan; and

WHEREAS, the parties have identified several water pipelines located in the South End Road area which are presently located within CRW boundaries and within the Urban Growth Management Boundary (UGMB); and

WHEREAS, the parties desire to jointly fund several South End-area water line connections and the construction of a water transmission line on S. South End Road from the current master meter location near McLoughlin School to Navaho Lane/Impala Lane area to avoid redundant construction of new water pipelines; and

WHEREAS, once the facilities are jointly constructed, this agreement will provide a means for the joint usage, ultimate transfer of jurisdiction, and maintenance responsibility of these lines to City in those areas noted herein; and

WHEREAS, the parties are also desirous of entering a rate setting methodology establishing a water rate for residents served by these lines; and

WHEREAS, the parties acknowledge that they have the authority to execute this intergovernmental cooperative agreement pursuant to ORS 190.003 to 190.030; and

WHEREAS, the parties represent that the persons signing this agreement on each party's behalf are duly authorized to bind it to the terms of this agreement.

NOW, THEREFORE, IT IS AGREED by and between the parties hereto as follows:

1. Effective Date. This agreement shall be effective when the last party enters into the same and shall be effective for a period of twenty years from that date. The parties shall review the terms of this agreement every five years and, unless one of the parties requests amendment or termination of this agreement 90 days prior to the expiration of that five year period, the agreement shall remain in full force and effect for an additional five year period, but, in the aggregate, no more than twenty years. If a party requests amendment or termination, the parties shall use the dispute resolution process provided by section 9 herein to resolve any disputes, including those related to division of assets or territory, provided that the non-requesting party shall be deemed the party charged with the default under Step Three of section 9. Any action by Metro or other authority with jurisdiction over matters affecting this Agreement shall trigger a review of the Agreement by the parties. No such actions, however, shall affect this Agreement unless it is so amended by mutual written consent of the parties.

2. **Identification of Joint Usage Lines**. The parties agree that the following water lines shall be jointly funded, connected, and used by the parties pursuant to the terms of this section and this agreement.

a. **South End Road**: Approximately 4,000-foot ductile iron water transmission line in South End Road as further described in Section 3. Includes appropriate 8-inch tees and gate valves at connecting streets and individual service reconnects by both parties on existing 12-inch line and new line. The amount of work to be completed for this line under this agreement may be decreased based on future development requirements to loop water lines in South End Road. Development would only be responsible for a basic 8-inch water line. As a minimum, the parties to this agreement must fund for oversizing the water line and the cross street connections and reconnections.

b. **Salmonberry Drive**: Appropriate connection at the east end of street as described in Section 3.

c. **Maywood Street**: Appropriate connection at the north end of street as described in Section 3.

d. **Finnigan's Way**: City shall connect new development off Parrish Road to CRW water line in Finnigan's Way and CRW shall approve connection details and activate the connection at the appropriate time.

e. **Longstanding Court**: CRW shall install a new 8-inch connection in the existing City 12-inch line in South End Road and connect this service subject to City connection detail approval.

f. **Rose Road**: CRW shall install a new 8-inch connection in the existing

City 12-inch line in South End Road and connect this service subject to City connection detail approval.

g. **Beutel Road**: CRW shall install and connect 8-inch tee in new South End Road transmission line subject to City connection detail approval.

h. **Parrish Road**: CRW shall install 8-inch tee in new South End Road transmission line. CRW shall make connection to 8-inch line in Parrish Road if City has provided for said line by way of development. Alternatively, the parties may agree in writing to other types of connection details when the Parrish Road line is developed to South End Road.

i. **Parkland Court**: CRW shall install and connect 8-inch tee in new South End Road transmission line subject to City connection detail approval.

j. **South End Court**: CRW shall install and connect 8-inch tee in new South End Road transmission line subject to City connection detail approval.

k. **Forest Ridge Lane**: CRW shall install and connect 8-inch tee in new South End Road transmission line subject to City connection detail approval.

l. **Proposed Merchant Meadows Subdivision Development Loop Line**: City shall provide for connection to Forest Ridge Lane subject to CRW approval of connection details in the event of future development of 3-1 E 12BA, Tax Lot 1800. CRW shall activate the connection if the future development of Tax Lot 1800 is completed. CRW shall activate the connection promptly in that event.

m. **Impala Lane**: CRW shall install and connect 8-inch tee in new South End Road transmission line subject to City connection detail approval.

n. **Navaho Way**: CRW shall install and connect 8-inch tee in new South End Road transmission line subject to City connection detail approval.

o. The following lines are also joint usage lines and do not require any connections:

1) Columbine Court

2) Elizabeth Court

3) Sunnyridge Court

4) Allen Court

5) Shamrock Lane

6) Turquoise Way

7) Deer Lane

The City, at its own cost, may extend and interconnect from the aforesaid water lines to allow City extension of water lines to adjacent areas. If the extension of the City lines constitutes an extraterritorial water line extension beyond then existent City Limits, CRW reserves its right to object to such extraterritorial extension on a case by case basis.

Where connection detail approval by either party is mentioned in this agreement, it includes the installation of required valves.

3. **Joint Construction of Connections and Transmission Line**. CRW and City shall jointly and equally fund the cost of making two connections of existing City and CRW water lines to be completed by CRW as part of the South End line construction effort as mentioned in Section 2b and 2c of this agreement. The parties shall also jointly and equally fund the construction of the ductile iron water transmission line, subject to pipe diameter determination, along S. South End Road and connections as outlined in Section 2a of this agreement. The transmission line is approximately 4,000 feet from McLoughlin School to the southerly terminus. CRW and the City shall jointly agree upon the final southerly terminus of this new transmission line between Impala Lane and the UGMB.

CRW will be responsible for the engineering, construction, and construction management of the transmission line and shall serve as the primary contracting public agency. CRW and the City shall jointly prepare and review, design and construction documents prior to bid. The City shall be invited to project meetings and shall be given progress reports by CRW with opportunity for comment. Change orders that increase the City's share by more than $10,000 per change or $50,000 aggregate must be approved by the City prior to authorization by CRW. CRW shall transmit any other progress payment information if requested. Payment shall be due within 30 days of invoice. At the completion of the project, CRW shall provide a final project accounting to ensure that the financial allocations set forth in this agreement are met with respect to final project construction costs. All performance and payment bonds and guarantees shall be for the benefit of CRW and the City. City and CRW shall each be responsible for one-half (1/2) of all costs associated with the engineering, construction, construction management, and other appropriate administrative fees of the aforesaid connections and the transmission line. CRW will bill City on a monthly basis for the City's share of these costs. Once this transmission line is placed in service, CRW shall abandon the existing CRW line in South End Road in place. CRW will use its best efforts to construct this transmission line during calendar year 2000.

4. **Master Meter**. The work provided for in this Agreement includes the installation of one master meter station located as shown on Figure 1, attached hereto and incorporated by reference.

a. Meter Operation and Maintenance Costs. The parties shall jointly share installation, operation, and maintenance costs for the master meter in even proportions. CRW will exercise best efforts in designing and constructing the master meter station during calendar year 2000. The City will perform operation and maintenance of the master meter station and shall account for costs on an annual basis.

b. Meter Station Ownership. The City shall be the owner of the master meter station proposed in this Agreement.

c. Meter Reading and Billing. The City shall be responsible for meter reading, billing, and annual accounting. The meter shall be calibrated and inspected annually. CRW shall have the right to inspect and test the meter at its cost upon seven day's written notice to the City.

d. Future Master Meter Relocations. The Master Meter shall be sized, located, and installed to minimize the need for future relocations. In the event the master meter must be moved due to expanding or shifting service territories or as land is annexed, the meter may only be moved after seventy five (75%) of the area is annexed to the City.

5. **Transfer of Jurisdiction and Operation and Maintenance Responsibility**. At such time as City annexes over seventy-five percent (75%) of the frontage on both sides of any of the water lines described in Section 2 of this agreement, jurisdiction, operation, and maintenance responsibility for the line shall be transferred from CRW to City. City shall notify CRW in writing of its intent to transfer jurisdiction of any line under this Section. CRW shall acknowledge the notification and cooperate with the City in completing any administrative transfer documents. Until such time, jurisdiction, operation, and maintenance responsibility will remain with CRW. In the event City extends its own water lines from the lines identified in Section 2, City shall be solely responsible for all operation and maintenance, and any connections to its own extended lines and shall receive all revenues therefrom.

After transfer of jurisdiction as described above, CRW may retain non-annexed properties as customers of CRW. On those properties that CRW retains, CRW is responsible for water services billing, meter reading, and collection. CRW will also retain all water service fees, related connection fees, system development fees and all miscellaneous water service fees, including water turn off and turn on fees and meter repair and replacement fees. The rights and responsibilities described above remain with CRW even though the responsibility for operation and maintenance has been transferred to the City. Upon annexation to the City, those properties retained by CRW will be transferred to the City and the City shall thereafter be responsible for water services billing, meter reading and collection and the City shall receive all water service fees, related connection fees, system development fees and all miscellaneous water service fees.

6. **Assumption of Bonded Debt Responsibility**. CRW shall retain bonded debt responsibility for all properties serviced by the aforesaid lines until those properties are annexed into City. When the properties are annexed into City, the City shall become responsible for the bonded debt obligation of the annexed property as provided for in ORS 222.520.

7. **Establishment of Volume Rate**. The volume rate consists of a wheeling rate portion and the South Fork wholesale rate portion.

a. **Wheeling Rate For Properties Connected To The Water Lines Identified In Section 2 Of This Agreement**. CRW shall pay to the City a wheeling rate of $0.8932 per hundred cubic feet for water used by the properties connected to the water lines identified in Section 2 of this agreement until these properties are annexed to City. The rate will be effective until a jointly funded economic study is completed to determine an appropriate rate. If the study is not completed within one year of the effective date of this agreement, the parties will update the rate set forth above based on the factors set forth in subsection 7c below.

b. **Wheeling Rate For Properties Connected To The Water Lines**

Identified In Section 2 Of This Agreement Where Jurisdiction, Operation, And Maintenance Responsibility Has Been Transferred To City. CRW shall pay to the City a wheeling rate of $1.0667 per hundred cubic feet of water used by properties connected to the water lines identified in Section 2 of this agreement when jurisdiction over the line serving the property has been transferred to the City under Section 5 of this agreement. The rate will be effective until a jointly funded economic study is completed to determine an appropriate rate. If the study is not completed within one year of the effective date of this agreement, the parties will update the rate set forth above based on the factors set forth in subsection 7c below.

c. **Volume Rate and Updates**. The two parties shall update the two wheeling rates in Section 7a and 7b every fifth year. This update is intended to account for variances in the number of customers within CRW served by the respective lines, metered usage, and variations of continuing costs and bonded indebtedness. Both parties agree to jointly fund an economic study update every five years. Between study updates, each year on the anniversary date of this agreement, the wheeling rate portion of the volume rate shall be increased by 75% of the Portland, Oregon Consumer Price Index based on the previous December 31 index. The South Fork wholesale portion of the volume rate will be adjusted annually to reflect the City's then current South Fork wholesale rate. CRW shall pay the City a volume water rate that includes the City's South Fork Water Board wholesale rate. City will then remit that portion of the volume rate directly to the South Fork Water Board.

8. **Amendment Provision**. The terms of this agreement may be amended or supplemented only by the mutual agreement of the parties. Any amendments or supplements must be in writing, refer to this agreement, and be executed by the parties.

9. **Dispute Resolution**.

a. Subject to extensions of time by mutual consent in writing, failure or unreasonable delay by any party to substantially perform any provision of this agreement shall constitute default. In the event of an alleged default or breach of any term or condition of this agreement, the party alleging such default or breach shall give the other party not less than 30 days notice in writing specifying the nature of the alleged default and the manner in which the default may be cured satisfactorily. During this 30-day period, neither party shall be considered in default for purposes of termination or instituting legal proceedings.

b. The parties shall first attempt to resolve the dispute by negotiation, followed by mediation, if negotiation fails to resolve the dispute.

Step One: (Negotiation). The City Manager and CRW General Manager, or other persons designated by each of the disputing parties will negotiate on behalf of the entities they represent. The Managers, or their representatives, shall then meet with each other and attempt to resolve the issue. If the dispute is resolved at this step, there shall be a written determination of such resolution, signed by each Manager and ratified by the governing bodies that shall be binding upon the parties.

Step Two: (Mediation). If the dispute cannot be resolved within thirty (30) days at Step One, the parties shall submit the matter to non-binding mediation. The parties shall attempt to agree on a mediator. If they cannot agree, the parties shall request a list of five (5) mediators from an entity or firm providing mediation services. The parties will attempt to mutually agree on a mediator from the list provided, but if they cannot agree, each party shall select one (1) name. The two selected shall select a third person. The dispute shall be heard by a panel of three (3) mediators and any common costs of mediation shall be borne equally by the parties who shall each bear their own costs and fees therefor. If the issue is resolved at this step, a written determination of such resolution shall be signed by each Manager and approved by the governing bodies.

Step Three (Legal Action). After exhaustion of the preceding processes, if the parties agree, any dispute or claim shall be settled by arbitration under the jurisdiction of the Circuit Court of the State of Oregon for Clackamas County pursuant to ORS Chapter 36 or by arbitration provided by the Department of Land Conservation and Development, at the election of the party charged with the default. In the absence of such an agreement, that same court shall have jurisdiction over any dispute.

10. **Applicable Law**. This agreement shall be construed and enforced in accordance with the laws of the State of Oregon.

11. **Attorneys' Fees.** In the event any legal action or proceeding is commenced to construe or enforce a provision of this Agreement, the losing party, as determined by the judge, shall pay the prevailing Party's reasonable attorneys' fees, paralegal fees, expert fees and costs as determined by the judge at trial, or upon any appeal, petition or arbitration, or any combination of the foregoing.

12. **Nonwaiver.** Failure by any party in time to require performance by any other party or parties of any of the provisions hereof shall in no way affect such party's rights to enforce the same, nor shall any waiver by any party or parties of any breach of this agreement be held to be a waiver of any succeeding breach or a waiver of this Agreement.

13. **Binding Effect.** The covenants, conditions, and terms of this agreement shall extend to, be binding upon, and inure to the benefit of any personal representatives, successors, and assigns of the parties hereto.

14. **Severability.** In case any one or more of the provisions contained in this agreement shall be invalid, illegal, or unenforceable in any respect, the validity, legality and enforceability of the remaining provisions shall remain.

15. **Notices.** Any notice herein required or permitted to be given, shall be given in writing and shall be effective when actually received and may be given by hand delivery or by United States mail, first class postage prepaid, addressed to the parties as follows:

FOR OREGON CITY:

City of Oregon City

Attention: City Manager

320 Warner Milne Road

Oregon City, Oregon 97045

FOR CLACKAMAS RIVER WATER:

Clackamas River Water

Attention: General Manager

16770 SE 82nd Drive, Suite 100

P.O. Box 2439

Clackamas, Oregon 97015

IT IS SO AGREED:

FOR OREGON CITY by and through its officials:

By: John F. Williams, Jr.

John F. Williams, Jr., Mayor

Date: Feb. 2, 2000

By: Leilani Bronson-Crelly

Leilani Bronson-Crelly, City Recorder

FOR CLACKAMAS RIVER WATER by or through its officials:

By: Paul E. Rogers

Paul Rogers, President

Date: 2-8-00

By: Lowell Hanna

Lowell Hanna, Secretary

Appendix E

CLACKAMAS RIVER WATER AND OREGON CITY REMUNERATION AGREEMENT

INTERGOVERNMENTAL AGREEMENT BETWEEN THE CITY OF OREGON CITY AND CLACKAMAS RIVER WATER

THIS INTERGOVERNMENTAL AGREEMENT is entered into between the City of Oregon City (the "City"), an Oregon municipal corporation, and Clackamas River Water ("CRW"), a domestic water supply district.

RECITALS:

WHEREAS, The City and CRW are parties to that Settlement Agreement (the "Settlement Agreement") between and among the City, CRW, Clackamas Regional Water Supply Commission ("CRWSC"), South Fork Water Board ("SFWB"), and Sunrise Water Authority ("SWA") entered into in May of 2014, amended in April 2016, and attached to this Agreement as Exhibit 1, and

WHEREAS, the Settlement Agreement resolved several disputes between and among the parties to the Settlement Agreement regarding the annexation of territory into the City and potential withdrawal of that territory from CRW, and

WHEREAS, The Settlement Agreement resolved several disputes among the parties to the Settlement Agreement, it did not resolve all outstanding disputes; in particular, it did not resolve a dispute regarding the valuation of assets upon withdrawal of territory, and

WHEREAS, Section II(C) of the Settlement Agreement required CRW and the City to reach agreement within a specified time regarding a methodology to determine the value of CRW assets for which CRW will be compensated upon withdrawal.

NOW THEREFORE, THE CITY AND CRW AGREE AS FOLLOWS:

Section 1: **Effective Date.** This agreement shall become effective upon the date of the last signature hereon.

Section 2: **Term**. The Parties agrees that this Agreement shall be in effect until terminated as set forth below.

Section 3: **Adoption of Methodology**. Upon withdrawal of territory from CRW into the City, the City will compensate CRW for CRW assets turned over to the City pursuant to ORS 222.540 according to the methodology set forth in the Technical Memorandum prepared by the FCS Group and dated February 26, 2018, attached to this Agreement as Exhibit 2 and made a part hereof.

Section 4: **Modification.** This Agreement may not be altered, modified, supplemented, or amended in any manner whatsoever except by mutual agreement of the parties in writing. Any such alteration, modification, supplementation, or amendment, if made, shall be effective only in the specific instance and for the specific purpose given, and shall be valid and binding only if signed by the parties. Notwithstanding the above, the Methodology adopted in Section 3 above expressly contemplates that the valuation of CRW's assets will be adjusted consistent with updates to the ENR-CCI. Such adjustments shall not be considered modifications to this Agreement.

Section 5: **Termination.** This Agreement may be terminated by written mutual consent of the parties, or by either party providing the other party 60 days advance written notice. Notwithstanding the termination of this Agreement, Section 3 of this Agreement will survive and remain in effect as to all assets constructed by or for CRW prior to the effective date of such termination.

Section 6: **Waiver.** No provision of this Agreement may be waived except in writing by the party waving compliance. No waiver of any provision of this Agreement shall constitute waiver of any other provision, whether similar or not, nor shall any one waiver constitute a continuing waiver. Failure to enforce any provision of this Agreement shall not operate as a waiver of such provision or any other provision.

Section 7: **Entire Agreement.** This Agreement sets forth the entire understanding between the parties with respect to remuneration for CRW assets transferred upon the withdrawal of territory from CRW by the City, and supersedes any and all prior understandings and agreements, whether written or oral, between the parties with respect to such subject matter.

Section 8: **Severability.** The parties agree that if any term or provision of this Agreement is declared by a court of competent jurisdiction to be illegal or in conflict with any law, the validity of the remaining terms and provision shall not be affected, and the right and obligations of the parties shall be construed and enforced as if the Agreement did not contain the particular term or provisions held to be invalid.

Section 9: **Construction of Agreement.** This Agreement shall not be construed against either party regardless of which party drafted it. Other than as modified by this Agreement, the applicable rules of contract construction and evidence shall apply.

Section 10: **Cooperation.** All parties agree to cooperate fully and execute any and all supplementary documents and to take all additional actions which may be necessary or appropriate to give full force and effect to the terms of this Agreement.

Section 11: **Binding Effect.** To the extent allowed by law, this Agreement shall be binding upon and inure to the benefit of the heirs, representatives, successors and assigns of each of the parties hereto, however they may be constituted.

Section 12: **Counterparts; Facsimile Execution**. This Agreement may be executed in counterparts, each of which, when taken together, shall constitute fully executed originals. Facsimile or e-mail signatures shall operate as original signatures with respect to this Agreement.

Section 13: **Dispute Resolution**. In the event of a dispute arising out of the interpretation or performance of this Agreement, the parties shall attempt in good faith to resolve all disputes promptly by mediation. If mediation fails to resolve the dispute, any legal action between the parties regarding the terms of this Agreement shall be brought in Clackamas County Circuit Court.

IN WITNESS WHEREOF, the parties execute this Agreement.

CITY OF OREGON CITY	CLACKAMAS RIVER WATER
By:	By:
Its: Mayor	Its:
Date: 5/16/18	Date: 5-21-18

P0787628.v3

FIRST AMENDMENT TO SETTLEMENT AGREEMENT

On May 24, 2014, the City of Oregon City (City), the South Fork Water Board (SFWB), the Clackamas River Water District (CRW), the Sunrise Water Authority (SWA) and the Clackamas Regional Water Supply Commission (CRWSC) entered into a settlement Agreement to address LUBA litigation over the adoption of a 190 agreement between CRW and SWA to create the CRWSC.

Section II.C of the Settlement Agreement states that, within two years of the execution of the Settlement Agreement, the Parties will reach an agreement regarding a methodology to determine the value of CRW assets for which CRW will be compensated upon withdrawal.

It now appears that the Parties will not be able to reach such an agreement within the two years contemplated by the Settlement Agreement and that, therefore, the Settlement Agreement should be amended for an additional period to allow the Parties to reach such an agreement.

ACCORDINGLY, THE SETTLEMENT AGREEMENT IS AMENDED AS FOLLOWS

Page 3 of 4, Section II, Agreement, Item C, the last sentence shall be replaced in its entirety to read:

> Within the next four years, the Parties will reach an agreement regarding a methodology to determine the value of CRW assets for which CRW will be compensated upon withdrawal.

All other terms and provisions of the Settlement Agreement not expressly amended above shall remain in full force and effect.

IN WITNESS WHEREOF, the parties hereto have set their hands as of the day and year hereinafter written.

CLACKAMAS RIVER WATER DISTRICT

By: [signature]

Title: President

Date 4/25/16

CITY OF OREGON CITY

By: __________

Title: __________

Date __________

CLACKAMAS REGIONAL WATER SUPPLY COMMISSION

By: __________

Title: __________

Date __________

SOUTH FORK WATER BOARD

By: __________

Title: __________

Date __________

SUNRISE WATER AUTHORITY

By: __________

Title: __________

Date __________

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IN WITNESS WHEREOF, the parties hereto have set their hands as of the day and year hereinafter written.

CLACKAMAS RIVER WATER DISTRICT

By: ______________________

Title: ______________________

Date ______________________

CITY OF OREGON CITY

By: ______________________

Title: Mayor, City of Oregon City

Date

CLACKAMAS REGIONAL WATER SUPPLY COMMISSION

By: ______________________

Title: Pres. – CRWSC

Date ______________________

SOUTH FORK WATER BOARD

By: ______________________

Title: Chair, South Fork Water Board

Date

SUNRISE WATER AUTHORITY

By: ______________________

Title: chair, Sunrise Water Authority

Date ______________________

P:\PublicWorks\Agencies & Other Service Providers\CRW\CRW Sunrise 2014 Agreement\Amendment to City-SFWB-CRW-SWA-CRWSC Settlement Agmt.docx

SETTLEMENT AGREEMENT

This Settlement Agreement is entered into by and between the City of Oregon City, the South Fork Water Board, the Clackamas River Water District, the Sunrise Water Authority and the Clackamas Regional Water Supply Commission.

I. RECITALS

WHEREAS, the City of Oregon City (City) is a municipal corporation that provides water to many of its residents through the South Fork Water Board (SFWB), which operates as an ORS 190 Intergovernmental agency owned in equal shares by and providing water for the City and the City of West Linn.

WHEREAS, Clackamas River Water District (CRW) is a domestic water supply district organized under ORS chapter 264 that provides water service to areas both within the City and contiguous to but outside the City.

WHEREAS, the Sunrise Water Authority (SWA) is a water authority organized under ORS 450.650 to 450.700 that provides domestic water service to areas outside and not contiguous to the City.

WHEREAS, when the City annexes new territory, the City may withdraw the territory from affected special districts under ORS 222.520 to 222.580.

WHEREAS, under ORS 450.987, the City may annex territory that is within the boundary of and served by a water authority but may not withdraw the improvements used to provide water service.

WHEREAS, on November 14, 2013, CRW approved Ordinance 03-2013 which authorized CRW to enter into an agreement under ORS chapter 190 (190 Agreement) with SWA to form and operate the Clackamas Regional Water Supply Commission (CRWSC) to oversee the supply of domestic water services to the combined territories of CRW and SWA.

WHEREAS, on November 20, 2013, SWA approved resolution 2013-02 that similarly authorized SWA to enter into the 190 Agreement with CRW to form and operate the CRWSC to oversee the supply of domestic water services to the combined territories of CRW and SWA.

WHEREAS, CRW Ordinance 03-2013 states that one of the purposes of the 190 Agreement is to "provide boundary protection not currently available to CRW."

WHEREAS, Section 8.3 of the 190 Agreement requires CRW and SWA to jointly defend the "legal service boundaries of the CRWSC, exclusive of any such areas residing within the urban growth boundaries of adjacent cities or boundaries of other governmental entities for which mutual service agreements have been established."

WHEREAS, the City and SFWB were concerned that the purpose statement in Ordinance 03-2013 and the provisions in Section 8.3 of the 190 Agreement signified an attempt to provide CRW with the same protection against the withdrawal of territory enjoyed by SWA under ORS 450.987, and that such a result would constitute a material harm to the interests of the City and SFWB.

WHEREAS, based on this and other concerns, on December 4, 2013, the City and SFWB appealed Ordinance 2013-03 and Resolution 2013-02 to the Land Use Board of Appeals (LUBA).

WHEREAS, on January 15, 2014, and again on March 12, 2014, the parties met through their representatives to discuss the LUBA appeals and to attempt to reach a settlement agreement.

WHEREAS, at the January 15 meeting, CRW and SWA stated that neither organization intended the 190 Agreement or the CRWSC to limit in any way the City's ability to withdraw territory from CRW upon annexation into the City of territory that is within and served by CRW and that the 190 Agreement does not in any way operate to limit such City authority. The parties further agreed that any authority the City has to withdraw territory or infrastructure under ORS 222.510 to 222.580 is not related to or in any way dependent on the location of the Metro Urban Growth Boundary (UGB) or CRW's legal boundary. The parties further agreed that the reference to "boundary protection" in Ordinance 03-1023 and the language in Section 8.3 of the 190 Agreement was intended to refer to the protection of CRW assets, not service area under ORS 222.510 to 222.580, subject to the equitable division of such assets under ORS 222.540. Finally, at the March 12 meeting, the parties agreed to a settlement concept as described in this Agreement.

WHEREAS, in return for CRW's and SWA's agreement, as stated above, that the City retains full authority under ORS 222.510 to 222.580 to withdraw territory from CRW upon annexation of the territory into the City, the City and SFWB agree to withdrawal of the appeals currently pending before LUBA.

Now, therefore, based on the foregoing recitals, the mutual promises and obligations set forth herein, and other good and valuable consideration, the receipt of which is hereby acknowledged, the parties agree as follows.

II. AGREEMENT

A. Within 10 days of the effective date of this Agreement, the City and SFWB will dismiss the appeals that have been filed with the Land Use Board of Appeals regarding the adoption of the 190 Agreement. In particular, the following two appeals will be dismissed:

City/SFWB v. Sunrise Water Authority, LUBA No. 2013-117, and
City/SFWB v. Clackamas River Water, LUBA No. 2013-118

B. The parties agree that neither CRW's Ordinance 03-2013, SWA's Resolution 2013-02, or the 190 Agreement itself are intended to alter the applicability of ORS 222.520 to 222.580

to CRW specifically, or to alter the legal rights, status, power or limitations of any party with respect to those and other statutes generally. The parties agree that the annexation and withdrawal statutes in place at the time of any future annexation or withdrawal will apply to any annexation or withdraw the City initiates. The parties understand and agree that when CRW adopted Ordinance No. 03-2013 which approved the 190 Agreement, the reference in the recitals regarding "boundary protection not currently available to CRW" was intended to provide adequate consideration for CRW assets in any area withdrawn, not protection for CRW's legal boundary.

From the effective date of this Agreement, CRW, SWA and CRWSC agree that they will not challenge the authority of the City to withdraw territory from CRW or CRWSC under ORS 222.510 to 222.580 upon or following annexation to the City. Notwithstanding the foregoing, nothing in this Agreement limits CRW, SWA or CRWSC from opposing annexation or withdrawal on grounds other than the City's authority to withdraw territory under ORS 222.510 to 222.580, including, but not limited to, any procedural grounds.

C. All parties understand that the nature of providing water services requires long-term investments that require a degree of certainty to ensure that those investments provide an adequate return to the party that makes the investment. Therefore, the parties agree that upon annexation and withdrawal of territory in the future, the parties will comply with the process in ORS 222.540 regarding the division of assets in the withdrawn territory. Within the next two years, the Parties will reach an agreement regarding a methodology to determine the value of CRW assets for which CRW will be compensated upon withdrawal.

D. The parties agree that the description of the CRWSC "legal service boundaries" in Section 8.3 of the 190 Agreement does not limit the authority or ability of the City to withdraw territory from CRW or CRWSC under ORS 222.510 to 222.580 upon or following annexation of the territory into the City and for SFWB to serve such areas. Notwithstanding the foregoing, the City and CRW may mutually agree in writing that CRW will serve other areas of the City in the future even though those areas may be outside CRW's and CRWSC's legal service boundaries.

E. This Agreement is not intended to prevent, nor does it prevent, the parties, or any number of them, from entering into other agreements for any subject, including the provision of water or transfer of assets.

III. TERMS AND CONDITIONS

A. Effective Date. This Agreement shall become effective upon the execution and delivery of this Agreement by each of the other parties. As each party is a public entity, the parties recognize that this Agreement requires approval by the duly constituted governing body of each party.

B. Cooperation. All parties agree to cooperate fully and execute any and all supplementary documents and to take all additional actions which may be necessary or appropriate to give

B. Cooperation. All parties agree to cooperate fully and execute any and all supplementary documents and to take all additional actions which may be necessary or appropriate to give full force and effect to the terms of this Agreement, including authorizing the withdrawal of territory from CRW or CRWSC by the City.

C. Binding Effect. To the extent allowed by law, this Agreement shall be binding upon and inure to the benefit of the heirs, representatives, successors and assigns of each of the parties hereto, however they may be constituted.

D. Amendment. No waiver, consent, modification, amendment, or other change of terms of this Agreement shall bind any party unless in writing and signed by all parties.

E. Counterparts; Facsimile Execution. This Agreement may be executed in counterparts, each of which, when taken together, shall constitute fully executed originals. Facsimile or e mail signatures shall operate as original signatures with respect to this Agreement.

F. Dispute Resolution. In the event of a dispute arising out of the interpretation or performance of this Agreement, the parties shall attempt in good faith to resolve all disputes promptly by mediation. If mediation fails to resolve the dispute, any legal action between the parties regarding the terms of this Agreement shall be brought in Clackamas County Circuit Court.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the Effective Date.

CLACKAMAS RIVER WATER DISTRICT By: [signature] Title: President Date: 5/12, 2014	CITY OF OREGON CITY By: ____ Title: ____ Date: ____, 2014
CLACKAMAS REGIONAL WATER SUPPLY COMMISSION By: [signature] Title: President Date: 5/12, 2014	SOUTH FORK WATER BOARD By: ____ Title: ____ Date: ____, 2014
SUNRISE WATER AUTHORITY By: Ronald L. Blake Title: Vice Chair Date: 5-22-14, 2014	

full force and effect to the terms of this Agreement, including authorizing the withdrawal of territory from CRW or CRWSC by the City.

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CLACKAMAS RIVER WATER DISTRICT By: ____________ Title: ____________ Date: ____________, 2014	CITY OF OREGON CITY By: ____________ Title: ____________ Date: ____________, 2014
CLACKAMAS REGIONAL WATER SUPPLY COMMISSION By: ____________ Title: ____________ Date: ____________, 2014	SOUTH FORK WATER BOARD By: [signature] Title: General Manager Date: 05-22, 2014
SUNRISE WATER AUTHORITY By: ____________ Title: ____________ Date: ____________, 2014	

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IN WITNESS WHEREOF, the parties have executed this Agreement as of the Effective Date.

CLACKAMAS RIVER WATER DISTRICT By: ____________ Title: ____________ Date: ____________, 2014	CITY OF OREGON CITY By: David W. Frasher Title: City Manager Date: 5-22-14, 2014
CLACKAMAS REGIONAL WATER SUPPLY COMMISSION By: ____________ Title: ____________ Date: ____________, 2014	SOUTH FORK WATER BOARD By: ____________ Title: ____________ Date: ____________, 2014
SUNRISE WATER AUTHORITY By: ____________ Title: ____________ Date: ____________, 2014	

FCS GROUP
Solutions-Oriented Consulting | Technical Memorandum

Date: February 26, 2018

To: Martin Montalvo, Operations Manager, City of Oregon City

Bob George, Chief Engineer, Clackamas River Water (CRW)

From: Gordon Wilson, Senior Program Manager Gordon Wilson

Copy: Brian Ginter, Murraysmith

Subject: Remuneration Methodology for Service Area Transfers from CRW to Oregon City

The following technical memo documents the recommended methodology for determining fair remuneration when service area is transferred from Clackamas River Water (CRW) to Oregon City. The first part of the memo discusses why Original Cost Less Depreciation is the valuation approach we recommend in this case, and the second part gives step-by-step instructions for using the valuation model that accompanies this memo. Our work is part of a larger study of boundary issues that has been conducted by Murraysmith.

SECTION 1: VALUATION APPROACH

PURPOSE

The purpose of this memo is to develop a standard methodology for determining remuneration from Oregon City to CRW when water service area and assets are transferred from CRW to the City. The timing of the transfers is uncertain, and available data may vary. The methodology must be robust and straightforward enough to be implemented by staff, with ready agreement between the two parties, without help from consultants.

WHY A REMUNERATION METHODOLOGY IS NEEDED

The City is growing, gradually annexing area within the Urban Growth Boundary (UGB). CRW, an ORS 264 water district, is the existing provider of water service to developed areas surrounding the City on three sides. CRW has invested and continues to invest in the network of pipes and related assets that distribute water to its service area.

The majority of the Murraysmith study has been to examine several specific conflict areas between the two jurisdictions and determine which provider makes the most sense for each, both now and ultimately. For the most part, there is clarity about who the service provider should be within city limits (the City) or outside the Urban Growth Boundary (CRW). Most of the conflict areas addressed by Murraysmith have to do with areas that are now outside the City but inside the UGB.

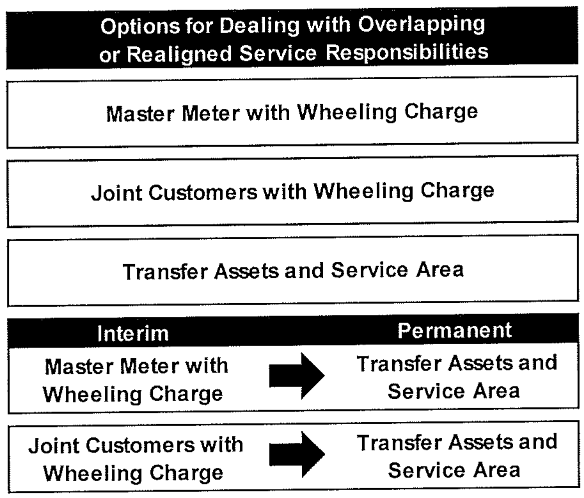
State law in general favors cities in the provision of services within their boundaries, and after annexation, the City has the right to withdraw service area from CRW. Barring reasons to the contrary, there is a presumption that eventually the entire UGB area will be annexed into the City and become part of the City water system.

However, even for areas expected eventually to be inside the City, there are reasons it might make sense for CRW to retain ownership of certain assets. For example, some segments of pipe passing through the City might be necessary to provide connectivity for CRW service areas outside the UGB.

In addition, there is uncertainty about the timing of annexations and development, so the short-term disposition of a given set of pipes and other assets might be different from the ultimate disposition.

As depicted in **Exhibit 1**, there are several mechanisms for dealing with overlapping or realigned responsibilities. In general, whenever the customer revenue is received by one agency but those customers are served through pipes that are owned by another agency, then a "wheeling charge" can compensate the agency that owns the pipes. If there is a master meter, the wheeling charge can be calculated based on the amount of water passing through the meter. Where there is a "ragged boundary" or the areas are so small that it would not be cost-effective to install a master meter, customers can be designated as "joint customers," and the agency who owns the pipes can be compensated based on the metered water consumption of those particular customers.

Exhibit 1: Options for Dealing with Overlapping or Realigned Service Responsibilities



However, sometimes when there are overlapping or realigned service responsibilities, the most straightforward resolution is simply to transfer the service area from CRW to the City, either now or after some triggering event in the future. This raises the question of remuneration. The two parties agree that when service area and assets are transferred from CRW to the City, there should be some kind of compensation from the City to CRW. So the question we deal with in this memo is: how much? And how should that amount be determined when the time comes?

This memo focuses only on the capital value of the transferred assets and service area. We assume that if a transfer area is large enough to affect the number of CRW employees, the two agencies will separately negotiate an employee transfer agreement complying with ORS 236.605-236.640.

DECISION: FOCUS ON CUSTOMERS OR ON PIPES?

Cost, Market, and Income

In business valuation—including for utilities—there are three general methods traditionally used to develop a fair value estimate: Cost, Market, and Income. The Cost method looks at what the owners invested to build or acquire the assets; the Market method looks at comparable sales; and the Income method looks at the future income potential of the business. Each method has several sub-methods.

For utilities, the Market method (based on comparable sales) is noticeably weaker than the other two, simply because water systems are not sold very often. However, the Cost and Income method are quite useful and potentially relevant to Oregon City and CRW. This leads to a judgment call in constructing a standard methodology for the two agencies: should we focus on customers or pipes?

Customers vs. Assets

Utilities are both a set of *customers* and a set of *assets*. Customers generate revenue. If they are existing customers, they generate monthly rate revenue, so transferring customers reduces revenue to one party and increases it to another party. If the service area being transferred is undeveloped land, then the development process can generate revenue from Systems Development Charges (SDCs).

Assets generate costs. Water system assets can include treatment facilities, water rights, pumps, buildings, vehicles and equipment, pipes, hydrants, meters, and services. These assets must be maintained and receive periodic capital investment. If the area transferred includes undeveloped land, the transfer includes the responsibility for planning and investing in future capital improvements.

The conflict areas described in this study are all relatively small parts of a water system rather than an entire system. No pumps, treatment facilities, or water rights are being considered for transfer. If the two parties choose to focus on the cost of the assets being transferred, those assets can be understood to consist of pipes and the things associated with a length of pipe—hydrants, valves, services, and meters along with the mains.

Both the Cost method and the Income method of valuation can yield useful insights into the value of a water system or subsystem. When FCS Group performs a full appraisal of a utility, we look at both methods closely before choosing the method that best fits a given set of facts. In this case, any methodology we recommend needs to be one that can be unambiguously applied by both agencies at some indeterminate time in the future. Simplicity and reliability are at a premium.

SUGGESTED FOCUS – COST OF ASSETS

Our recommendation in this case is that the standard methodology focus on the *cost* of the transferred pipe and other assets, not on the potential income from the transfer of customers and undeveloped land. Following are the reasons for this recommendation.

- The Cost method would be easier to replicate in the future without the help of a consultant.
- The Cost method relies on data from the past rather than projections about the future. While historical data is rarely as complete as we might wish, at least the basic facts are relatively unambiguous, so both parties could readily reach agreement on the remuneration value.
- With the Income method, more subjective judgment is needed, particularly with respect to:
  - What discount rate to use in the discounted cash flow forecast;
  - What growth rate to assume for undeveloped land; and
  - How to deal with stranded overhead and fixed plant capacity costs.

  The discount rate in particular can make a big difference to the outcome, and it is inherently a subjective judgment.

- With the Cost method, the data is not always clean, but there are ways to deal with incomplete data that can be agreed to in advance.
- Finally, the pipes and other assets are what the City and CRW managers themselves focus on most when they discuss this subject.

We recognize that there is a revenue impact to a service area transfer. However, a methodology based on asset costs will best fit the two agencies' mutual goals.

MEASURING THE COST OF ASSETS

Even after deciding to focus on the cost of assets, we still need to decide how to measure that cost in particular instances. There is more than one way to measure an agency's prior investment in a group of assets, so we will next consider which method best applies in this case.

Criteria

In choosing a way to measure CRW's investment, we use two main criteria. These criteria should ensure that each agency has the right incentives during the interim period before asset transfer.

(1) CRW should be made whole for its prior investment in system assets.

Given the uncertain pace of development and annexation, as long as part of its service area is within the UGB, CRW should have the incentive to make needed investments without having to worry about those investments being stranded by a City takeover of assets without adequate compensation. Facing a choice about whether to invest in assets, CRW should be indifferent to the possibility of future City withdrawal of those assets. This is Criterion #1.

There can be a consultation requirement for new water line extensions within the UGB, to allow the City to raise objections before CRW makes a particular investment. It is also reasonable for the pipe design and construction standards to match the City's requirements, given that the City will eventually be maintaining the pipe. That is analogous to developers having to meet the utility's standards when installing infrastructure that is to be accepted by either CRW or the City.

For developer-built infrastructure, the asset value should be zero, since there is no CRW ratepayer investment in those lines. However, if a water line originally built by a developer is later replaced by CRW, then the replacement cost should be included in the remuneration value.

(2) The remuneration method should take into account the age of the assets, as a surrogate measure for their physical condition.

The City should not have to worry about paying "like-new" prices for a set of pipes and then having to replace those pipes in just a few years because they are so deteriorated.

Sometimes pipes must be replaced prematurely because of growth—they may be too small for the demand generated by the next subdivision down the line. That is different from replacement due purely to age and condition. In designing a remuneration methodology, Criterion #2 is to make sure that the risk of having to reinvest for age-related reasons is taken into account in the price.

Potential Measures of the Cost of Assets to be Transferred

Original Cost Less Depreciation (OCLD)

This is the "net book value" of an asset after subtracting developer-funded infrastructure. It is also known as the value of the "remaining useful life" of the asset. It is simply whatever CRW originally spent on an asset minus accumulated depreciation since the year of construction.

This measure requires a way to allocate the cost from the original construction area to the area being transferred. It also requires some reasonable assumptions—which can be agreed upon in advance—about the estimated useful life of the assets.

This measure works best when historical cost records are available, but it can still be used (with agreed-upon assumptions) without original historical cost records.

This measure directly addresses Criterion #1, by ensuring that CRW receives what it put into the assets, adjusted only for the degree to which the asset is "used up" over time.

Reproduction Cost Less Depreciation (RCLD)

This method consists of the estimated reproduction cost in today's dollars, then subtracting developer-funded infrastructure and accumulated depreciation.

This method is sometimes used by state public utilities commissions to determine how much "rate base" to allow a private water company after the acquisition of another system. However, in this case, the two parties do not include a regulated private water company whose rate-setting is limited by its calculated rate base. Both parties are municipal utilities with authority to set rates as needed to meet current and future costs.

Like OCLD, this measure also requires a way to allocate the cost from the original investment area to the area being transferred. It also requires some reasonable assumptions—which can be agreed upon in advance—about the estimated useful life of the assets.

This measure can be used regardless of the availability of historical cost data. However, it would require updated estimates of reproduction unit costs each time a transfer took place.

This measure will yield a higher cost than the OCLD. By starting with reproduction cost, it is more detached from what CRW actually paid for an asset.

Percentage of Debt Service

There is another method that is unambiguous in its administration even though it is really based on revenue rather than asset cost. That is to have the City pay for a percentage of the District's debt service equal to the percentage of total rate revenue that comes from the transferred service area. In other words, if a transferred area generates 1.5% of the total CRW rate revenue at the time of the transfer, the City would pay 1.5% of the debt service each year on the debt that is outstanding at the time of the transfer, until that debt is retired. If that debt is refunded and replaced for more favorable financing terms, the City's payment would be reduced in proportion with the reduction in CRW's debt service.

This method focuses on making CRW whole not for its capital investment—in fact, it is not even related to the amount of capital investment in a particular set of assets. Instead, it focuses on making

CRW whole by ensuring receipt of the amount of revenue that would have been generated by customers in the transferred area for their proportionate share of debt service. In other words, at the time of a transfer, it allows CRW to ensure that it can still pay its already-committed debt service without raising rates on everyone else.

This method is used in some agreements between districts and cities in Washington. (Like Oregon statutes, Washington statutes give cities the right to withdraw territory from a district after annexation.) One agreement between a city and district in Washington uses a hybrid approach—if the assets are less than ten years old, the district receives the Original Cost Net Less Depreciation, and if the assets are ten or more years old, the "percentage of debt service" method is used.

The assurance of receiving the same share of debt service has some appeal for districts in cases where the amount of service area taken by the city might be a significant share of the district's territory. It guarantees that a district will not have stranded debt, no matter how much territory is withdrawn at one time.

This method can also be readily calculated by staff without ambiguity and without help from consultants. This is the simplest of the three alternatives to administer.

However, the "percentage of debt service" approach has some notable drawbacks.

- First, it ignores equity-funded capital investments—those paid for with reserves or current rates. Instead, it only takes into account debt-funded capital investment. If a district's capital program were 100% funded by debt, then this method would compensate for a proportionate share of all asset costs, but that is rarely the case. In this case, CRW capital is mostly funded by current rates, so this method would result in lower compensation than the actual cost of the assets.
- Secondly, it does not at all meet Criterion #1, which is for CRW to have an incentive to invest in the system. Because this method is disconnected from the cost of a particular set of assets, and because there may be little relationship between the geographic distribution of rate revenue and the location of capital projects, CRW would have a disincentive to extend a water line into a previously unserved area, particularly if that area is ready for development but with few customers at present.

Recommended Approach

We recommend Original Cost Less Depreciation (OCLD).

It directly addresses the two criteria, giving both parties the incentive to make logical capital investment decisions during the interim period before service area withdrawal.

Conceptually, it is the most straightforward of the three methods discussed here. It can be calculated by the staff without ambiguity. Although it is dependent on historical data that might be incomplete, there can be agreed-upon ways of addressing situations where data on historical costs is limited.

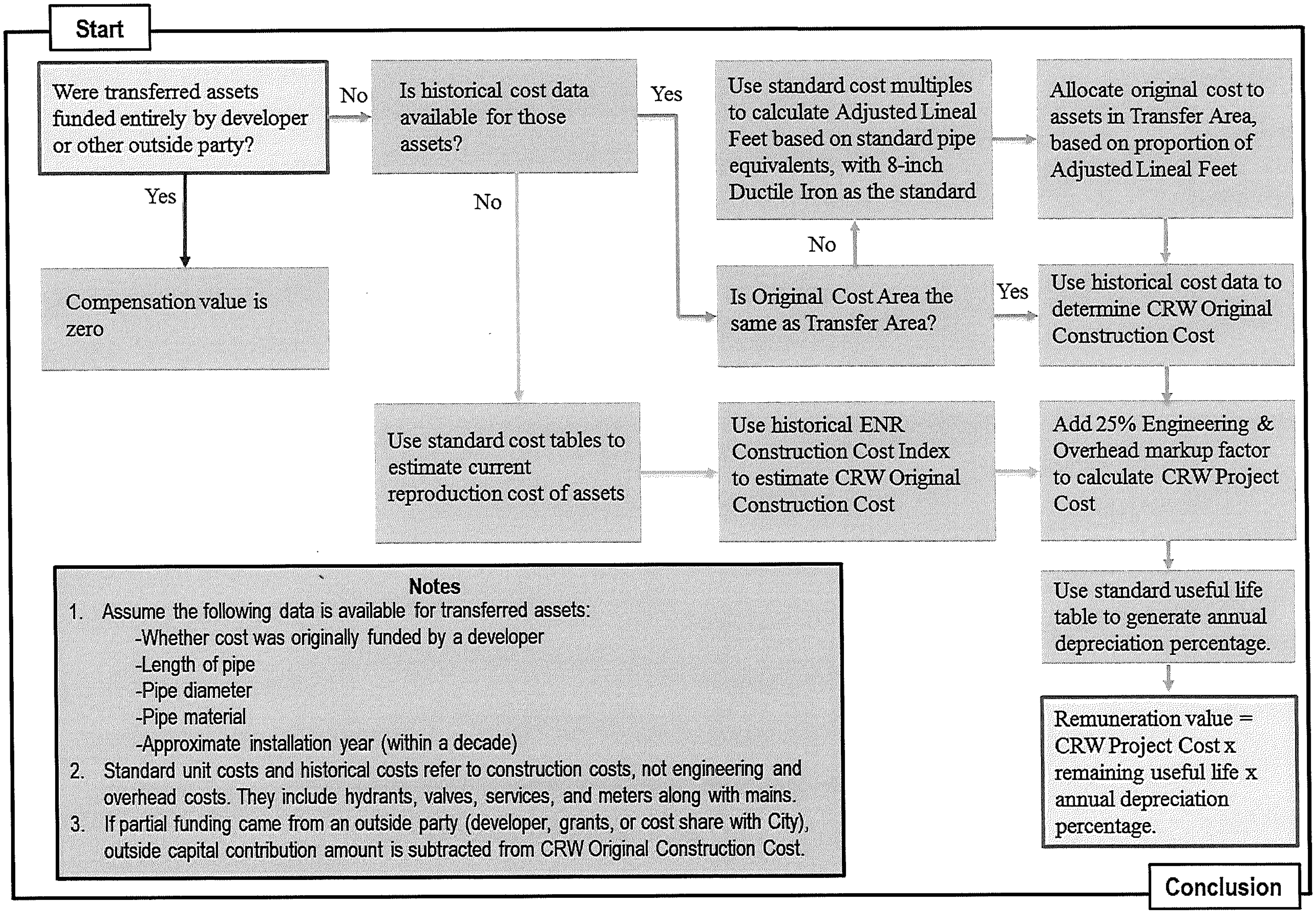
The conflict areas in this study are small, so for CRW, the potential for stranded debt is not a major risk and the "Percentage of Debt Service" method would have no appeal.

SECTION 2: HOW TO CALCULATE ORIGINAL COST LESS DEPRECIATION

OVERVIEW OF METHODOLOGY

Exhibit 2 on the following page gives an overview of the step-by-step approach to determining the Original Cost Less Depreciation. The required steps depend on what data is available and how the assets were originally funded. These steps are described more fully in the subsequent narrative.

Exhibit 2: Calculation Methodology – Remuneration Value of Water System Assets Transferred from CRW to Oregon City



Notes

1. Assume the following data is available for transferred assets:
   - -Whether cost was originally funded by a developer
   - -Length of pipe
   - -Pipe diameter
   - -Pipe material
   - -Approximate installation year (within a decade)
2. Standard unit costs and historical costs refer to construction costs, not engineering and overhead costs. They include hydrants, valves, services, and meters along with mains.
3. If partial funding came from an outside party (developer, grants, or cost share with City), outside capital contribution amount is subtracted from CRW Original Construction Cost.

INFRASTRUCTURE FUNDED BY OUTSIDE PARTIES

The first step is to ask whether any portion of the transferred assets were paid for by a developer or other outside party.

Any part of the transfer area that consists *entirely* of developer-built infrastructure would carry a remuneration value of zero, because CRW ratepayers did not invest in the infrastructure.

If *part* of the cost of an asset was funded by an outside party, then the amount of the outside capital contribution should be excluded from the calculation of the remuneration value, so that CRW is just being compensated for its own ratepayer investment.

- *Ratepayer investment* includes not only cash funding of capital projects but also proceeds of debt that is repaid by rate revenue—either past debt service already paid or future debt service yet to be paid. Either way it counts as ratepayer investment.

In addition to developer-built infrastructure, funding from outside parties could mean a State or federal grant, or it could mean cost-sharing from other agencies--including the City's contribution to the cost of the pipe in South End Road.

Even if a pipe was initially installed by a developer, if CRW made subsequent capital renovations of the pipe, that pipe does have a value based on its cost of renovation.

The general principle is that CRW should be compensated for the cost of that portion of its assets for which its ratepayers were the ultimate source of capital funding.

What if the records are unclear about whether a particular segment of pipe was developer-built or not?

- In that case, a reasonable guess will need to be made by CRW and discussed with the City, based on similar developments of the same approximate age and CRW development policies at the time. If there is no knowledge of standard development policies at the time that a particular set of pipe was constructed, a reasonable default assumption would be that any pipe serving a residential street was built by developers and that the larger pipe connecting neighborhoods was built by CRW.

AVAILABLE DATA

The next step is to consider what historical cost data is available.

This standard methodology assumes that CRW will have good information about its current asset inventory but not necessarily information about when those assets were built or how much they cost. The following data or some reasonable assumptions are needed for the model:

Length of Pipe – CRW should have this data in its inventory.

Pipe Diameter – CRW should have this data in its inventory.

Pipe Material – If this data is not in the CRW inventory, discussion with the City might be needed to arrive at an agreed-upon assumption. It can usually be inferred by the approximate year of installation, along with the type of pipe used in other areas of the same vintage.

Year of Installation – This data may or may not be available in CRW's records. If it is not, a reasonable assumption might need to be made by CRW staff and discussed with the City. Based on a combination of file research and the memory of long-time employees (of either CRW or County development staff), the staff should estimate the approximate decade in which a particular development was built, then assume the midpoint in that decade. In this estimate, our goal is not perfection but the best available.

Original Cost – There might or might not be historical cost data available for a given set of pipes proposed for transfer to the City. The following sections of this memo address both possibilities.

WHEN HISTORICAL COST DATA IS AVAILABLE

Original Cost Area and Transfer Area

Even when historical cost data is available, it is possible that the area to which the original construction data applies is not the same as the area proposed to be transferred to the City. For the sake of explanation, we will refer to two types of boundaries: *Original Cost Area* and *Transfer Area.* These two geographic areas might contain a different set of pipes.

Original Cost Area is defined by the geographic scope of the original construction project when the pipe was first built. Historical cost data applies to the Original Cost Area.

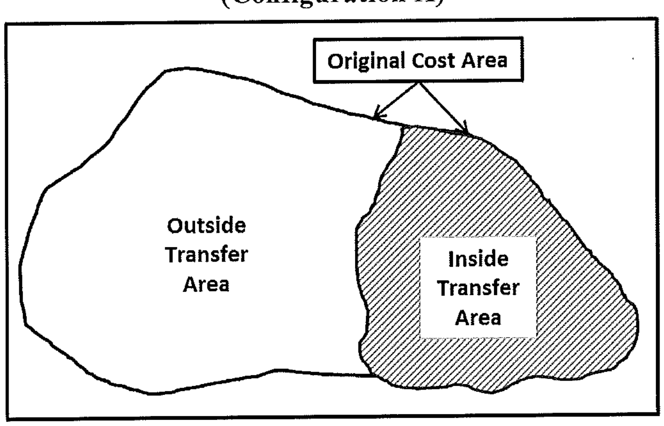
Transfer Area is the area containing the assets that are being transferred to the City.

Potential Types of Correspondence

There are three possible types of correspondence between Original Cost Area and Transfer Area. In this explanation, we will call them Configuration A, B, and C.

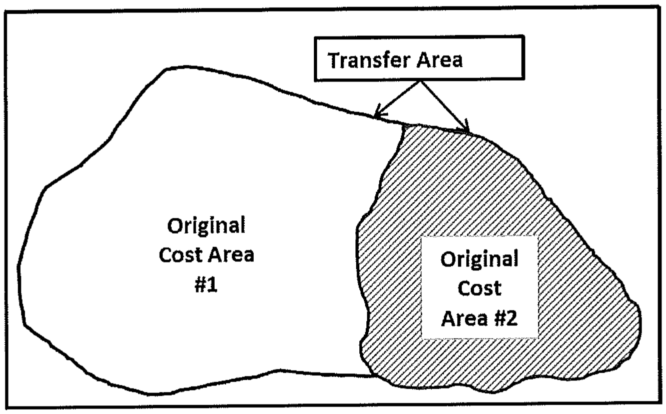
When an area is proposed for transfer from CRW to the City, the staff might find that the original cost data applies to an area that is larger than the Transfer Area, and that the Original Cost Area includes all of the Transfer Area. This is Configuration A, depicted in **Exhibit 3**. We will describe later how this allocation is to be done. In this case, the original costs will have to be allocated between Inside Transfer Area and Outside Transfer Area.

Exhibit 3: Allocate Original Cost Area Between Inside and Outside Transfer Area (Configuration A)



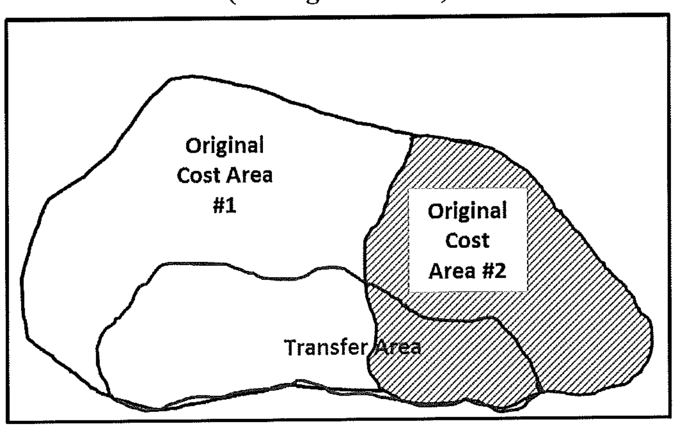
Another possibility is that the Transfer Area is a combination of more than one Original Cost Area. This is Configuration B, depicted in **Exhibit 4**. In this case, all that is needed is to simply add together the OCLD of each Original Cost area.

Exhibit 4: Sum Together Two or More Original Cost Areas (Configuration B)



Finally, the Transfer Area might be a subset of more than one Original Cost Area. This would be Configuration C, illustrated in **Exhibit 5**.

Exhibit 5: Allocate Multiple Original Cost Areas, then Sum Inside Transfer Areas (Configuration C)



In this case, more than one Original Cost Area should be allocated between Inside Transfer Area and Outside Transfer Area. After that calculation, all the Inside Transfer Areas would be summed together to arrive at the remuneration value for the combined Transfer Area. **Exhibit 6** illustrates an allocation with Configuration C, where neither Original Cost Area nor Transfer Area fit inside the other. The data is based on an actual utility valuation. It looks complicated, but it works reliably.

Exhibit 6: Example Valuation When Transfer Area Differs from Original Cost Area

Geographic Areas>>>			Area to be Transferred to City				
			Original Cost Area				
			Costa Estates				
Valuation Components	Total Original Cost Area	Sheldon Acres	Forest Village	Peak View	Total Costa Estates	Green Mountain	Total Transfer Area
District Investment							
Original Construction Cost	$ 2,837,518	$ 953,817	$ 30,077	$1,781,181	$1,883,701	$ -	$1,883,701
Subsequent Capital Improvements	4,401,786	1,612,503	553,692	2,079,315	2,761,354	25,000	2,846,354
Total District Investment	$ 7,239,303	$ 2,566,320	$ 583,769	$3,860,496	$4,645,055	$ 25,000	$4,730,055

Partial Knowledge

Looking at Configuration C raises the question: what if we know the historical costs for one area and do not know the historical costs for another area? That answer is that allocating historical costs between Inside and Outside Transfer Area only is needed when there are historical costs to allocate. If there are no historical costs, a different method is used—one that does not require allocating between different areas. That other method is the standard unit cost table, which is discussed below.

So in the situation depicted above in **Exhibit 5**, imagine that we have records of the original construction costs for Original Cost Area #1, but for Original Cost Area #2, we do not. In that case, the person generating the remuneration value would:

- Allocate the actual historical costs for Original Cost Area #1 between Inside Transfer Area and Outside Transfer Area; then,
- Use the standard unit cost method to estimate the OCLD of just the Inside Transfer Area part of Original Cost Area #2; and then,
- Sum the OCLD of the two Inside Transfer Areas.

Whenever any actual historical costs are available, they are preferable to using the standard unit cost method, even though the actual historical costs might have to be allocated across different areas.

Allocating an Original Cost Area Between Inside and Outside Transfer Area

For this section, we'll assume that historical cost data is available but needs to be allocated between Inside and Outside the Transfer Area. How should that be done?

The simplest approach would be to calculate the average cost per foot (total construction cost divided by total lineal feet) and multiply that unit cost by the number of lineal feet inside the Transfer Area. However, simple lineal feet might not yield an accurate result, so an adjustment is needed to control for the size and type of pipe.

For example, it is possible that an original area included a construction project with a 12" main along a major road along with some smaller 6" mains along side streets, and that the transfer area consists of just the 6" mains. (That seems like a realistic scenario, because the 12" main along the major road might need to remain with CRW for the sake of connectivity.) In that situation, if we simply allocate the construction cost by the number of lineal feet of mains, we will be over-valuing the transfer area.

Standard Pipe Equivalents

We suggest creating a new metric to create equivalence. For this discussion, we call it a "standard pipe equivalent," where the standard pipe is assumed to be an 8" ductile iron pipe. Each type of pipe material can be assigned a standard percentage equivalency in relation to the cost of ductile iron. Similarly, each size of pipe can be assigned a standard multiple in relation to the cost of 8" pipe. The goal of the equivalence factors would be to create a unit cost that can be compared with some other type and size of pipe.

In developing relative cost factors, local is better than national estimates, and recent is better than older estimates. The two parties should agree in advance about which factors should be used in defining the equivalent unit.

Our suggested equivalence factors are shown in **Tables 1 and 2**.

Table 1: Assumed Equivalence for Pipe Material (Table 1 from Model)

Assumed % of Ductile Iron Cost for a Given Size Pipe	
Asbestos Cement	84%
Cast Iron	80%
Ductile Iron	100%
HDPE	70%
PVC	80%
Steel	123%

Table 2: Assumed Equivalence for Pipe Size (Table 2 from Model)

Assumed Multiple of 8" Cost for a Given Pipe Material	
1"	0.43
1.5"	0.49
2"	0.54
2.5"	0.69
3"	0.70
4"	0.78
6"	0.91
8"	1.00
10"	1.11
12"	1.19
14"	1.49
16"	1.51
20"	1.73
24"	1.95
36"	2.16

Sources

Where did these cost relationships come from? It is difficult to assemble enough data from actual bid tabulations from any one utility for the various potential pipe sizes and materials. Some of our past clients have taken the time to compare the cost of various sizes of pipe, but not many do a cost comparison for both size and material of the pipe. However, we performed an appraisal for the City of Vallejo, California in 2012, which had unit costs provided by the engineering firm CH2M for a wide range of pipe sizes and also pipe materials. We had also accumulated from various clients over time a set of cost relationships that dealt with pipe size only, but which included some sizes not found in Vallejo's pipe inventory. So we used that secondary source to fill in gaps in the Vallejo data. That combined set of unit costs became the starting point for the assumed cost relationships between different pipe sizes and materials, shown in Tables 1 and 2.

> **Terminology:** "*Tables*" are part of the model; they are used in the actual calculation of the remuneration value. "*Exhibits*" are only part of the memo; they are used only for explanation or illustration. **Appendix A** shows all of the tables in order.

There are obvious limits with these sources. The CH2M unit costs were developed for a particular situation in northern California in 2012, not intended for use in Oregon in 2017. Those unit costs provided the differentiation we need between pipe sizes and materials, but as we noted earlier about cost estimates, local is better than national, and recent is better than older. So we asked the staff from the Portland office of Murraysmith to review the unit costs in light of their recent experience with construction projects in the Portland area. The Murraysmith staff made some adjustments and brought the whole table up to 2017 price levels. The result was a table of standard unit costs (Table 3 in the model, shown later in this memo). The source data is shown in **Appendix B**.

We have gone into detail in describing the source of the standard estimates in order to convey their limitations as well as their advantages. We do not want to oversell these tables, but even while being clear about their limitations, we believe that they provide a reasonable basis for differentiating between the cost of 8" ductile iron pipe and the cost of alternate materials and sizes. This makes them useful for helping Oregon City and CRW arrive at agreed-upon cost estimates at some future date. Based on discussions with staff from both the City and CRW, our understanding is that these standard cost assumptions are acceptable to both parties.

Example – How to Use Standard Pipe Equivalents

For an example, we will assume an original area that contained 600 lineal feet of 12" ductile iron main plus 1,800 lineal feet of 8" cast iron main. Of that total original area, only the 8" cast iron is proposed to be transferred, while the 12" ductile iron is proposed to be retained by CRW.

Exhibit 7 shows the allocation of a $360,000 construction cost between the two groups of pipe, both with and without an adjustment for standard pipe equivalents.

Exhibit 7: Example Allocation With and Without Adjustment for Standard Pipe Equivalents

Illustration of Use of Standard Pipe Equivalents	Total	12" Ductile Iron Pipe	8" Cast Iron Pipe
		Outside Transfer Area	Inside Transfer Area
Actual Construction Cost	$ 360,000		
Lineal Feet - Original Cost Area	2,400	600	1,800
Cost per Lineal Foot (Unadjusted)	$ 150.00		
Allocation without Adjustment	$ 360,000	$ 90,000	$ 270,000
Adjustment to Standard Pipe Equivalents:			
Adjustment Factor - Pipe Size		1.19	1.00
Adjustment Factor - Pipe Material		100%	80%
Adjusted Lineal Feet	2,154	714	1,440
Cost per Adjusted Lineal Foot	$ 167.13		
Allocation with Adjustment	$ 360,000	$ 119,331	**$ 240,669**
Impact of Adjustment	$ -	$ 29,331	$ (29,331)

If we simply allocate the total cost according to total lineal feet, we end up with an allocated construction cost of $270,000 for the transfer area. That is because each lineal foot in this example cost an average of $150.00 to construct, and there are 1,800 lineal feet inside the transfer area. (This is before adding an overhead factor, discussed later in this memo.)

However, if we adjust for the relative cost of various pipe sizes and materials, the picture changes. Following Tables 1 and 2, a 12" main carries a standard multiple of 1.19 times the unit cost of an 8" main, and a cast iron main is assumed to be on average 80% of the cost of a ductile iron main. So the

"Inside Transfer Area" segment would be 1,800 x 1.00 x 80% = 1,440 adjusted lineal feet, and the "Outside Transfer Area" segment would be 600 x 1.19 x 100% = 714 adjusted lineal feet. The total length of standard pipe equivalents is now 2,154 adjusted lineal feet, and the construction cost averages $167.13 per adjusted lineal foot. Because CRW in this example would be retaining the larger pipe with a higher-quality material, the construction cost allocated to the transfer area would only be $240,669 instead of $270,000—a difference of $29,331.

WHEN HISTORICAL COST DATA IS MISSING

What if there is no historical cost data? In that case there is no need to reconcile the Original Cost Area with the Transfer Area, since there is no Original Cost Area. There is only a Transfer Area, with a known set of pipes of a certain length, material and approximate vintage.

Where there is no historical cost data, developing an Original Cost is a two-step process. First, we use a standard unit cost table to estimate current reproduction cost—what the pipe would cost if built today. Then we use the Engineering News-Record Construction Cost Index (ENR-CCI) to project backwards in time, generating an estimate of what the pipe would have cost when it was installed.

Standard Unit Cost Table for Current Reproduction Costs

We described earlier our process of developing the standard unit costs. Those standard unit costs are shown in **Table 3**. This is our primary tool for dealing with areas where there is missing historical cost data.

Table 3: Standard Unit Costs as of 2017 (Table 3 from Model)

Benchmark Year for Cost Estimates	**2017**	8" Ductile Iron Unit Cost in Benchmark Year				**$159/LF**
Assumed Reference Year	**2017**	8" Ductile Iron Unit Cost in Reference Year				$159/LF
Assumed Reproduction Unit Costs of Water Pipe by Material and Size in Transfer Year 2017						
Size	**Asbestos Cement**	**Cast Iron**	**Ductile Iron**	**HDPE**	**PVC**	**Steel**
1"	57	55	68	48	55	84
1.5"	65	62	78	55	62	96
2"	72	69	86	60	69	106
2.5"	92	88	110	77	88	135
3"	93	89	111	78	89	137
4"	104	99	124	87	99	153
6"	122	116	145	101	116	178
8"	134	127	159	111	127	196
10"	148	141	176	124	141	217
12"	159	151	189	132	151	233
14"	199	190	237	166	190	291
16"	202	192	240	168	192	295
20"	231	220	275	193	220	338
24"	260	248	310	217	248	381
36"	288	275	343	240	275	422
Note: the unit costs shown above represent construction cost only; a 25% markup for engineering and overhead is added later in the calculation. These unit costs are intended to include not just the actual pipe but also the appurtenances (hydrants, valves, services, meters, etc.) customarily installed along with a water line extension.						

In the earlier example (where the transfer area consisted of 1,800 lineal feet of 8-inch cast iron pipe), if historical costs are unavailable, then a current reproduction cost can be estimated by multiplying 1,800 lineal feet by the standard unit cost ($127/LF in 2017). This is illustrated in **Exhibit 8**.

Exhibit 8: Example Using Standard Unit Costs When Historical Cost Data is Missing

Illustration of Use of Standard Cost Table	8" Cast Iron Pipe
	Inside Transfer Area
Construction Cost	
Lineal Feet - Transfer Area	1,800
Cost per Lineal Foot (Table 3)	$ 127.00
Estimated Construction Cost	$ 228,600

Keeping the Standard Unit Costs Up-to-Date

Table 3 has unit costs for 2017. How can we update those costs in future years when an asset transfer might take place? We suggest one of two approaches. Either the unit costs can be benchmarked again using bid data, or—more simply—the table can be adjusted for ENR-CCI inflation.

Terminology: Benchmark Year and Reference Year

In this discussion we will use two terms: "benchmark year" and "reference year." The *benchmark year* is the year for which the most recent unit cost estimates were generated. In this case that is 2017, based on the date of the cost review by Murraysmith. The benchmark year will probably not change often, even when the reference year is changed.

The *reference year* is the most recent year for which a full year of ENR-CCI data is available, at the time a service area transfer is being planned. For example, for a transfer that is scheduled to take place on July 1, 2019, the most up-to-date estimate of the remuneration value could be generated in January of 2019, after the ENR index have been published for all twelve months of 2018. In this example, the *reference year* would be 2018, the year before the planned transfer date. The unit cost tables are set to automatically adjust with the ENR-CCI, but only if the "reference year" cell has been set to the most recent year of ENR index data and that data has been entered into the model. There is now ENR data for all of 2017, so in the model delivered with this memo, the reference year is 2017.

Updating the Benchmark Data

If the two agencies want to update the benchmark costs, one way to do it is to get a recent bid for the construction of 8" ductile iron pipe and divide by the number of lineal feet, leaving the relationship with other pipe sizes and materials as they are in Tables 1 and 2. If that approach is used to update the cost table, then the top row in Table 3—the benchmark year and the benchmark cost per foot of 8" ductile iron pipe—should have new values entered. In the model, the other values in this table will automatically change with the "8-inch Ductile Iron Unit Cost in Benchmark Year" cell.

Adjusting Unit Costs Using the ENR Construction Cost Index

Updating the benchmark data would be a research project that might take a lot of staff time. A simpler alternative is to use the ENR-CCI to escalate the unit costs. Furthermore, even if new benchmark data is generated, there still might be a need to make an inflation adjustment, just because the only available bid tabs for an updated benchmark might have been from a project 3 or 4 years earlier. How should unit costs be updated using the ENR Construction Cost Index?

In the model, updating the unit cost table with the ENR-CCI has two steps. First, enter the most recent ENR-CCI data; second, update the "reference year" in Table 3.

Entering ENR-CCI Data

Exhibit 9 shows recent monthly values for the 20-City Average ENR-CCI. The values through December 2017 are real. The values for January through December 2018 (highlighted in yellow) are hypothetical—they simply assume 4% inflation during the twelve months.

Exhibit 9: Monthly Values of 20-City ENR-CCI (Excerpt from Table 4 in the Model, with Hypothetical Data for January-December 2018)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL AVERAGE
2015	9,971.96	9,961.75	9,972.38	9,992.34	9,975.48	10,036.38	10,037.40	10,038.79	10,065.09	10,128.32	10,092.38	10,135.00	**10,034**
2016	10,132.55	10,181.92	10,242.09	10,279.94	10,315.44	10,337.05	10,379.26	10,385.65	10,403.43	10,434.56	10,442.61	10,530.94	**10,339**
2017	10,542.01	10,558.63	10,667.39	10,678.15	10,692.17	10,702.81	10,789.41	10,826.31	10,822.92	10,817.11	10,870.06	10,873.46	**10,737**
2018	10,963.69	10,980.98	11,094.09	11,105.28	11,119.86	11,130.92	11,220.99	11,259.36	11,255.84	11,249.79	11,304.86	11,308.40	**11,166**
2019													**#N/A**
2020													**#N/A**
2021													**#N/A**

Hypothetical values for Jan-Dec 2018.

Not Valid Until Entire Year Filled

The rightmost column is the average of the values for each month of the year. After a year is completed and the monthly values are entered, the yearly average value can be used to update the unit costs to account for inflation between the benchmark year and the reference year.

A more complete version of this table is shown as Table 4 in Appendix A. When the time comes to generate a new remuneration value estimate, this data will need to be updated. You can either look it up on the ENR web site or you can call FCS GROUP for historical ENR-CCI data.

Updating the Reference Year

After entering the most recent ENR-CCI data, a new reference year will need to be entered at the top of Table 3. The entire table is then updated automatically. **Exhibit 10** shows what this would look like, assuming a transfer date in 2019 and the same inflation we saw in Exhibit 9 for 2018.

Exhibit 10: Unit Cost Table Incorporating Hypothetical Inflation through December 2018

Benchmark Year for Cost Estimates	2017	8" Ductile Iron Unit Cost in Benchmark Year	$159/LF
Assumed Reference Year	2018	8" Ductile Iron Unit Cost in Reference Year	$165/LF

Assumed Reproduction Unit Costs of Water Pipe by Material and Size in Transfer Year 2018						
Size	**Asbestos Cement**	**Cast Iron**	**Ductile Iron**	**HDPE**	**PVC**	**Steel**
1"	60	57	71	50	57	87
1.5"	68	65	81	57	65	100
2"	75	71	89	63	71	110
2.5"	96	91	114	80	91	140
3"	97	93	116	81	93	142
4"	108	103	129	90	103	159
6"	126	120	150	105	120	185
8"	139	132	165	116	132	203
10"	154	147	184	128	147	226
12"	165	157	197	138	157	242
14"	207	197	246	172	197	303
16"	210	200	250	175	200	307
20"	240	229	286	200	229	352
24"	271	258	322	226	258	397
36"	300	286	357	250	286	439

Hypothetical with 2018 inflation data

In this example, our benchmark costs still came from 2017—that hasn't changed. However, the reference year for these cost estimates is a year later—2018 instead of 2017. As a result, the cost of 8" ductile iron pipe is no longer $159 per lineal foot; it is now assumed to be $165 per lineal foot because of the extra year of inflation. The other costs in the table are updated proportionately.

Caution – Enter Inflation Data *Before* Changing the Reference Year

Just as a cautionary note, **Exhibit 11** shows the unit cost table if we specify 2019 as the reference year but no ENR data has been entered for 2019. It doesn't work. The model cannot adjust unit costs to a year for which inflation data has not been entered.

Exhibit 11: Unit Cost Table Where ENR-CCI Data Has Not Been Entered for Reference Year

Benchmark Year for Cost Estimates	2017	8" Ductile Iron Unit Cost in Benchmark Year	$159/LF
Assumed Reference Year	2019	8" Ductile Iron Unit Cost in Reference Year	#N/A

Assumed Reproduction Unit Costs of Water Pipe by Material and Size in Transfer Year 2019						
Size	**Asbestos Cement**	**Cast Iron**	**Ductile Iron**	**HDPE**	**PVC**	**Steel**
1"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
1.5"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2.5"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
6"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
8"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
10"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
12"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
14"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
16"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
20"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
24"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
36"	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

Hypothetical where 2019 is the reference year but no ENR inflation data has been entiered for 2019

Projecting Backwards to Develop Estimated Original Costs

We mentioned earlier (way back, on page 15) that when historical cost data is missing, a two-step process is required. The first step was to use the standard unit cost table, after making sure that the unit costs are up-to-date.

The second step is to project current replacement costs backwards in time to the estimated date when the assets were built, using the historical ENR-CCI.

The unit cost table is useful for estimating *current* reproduction costs (including what might be "current" at some point in the future). However, our methodology for determining the remuneration value depends on the *original* cost of the transferred assets, not the current reproduction costs. The transferred assets might have been built in 2010 or 1980 or 1950. Because of inflation over time, there can be a big difference between the original cost and today's reproduction cost.

In the model accompanying this memo, Table 5 contains the annual average ENR-CCI (averaged over a sample of 20 cities across the country) for each year extending back to 1908. That table is shown in its entirety in Appendix A. A subset of those data points, showing the index every five years, is shown below in **Exhibit 12**.

Exhibit 12: Historical Data from ENR-CCI (Selected Data Points from Table 5)

Engineering News-Record (ENR) 20 City Average Construction Cost Index (CCI)
Assumed Reference Year: 2017

Year	ENR CCI (Yearly Avg)	Yearly Increase	2017 Cost as Multiple of Original Cost	Original Cost as % of 2017 Cost
1908	97	N/A	110.69	0.9%
1910	96	5.5%	111.84	0.9%
1915	93	4.5%	115.45	0.9%
1920	251	26.8%	42.78	2.3%
1925	207	-3.7%	51.87	1.9%
1930	203	-1.9%	52.89	1.9%
1935	196	-1.0%	54.78	1.8%
1940	242	2.5%	44.37	2.3%
1945	308	3.0%	34.86	2.9%
1950	510	6.9%	21.05	4.8%
1955	660	5.1%	16.27	6.1%
1960	824	3.4%	13.03	7.7%
1965	971	3.7%	11.06	9.0%
1970	1,381	8.8%	7.77	12.9%
1975	2,212	9.5%	4.85	20.6%
1980	3,237	7.8%	3.32	30.1%
1985	4,182	0.8%	2.57	39.0%
1990	4,732	2.5%	2.27	44.1%
1995	5,471	1.2%	1.96	51.0%
2000	6,221	2.7%	1.73	57.9%
2005	7,446	4.7%	1.44	69.4%
2010	8,802	2.7%	1.22	82.0%
2015	10,034	2.3%	1.07	93.5%
2016	10,339	3.0%	1.04	96.3%
2017	10,737	3.8%	1.00	100.0%

The reference year shown here is 2017. So in this table, the fourth column shows costs in 2017 as a multiple of costs in a given historical year. The fifth column shows costs in a given historical year as a percentage of costs in 2017. In order to project backwards in time, the model automatically refers to Table 5, finds the year of construction for the assets, then multiplies the current reproduction cost of the assets by the percentage in the fifth column. For example, consider an asset with an estimated 2017 reproduction cost of $500,000 for which the estimated construction year was 1985. The estimated original cost of this asset in 1985 dollars would be 39.0% x $500,000, or $195,000. This approach obviously depends on a lot of averages and theoretical adjustments, but lacking real historical costs, this is a reasonable way to do it.

FINAL STEPS

So far we have developed an estimate of the CRW Original Construction Cost of the assets being transferred, using either actual historical data (with any needed adjustments to match the Original Cost Area with the Transfer Area) or using estimates from a standard unit cost table, which are then projected backward to the year of construction. We have made sure that the City is only compensating CRW for investments that CRW ratepayers have made in the assets, not for pipes paid for by developers, grants, or cost-sharing partnerships.

There are two more steps. One is to add an engineering and overhead markup factor. The other is to factor in depreciation.

Engineering and Overhead Markup Factor

The most readily measurable cost component in any construction project is the direct construction cost—what the contractor charges the owner for building a water line and its appurtenances. However, the full project cost also includes costs that are just as necessary, though less measurable. These "soft costs" include the engineering to design the capital project, project administration, construction inspection, and indirect support (payroll, accounts payable, etc.) for the people who directly perform the project administration, design, or construction.

The most common approach to these costs in intergovernmental contracts is for the parties to agree on a markup percentage that can be applied to the direct construction costs. Based on our experience with other agencies, we suggest a 1.25 markup factor, which implies that engineering and other soft costs average about 25% of direct construction costs. For example, if the Original Construction Cost of a set of pipes is $200,000, the Original Project Cost would be 1.25 x $200,000, or $250,000.

The managers from both the City and CRW indicated support for that factor, so that is built into the procedure we are documenting in this memo. In our terminology, "Original *Construction* Cost" is without the markup factor, while "Original *Project* Cost" includes the markup factor.

Depreciation

Depreciation is a theoretical construct that allows for the value of an asset to diminish over time as the asset becomes more physically or functionally obsolete. In our methodology we assume straight-line depreciation. Under straight-line depreciation, the annual charge simply consists of original asset cost divided by expected useful life. The *annual depreciation percentage* is the percentage of original cost subtracted from the asset value each year. This is calculated as 1 divided by the expected useful life. For example, if a water line is expected to last for 50 years, then the depreciation percentage is 2%, because 1 divided by 50 equals 2%.

With depreciation, the key variable is the expected useful life chosen for a particular type of asset—the longer the expected useful life, the more the remuneration value will be at a given asset age. **Table 6** shows the expected useful life assumptions that were discussed with and agreed upon by managers from both the City and CRW.

Terminology: *Remaining useful life* is the expected useful life minus the age of the asset, but not less than zero. "Net book value" refers to the original cost minus accumulated depreciation over the life of the asset. "Net book value" is also described as the *value of the remaining useful life*. For our purposes, the terms "net book value," "value of remaining useful life," original cost less depreciation" (OCLD), and "remuneration value" all mean the same thing.

Table 6: Assumed Useful Life of Various Types of Pipe

Assumed Asset Useful Lives, By Pipe Material		
	Useful Life	Deprec. %
Asbestos Cement	50 Years	2.00%
Cast Iron	75 Years	1.33%
Ductile Iron	100 Years	1.00%
HDPE	50 Years	2.00%
PVC	50 Years	2.00%
Steel	50 Years	2.00%

Calculating the OCLD

The simplest way to calculate the OCLD is to multiply three quantities: the CRW Original Project Cost, the annual depreciation percentage, and the remaining useful life (which is the expected useful life minus the age of the asset, but not less than zero).

For example, imagine steel water lines with an Original Project Cost of $100,000, to be transferred when 40 years old. In Table 6, steel pipes have a 50-year useful life, implying a 2% annual depreciation percentage. At the transfer date, there are 10 years of remaining useful life. Multiplying the 2% annual depreciation percentage by 10 years means 20% of the value remains. When applied to the $100,000 Original Project Cost, that means $20,000 of value is being transferred.

METHODOLOGY – SUMMARY OF STEPS

1. Examine what data is available about the assets in the transfer area.
2. If infrastructure is entirely developer-funded, then there are no further steps—the remuneration is zero. If there was outside funding that partially contributed to the cost of the assets, make sure that the cost figures only include CRW ratepayer investment.
3. If CRW invested in a group of assets, then research pipe length, diameter, material, installation year, and any relevant original cost figures for the initial construction and any subsequent renovations.
4. If there is data on original costs, compare the Original Cost Area with the Transfer Area. If needed, allocate the cost of pipes in one or more Original Cost Areas between Inside Transfer Area and Outside Transfer Area, and sum the allocated costs for all the Inside Transfer Areas. The allocation should be based on the number of adjusted lineal feet in standard pipe equivalents, where an 8" ductile iron pipe is the standard. Tables 1 and 2 are used for this adjustment. The result of matching up these areas should be a CRW Original Construction Cost for the assets in the Transfer Area.
5. If there is no data on original cost, use the standard cost table (Table 3) to generate a current reproduction cost. (If necessary, update the standard cost table for subsequent inflation by entering the most recent ENR data in Table 4 and then adjusting the reference year in Table 3.) From that point, project backwards in time using the ENR Construction Cost Index history (Table 5) to estimate the CRW Original Construction Cost for the assets in the Transfer Area at the time the pipe was installed. If there is no exact data on the installation year, estimate the decade and assume the midpoint in the decade.
6. After arriving at the CRW Original Construction Cost, add a 25% engineering and overhead markup factor to calculate the CRW Original Project Cost.
7. Based on the type of pipe and the standard useful life in Table 6, identify the depreciation percentage. The remaining useful life consists of the expected total useful life minus the age of this particular asset, but not less than zero.
8. The remuneration value consists of the value of the remaining useful life (also referred to as the "net book value" or the "Original Cost Less Depreciation" or "OCLD"). This is calculated by multiplying the CRW Original Project Cost, the depreciation percentage, and the remaining useful life.

CALCULATIONS FOR ACTUAL CONFLICT AREAS

Appendix A shows calculations for the actual conflict areas discussed in the Murraysmith study. For these estimates, CRW staff provided the pipe lengths, diameter, materials, approximate installation year, and (where available) historical cost information. Tables 1-6 contain the standard cost tables and ENR inflation tables. Tables 7-9 show how the remuneration value can be calculated. For the sake of illustration, the remuneration values in Table 9 assume a transfer year of 2020 for each of the conflict areas. In reality, this parameter would need to be specified whenever a particular area is being considered for transfer from CRW to the City, because the transfer year affects the remaining useful life, which in turn affects the remuneration value.

For the 2001 South End Road water line, the cost detail is shown in **Appendix C**. The Murraysmith analysis divided that project into five pipe segments. The first segment (between the old master meter near John McLaughlin Elementary School and the relocated master meter) was subject to a 50% cost-sharing agreement with the City. The remaining four segments were entirely paid for by CRW.

Because the cost detail for South End Road lumped together the CRW share of the cost, that cost needed to be allocated across the five segments. We did that with a two-step process. First we dealt with the first segment—the 12" ductile iron line between the old and new master meter, for which there was a 50% cost-sharing agreement. We assumed that the CRW share of the first segment matched the City's cost share for each regular line item in the cost breakdown. (The three change orders for that segment were special requests by one party or the other, not subject to the 50% cost sharing, so the total cost of that segment ended up with 50.9% of the cost borne by the City rather than 50%.)

After subtracting the CRW share of the first segment from the total CRW cost, the remainder represented the combined cost for the four segments that were entirely funded by CRW. That cost was allocated to the individual segments based on adjusted lineal feet, using 8" ductile iron as the standard pipe equivalent—the same method that would be used if some segments were inside and other segments were outside the transfer area.

TIPS FOR USING THE MODEL

If no updates are made to the benchmark costs and no further changes are made to the pipe inventory and cost data, then in the future, the tables shown in Appendix A can almost be used as they are. However, three steps will always be required:

1. Update Table 4 (the monthly ENR table) with the most recent data available. FCS GROUP maintains ENR-CCI data in the format used for Table 4. If the parties don't maintain the data themselves, they can always call us, and we can send you our latest ENR index file.
2. Go to Table 3 and enter the most recent full year of ENR data as the "Reference Year." This will automatically update the standard unit costs.
3. Go to Table 9 and specify the planned transfer year for a particular group of pipes.

After those three steps, the rightmost column of Table 9 will show the remuneration value for a given pipe or group of pipes.

Over time, changes will likely be made to the pipe inventory data as a result of new CIP projects or developer-installed infrastructure. If this happens to the segments in the conflict areas identified by Murraysmith, or if a proposed transfer area does not quite fit the Murraysmith pipe segments, then additional rows may need to be added to either Table 7 or 8 (depending on whether there is historical cost data) and also to Table 9. Then the relevant data on pipe material, diameter, length, and date of installation will need to be entered.

In the model, only the cells with blue font are direct-entry cells. The cells with black font are formulas that should not be changed. If new rows need to be added, the formula cells can be copied from existing rows to the new rows. In all cases, of course, the results should be reviewed to ensure that they make sense and any errors are corrected.

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APPENDIX A

Standard Tables in Remuneration Model

- **Table 1:** Assumed % of Ductile Iron Cost for a Given Size Pipe
- **Table 2:** Assumed Multiple of 8" Cost for a Given Pipe Material
- **Table 3:** Standard Unit Costs as of 2017
- **Table 4:** Monthly ENR Construction Cost Index Data (20-City Average), to be Updated in Future Years
- **Table 5:** Annual Average ENR Construction Cost Index, with Factors to Convert Between a Historical Year and a Reference Year
- **Table 6:** Assumed Asset Useful Lives by Pipe Material
- **Table 7:** Original Cost of Transfer Area When Original Cost Data is Available
- **Table 8:** Original Cost of Transfer Area When Original Cost Data is Not Available
- **Table 9:** Calculation of Remuneration Value (CRW Original Cost Less Depreciation)

Table 1: Assumed Equivalents for Pipe Material

Assumed % of Ductile Iron Cost for a Given Size Pipe	
Asbestos Cement	84%
Cast Iron	80%
Ductile Iron	100%
HDPE	70%
PVC	80%
Steel	123%

Table 2: Assumed Equivalents for Pipe Size

Assumed Multiple of 8" Cost for a Given Pipe Material	
1"	0.43
1.5"	0.49
2"	0.54
2.5"	0.69
3"	0.70
4"	0.78
6"	0.91
8"	1.00
10"	1.11
12"	1.19
14"	1.49
16"	1.51
20"	1.73
24"	1.95
36"	2.16

Table 3: Standard Unit Costs as of 2017

Benchmark Year for Cost Estimates	**2017**	8" Ductile Iron Unit Cost in Benchmark Year	**$159/LF**
Assumed Reference Year	**2017**	8" Ductile Iron Unit Cost in Reference Year	$159/LF

Assumed Reproduction Unit Costs of Water Pipe by Material and Size in Transfer Year 2017						
Size	**Asbestos Cement**	**Cast Iron**	**Ductile Iron**	**HDPE**	**PVC**	**Steel**
1"	57	55	68	48	55	84
1.5"	65	62	78	55	62	96
2"	72	69	86	60	69	106
2.5"	92	88	110	77	88	135
3"	93	89	111	78	89	137
4"	104	99	124	87	99	153
6"	122	116	145	101	116	178
8"	134	127	159	111	127	196
10"	148	141	176	124	141	217
12"	159	151	189	132	151	233
14"	199	190	237	166	190	291
16"	202	192	240	168	192	295
20"	231	220	275	193	220	338
24"	260	248	310	217	248	381
36"	288	275	343	240	275	422

Note: the unit costs shown above represent construction cost only; a 25% markup for engineering and overhead is added later in the calculation. These unit costs are intended to include not just the actual pipe but also the appurtenances (hydrants, valves, services, meters, etc.) customarily installed along with a water line extension.

Table 4: Monthly ENR Construction Cost Index Data (20-City Average)

FCS Group Interest Rate Database
ENR-CCI (20-City Average)

ENR Construction Cost Index - 20 City Average: 200 hours of common labor at the 20-city average of common labor rates, plus 25 cwt of standard structural steel shapes at the mill price prior to 1996 and the fabricated 20-city price from 1996, plus 1.128 tons of Portland cement at the 20-city price, plus 1,088 board-ft of 2 x 4 lumber at the 20-city price.

Source: http://enr.construction.com/magazine/archives.asp http://www.enr.com/topics/604-construction-economics
View entire issue > Construction Economics

Enter ENR CCI Index

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL AVERAGE
1990	4,680.00	4,685.00	4,691.00	4,693.00	4,707.00	4,732.00	4,734.00	4,752.00	4,774.00	4,771.00	4,787.00	4,777.00	**4,732**
1991	4,777.00	4,773.00	4,772.00	4,766.00	4,801.00	4,818.00	4,854.00	4,892.00	4,891.00	4,892.00	4,896.00	4,889.00	**4,835**
1992	4,888.00	4,884.00	4,927.00	4,946.00	4,965.00	4,973.00	4,992.00	5,032.00	5,042.00	5,052.00	5,058.00	5,059.00	**4,985**
1993	5,071.00	5,070.00	5,106.00	5,167.00	5,262.00	5,260.00	5,252.00	5,230.00	5,255.00	5,264.00	5,278.00	5,310.00	**5,210**
1994	5,336.00	5,371.00	5,381.00	5,405.00	5,405.00	5,408.00	5,409.00	5,424.00	5,437.00	5,437.00	5,439.00	5,439.00	**5,408**
1995	5,443.00	5,444.00	5,435.00	5,432.00	5,433.00	5,432.00	5,484.00	5,506.00	5,491.00	5,511.00	5,519.00	5,524.00	**5,471**
1996	5,523.00	5,532.00	5,537.00	5,550.00	5,572.00	5,597.00	5,617.00	5,652.00	5,683.00	5,719.00	5,740.00	5,744.00	**5,622**
1997	5,765.00	5,769.00	5,759.00	5,799.00	5,837.00	5,860.00	5,863.00	5,854.00	5,851.00	5,848.00	5,838.00	5,858.00	**5,825**
1998	5,852.00	5,874.00	5,875.00	5,883.00	5,881.00	5,895.00	5,921.00	5,929.00	5,963.00	5,986.00	5,995.00	5,991.00	**5,920**
1999	6,000.00	5,992.00	5,986.00	6,008.00	6,006.00	6,039.00	6,076.00	6,091.00	6,128.00	6,134.00	6,127.00	6,127.00	**6,060**
2000	6,130.00	6,160.00	6,202.00	6,201.00	6,233.00	6,238.00	6,225.00	6,233.00	6,224.00	6,259.00	6,266.00	6,283.00	**6,221**
2001	6,281.00	6,272.00	6,279.00	6,286.00	6,288.00	6,318.00	6,404.00	6,389.00	6,391.00	6,397.00	6,410.00	6,390.00	**6,342**
2002	6,462.00	6,462.00	6,502.00	6,480.00	6,512.00	6,532.00	6,605.00	6,592.00	6,589.00	6,579.00	6,578.00	6,563.00	**6,538**
2003	6,581.00	6,640.00	6,627.00	6,635.00	6,642.00	6,694.00	6,696.00	6,733.00	6,741.00	6,771.00	6,794.00	6,782.00	**6,695**
2004	6,825.00	6,861.00	6,957.00	7,017.00	7,064.00	7,109.00	7,126.00	7,188.00	7,298.00	7,314.00	7,312.00	7,308.00	**7,115**
2005	7,297.00	7,298.00	7,309.00	7,355.00	7,398.00	7,415.00	7,422.00	7,479.00	7,540.00	7,563.00	7,630.00	7,647.00	**7,446**
2006	7,660.00	7,689.00	7,692.00	7,695.00	7,691.00	7,700.00	7,721.00	7,723.00	7,763.00	7,883.00	7,911.00	7,888.00	**7,751**
2007	7,879.58	7,879.54	7,856.27	7,864.70	7,942.00	7,938.58	7,959.17	8,007.48	8,049.65	8,045.14	8,091.81	8,089.45	**7,967**
2008	8,090.06	8,094.28	8,109.00	8,112.00	8,141.00	8,185.00	8,293.00	8,362.00	8,557.00	8,623.00	8,602.45	8,551.32	**8,310**
2009	8,549.06	8,532.73	8,534.00	8,528.39	8,573.87	8,578.28	8,566.14	8,563.80	8,585.71	8,596.31	8,591.79	8,641.45	**8,570**
2010	8,660.08	8,672.00	8,671.07	8,676.68	8,761.00	8,804.79	8,864.72	8,858.00	8,836.00	8,920.54	8,950.64	8,952.40	**8,802**
2011	8,938.30	8,998.02	9,010.80	9,027.23	9,034.67	9,052.64	9,080.15	9,088.24	9,115.95	9,146.95	9,173.21	9,171.73	**9,070**
2012	9,175.94	9,198.29	9,267.57	9,272.95	9,289.65	9,291.40	9,323.58	9,350.99	9,341.03	9,375.52	9,398.41	9,412.25	**9,308**
2013	9,437.27	9,453.02	9,455.98	9,483.70	9,515.86	9,542.33	9,551.78	9,545.33	9,551.58	9,688.86	9,666.46	9,667.77	**9,547**
2014	9,664.00	9,681.11	9,702.00	9,749.51	9,795.92	9,800.38	9,834.63	9,846.00	9,870.12	9,886.06	9,912.01	9,936.44	**9,807**
2015	9,971.96	9,961.75	9,972.38	9,992.34	9,975.48	10,036.38	10,037.40	10,038.79	10,065.09	10,128.32	10,092.38	10,135.00	**10,034**
2016	10,132.55	10,181.92	10,242.09	10,279.94	10,315.44	10,337.05	10,379.26	10,385.65	10,403.43	10,434.56	10,442.61	10,530.94	**10,339**
2017	10,542.01	10,558.63	10,667.39	10,678.15	10,692.17	10,702.81	10,789.41	10,826.31	10,822.92	10,817.11	10,870.06	10,873.46	**10,737**

Not Valid Until Entire Year Filled

Rolling Annual CCI Increases

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	Annual Increase
1991	2.07%	1.88%	1.73%	1.56%	2.00%	1.82%	2.53%	2.95%	2.45%	2.54%	2.28%	2.34%	**2.18%**
1992	2.32%	2.33%	3.25%	3.78%	3.42%	3.22%	2.84%	2.86%	3.09%	3.27%	3.31%	3.48%	**3.10%**
1993	3.74%	3.81%	3.63%	4.47%	5.98%	5.77%	5.21%	3.93%	4.22%	4.20%	4.35%	4.96%	**4.53%**
1994	5.23%	5.94%	5.39%	4.61%	2.72%	2.81%	2.99%	3.71%	3.46%	3.29%	3.05%	2.43%	**3.78%**
1995	2.01%	1.36%	1.00%	0.50%	0.52%	0.44%	1.39%	1.51%	0.99%	1.36%	1.47%	1.56%	**1.18%**
1996	1.47%	1.62%	1.88%	2.17%	2.56%	3.04%	2.43%	2.65%	3.50%	3.77%	4.00%	3.98%	**2.76%**
1997	4.38%	4.28%	4.01%	4.49%	4.76%	4.70%	4.38%	3.57%	2.96%	2.26%	1.71%	1.98%	**3.61%**
1998	1.51%	1.82%	2.01%	1.45%	0.75%	0.60%	0.99%	1.28%	1.91%	2.36%	2.69%	2.27%	**1.64%**
1999	2.53%	2.01%	1.89%	2.12%	2.13%	2.44%	2.62%	2.73%	2.77%	2.47%	2.20%	2.27%	**2.35%**
2000	2.17%	2.80%	3.61%	3.21%	3.78%	3.30%	2.45%	2.33%	1.57%	2.04%	2.27%	2.55%	**2.67%**
2001	2.46%	1.82%	1.24%	1.37%	0.88%	1.28%	2.88%	2.50%	2.68%	2.20%	2.30%	1.70%	**1.94%**
2002	2.88%	3.03%	3.55%	3.09%	3.56%	3.39%	3.14%	3.18%	3.10%	2.85%	2.62%	2.71%	**3.09%**
2003	1.84%	2.75%	1.92%	2.39%	2.00%	2.48%	1.38%	2.14%	2.31%	2.92%	3.28%	3.34%	**2.40%**
2004	3.71%	3.33%	4.98%	5.76%	6.35%	6.20%	6.42%	6.76%	8.26%	8.02%	7.62%	7.76%	**6.28%**
2005	6.92%	6.37%	5.06%	4.82%	4.73%	4.30%	4.15%	4.05%	3.32%	3.40%	4.35%	4.64%	**4.65%**
2006	4.97%	5.36%	5.24%	4.62%	3.96%	3.84%	4.03%	3.26%	2.96%	4.23%	3.68%	3.15%	**4.10%**
2007	2.87%	2.48%	2.14%	2.21%	3.26%	3.10%	3.08%	3.68%	3.69%	2.06%	2.29%	2.55%	**2.78%**
2008	2.67%	2.73%	3.22%	3.14%	2.51%	3.10%	4.19%	4.43%	6.30%	7.18%	6.31%	5.71%	**4.31%**
2009	5.67%	5.42%	5.24%	5.13%	5.32%	4.80%	3.29%	2.41%	0.34%	-0.31%	-0.12%	1.05%	**3.13%**
2010	1.30%	1.63%	1.61%	1.74%	2.18%	2.64%	3.49%	3.44%	2.92%	3.77%	4.18%	3.60%	**2.71%**
2011	3.21%	3.76%	3.92%	4.04%	3.12%	2.81%	2.43%	2.60%	3.17%	2.54%	2.49%	2.45%	**3.04%**
2012	2.66%	2.23%	2.85%	2.72%	2.82%	2.64%	2.68%	2.89%	2.47%	2.50%	2.45%	2.62%	**2.63%**
2013	2.85%	2.77%	2.03%	2.27%	2.44%	2.70%	2.45%	2.08%	2.25%	3.34%	2.85%	2.71%	**2.56%**
2014	2.40%	2.41%	2.60%	2.80%	2.94%	2.70%	2.96%	3.15%	3.33%	2.04%	2.54%	2.78%	**2.72%**
2015	3.19%	2.90%	2.79%	2.49%	1.83%	2.41%	2.06%	1.96%	1.98%	2.45%	1.82%	2.00%	**2.32%**
2016	1.61%	2.21%	2.70%	2.88%	3.41%	3.00%	3.41%	3.46%	3.36%	3.02%	3.47%	3.91%	**3.04%**
2017	4.04%	3.70%	4.15%	3.87%	3.65%	3.54%	3.95%	4.24%	4.03%	3.67%	4.09%	3.25%	**3.85%**

Not Valid Until Entire Year Filled

Table 5: Historical ENR Construction Cost Index – Annual Average

Engineering News-Record (ENR) 20 City Average Construction Cost Index (CCI)
Assumed Reference Year: 2017

Year	ENR CCI (Yearly Avg)	Yearly Increase	2017 Cost as Multiple of Original Cost	Original Cost as % of 2017 Cost
1908	97	N/A	110.69	0.9%
1909	91	-6.2%	117.99	0.8%
1910	96	5.5%	111.84	0.9%
1911	93	-3.1%	115.45	0.9%
1912	91	-2.2%	117.99	0.8%
1913	100	9.9%	107.37	0.9%
1914	89	-11.0%	120.64	0.8%
1915	93	4.5%	115.45	0.9%
1916	130	39.8%	82.59	1.2%
1917	181	39.2%	59.32	1.7%
1918	189	4.4%	56.81	1.8%
1919	198	4.8%	54.23	1.8%
1920	251	26.8%	42.78	2.3%
1921	202	-19.5%	53.15	1.9%
1922	174	-13.9%	61.71	1.6%
1923	214	23.0%	50.17	2.0%
1924	215	0.5%	49.94	2.0%
1925	207	-3.7%	51.87	1.9%
1926	208	0.5%	51.62	1.9%
1927	206	-1.0%	52.12	1.9%
1928	207	0.5%	51.87	1.9%
1929	207	0.0%	51.87	1.9%
1930	203	-1.9%	52.89	1.9%
1931	181	-10.8%	59.32	1.7%
1932	157	-13.3%	68.39	1.5%
1933	170	8.3%	63.16	1.6%
1934	198	16.5%	54.23	1.8%
1935	196	-1.0%	54.78	1.8%
1936	206	5.1%	52.12	1.9%
1937	235	14.1%	45.69	2.2%
1938	236	0.4%	45.49	2.2%
1939	236	0.0%	45.49	2.2%
1940	242	2.5%	44.37	2.3%
1941	258	6.6%	41.62	2.4%
1942	276	7.0%	38.90	2.6%
1943	290	5.1%	37.02	2.7%
1944	299	3.1%	35.91	2.8%
1945	308	3.0%	34.86	2.9%
1946	346	12.3%	31.03	3.2%
1947	413	19.4%	26.00	3.8%
1948	461	11.6%	23.29	4.3%
1949	477	3.5%	22.51	4.4%
1950	510	6.9%	21.05	4.8%
1951	543	6.5%	19.77	5.1%
1952	569	4.8%	18.87	5.3%
1953	628	10.4%	17.10	5.8%
1954	628	0.0%	17.10	5.8%
1955	660	5.1%	16.27	6.1%
1956	692	4.8%	15.52	6.4%
1957	724	4.6%	14.83	6.7%
1958	759	4.8%	14.15	7.1%
1959	797	5.0%	13.47	7.4%
1960	824	3.4%	13.03	7.7%
1961	847	2.8%	12.68	7.9%
1962	872	3.0%	12.31	8.1%
1963	901	3.3%	11.92	8.4%
1964	936	3.9%	11.47	8.7%
1965	971	3.7%	11.06	9.0%
1966	1,019	4.9%	10.54	9.5%
1967	1,074	5.4%	10.00	10.0%
1968	1,155	7.5%	9.30	10.8%
1969	1,269	9.9%	8.46	11.8%
1970	1,381	8.8%	7.77	12.9%
1971	1,581	14.5%	6.79	14.7%
1972	1,753	10.9%	6.12	16.3%
1973	1,895	8.1%	5.67	17.6%
1974	2,020	6.6%	5.32	18.8%
1975	2,212	9.5%	4.85	20.6%
1976	2,401	8.5%	4.47	22.4%
1977	2,576	7.3%	4.17	24.0%
1978	2,776	7.8%	3.87	25.9%
1979	3,003	8.2%	3.58	28.0%
1980	3,237	7.8%	3.32	30.1%
1981	3,535	9.2%	3.04	32.9%
1982	3,825	8.2%	2.81	35.6%
1983	4,066	6.3%	2.64	37.9%
1984	4,148	2.0%	2.59	38.6%
1985	4,182	0.8%	2.57	39.0%
1986	4,295	2.7%	2.50	40.0%
1987	4,406	2.6%	2.44	41.0%
1988	4,519	2.6%	2.38	42.1%
1989	4,615	2.1%	2.33	43.0%
1990	4,732	2.5%	2.27	44.1%
1991	4,835	2.2%	2.22	45.0%
1992	4,985	3.1%	2.15	46.4%
1993	5,210	4.5%	2.06	48.5%
1994	5,408	3.8%	1.99	50.4%
1995	5,471	1.2%	1.96	51.0%
1996	5,622	2.8%	1.91	52.4%
1997	5,825	3.6%	1.84	54.3%
1998	5,920	1.6%	1.81	55.1%
1999	6,060	2.3%	1.77	56.4%
2000	6,221	2.7%	1.73	57.9%
2001	6,342	1.9%	1.69	59.1%
2002	6,538	3.1%	1.64	60.9%
2003	6,695	2.4%	1.60	62.4%
2004	7,115	6.3%	1.51	66.3%
2005	7,446	4.7%	1.44	69.4%
2006	7,751	4.1%	1.39	72.2%
2007	7,967	2.8%	1.35	74.2%
2008	8,310	4.3%	1.29	77.4%
2009	8,570	3.1%	1.25	79.8%
2010	8,802	2.7%	1.22	82.0%
2011	9,070	3.0%	1.18	84.5%
2012	9,308	2.6%	1.15	86.7%
2013	9,547	2.6%	1.12	88.9%
2014	9,807	2.7%	1.09	91.3%
2015	10,034	2.3%	1.07	93.5%
2016	10,339	3.0%	1.04	96.3%
2017	10,737	3.8%	1.00	100.0%

Table 6: Assumed Useful Life of Different Classes of Pipe

Assumed Asset Useful Lives, By Pipe Material		
	Useful Life	Deprec. %
Asbestos Cement	50 Years	2.00%
Cast Iron	75 Years	1.33%
Ductile Iron	100 Years	1.00%
HDPE	50 Years	2.00%
PVC	50 Years	2.00%
Steel	50 Years	2.00%

Table 7: Original Cost of Transfer Area When Historical Cost Data is Available

Conflict Area	Remuneration ID #	Transfer Area	Asset ID #	Original Cost Area	Pipe Material	Pipe Size (inches)	Developer Built?	Installation Year
Note: If transfer area is comprised of more than one original area, determine Inside Transfer Area cost for each original area, then sum them together.								
Park Place	8	Hilltop Road segment	899.1		Ductile Iron	8"	No	2004
Park Place	8	Donovan Road segment	899		Ductile Iron	12"	No	2004
		Total Area		Donovan Rd-Middle School				
Thayer	20	Thayer from Development to UGB	3532	Thayer from Development to UGB	Ductile Iron	12"	No	2003
South End Road	22	J McL ES to New Master Meter	0001	South End Rd - Cost Share Part	Ductile Iron	12"	No	2001
South End Road	23	New Master Meter to Sta 44+85	0002		Ductile Iron	12"	No	2001
South End Road	23	Sta 44+85 to Sta 56+15	0003		Ductile Iron	12"	No	2001
South End Road	23	Sta 56+15 to Sta 59+80	0004		Ductile Iron	12"	No	2001
South End Road	23	Sta 59+8015 to Sta 104+40	0005		Ductile Iron	8"	No	2001
		Total Area		South End Rd - 100% CRW Part				

Transfer Area	Asset ID #	Pipe Length (LF): Total Original Area	Pipe Length (LF): Inside Transfer Area	Pipe Length (LF): Outside Transfer Area	Adjusted Pipe Length (LF, 8" DI-equivalent): Inside Transfer Area	Adjusted Pipe Length (LF, 8" DI-equivalent): Outside Transfer Area	Adjusted Pipe Length (LF, 8" DI-equivalent): Total Original Area	Construction Cost in Original Area
Hilltop Road segment	899.1	2,211 LF	0 LF	2,211 LF	0 LF	2,211 LF	2,211 LF	
Donovan Road segment	899	1,637 LF	1,637 LF	0 LF	1,948 LF	0 LF	1,948 LF	
Total Area		3,848 LF	1,637 LF	2,211 LF	1,948 LF	2,211 LF	4,159 LF	$ 274,938
Thayer from Development to UGB	3532	9,245 LF	9,245 LF	0 LF	11,002 LF	0 LF	11,002 LF	$ 822,725
J McL ES to New Master Meter	0001	4,111 LF	4,111 LF	0 LF	4,892 LF	0 LF	4,892 LF	$ 408,198
New Master Meter to Sta 44+85	0002		445 LF		530 LF	0 LF		
Sta 44+85 to Sta 56+15	0003		1,130 LF		1,345 LF	0 LF		
Sta 56+15 to Sta 59+80	0004		365 LF		434 LF	0 LF		
Sta 59+8015 to Sta 104+40	0005		4,460 LF		4,460 LF	0 LF		
Total Area		6,400 LF	6,400 LF	0 LF	6,769 LF	0 LF	6,769 LF	$ 177,484

Transfer Area	Asset ID #	Construction Cost in Original Area	Partial Outside Funding	CRW Constr. Cost in Original Area	CRW Cost per Adjusted Lineal Foot	Allocated Cost Inside Transfer Area	CRW Orig Constr Cost in Transfer Area
Hilltop Road segment	899.1					$ -	$ -
Donovan Road segment	899					128,777	128,777
Total Area		$ 274,938	$ -	$ 274,938	$ 66.11	$ 128,777	$ 128,777
Thayer from Development to UGB	3532	$ 822,725	$ -	$ 822,725	$ 74.78	$ 822,725	$ 822,725
J McL ES to New Master Meter	0001	$ 408,198	$ 207,669	$ 200,528	$ 40.99	$ 200,528	$ 200,528
New Master Meter to Sta 44+85	0002					$ 13,886	$ 13,886
Sta 44+85 to Sta 56+15	0003					35,260	35,260
Sta 56+15 to Sta 59+80	0004					11,389	11,389
Sta 59+8015 to Sta 104+40	0005					116,949	116,949
Total Area		$ 177,484	$ -	$ 177,484	$ 26.22	$ 177,484	$ 177,484

Table 8: Original Cost of Transfer Area When Historical Cost Data is Not Available

Conflict Area	Remuneration ID #	Transfer Area	Asset ID #	Additional Description	Pipe Material	Pipe Size (inches)	Developer Built?	Installation Year
Leland McCord	4	Leland McCord	709		Steel	8"	No	1960
Leland McCord	4	Leland McCord	1524		Steel	6"	No	1960
Leland McCord	4	Leland McCord	1525		Steel	8"	No	1960
Leland McCord	4	Leland McCord	1937		Steel	8"	No	1960
Leland McCord	4	Leland McCord	2262		Steel	8"	No	1960
		Total Area						
Park Place	1	Holly Lane South to UGB	280		Steel	12"	No	1960
Park Place	1	Holly Lane South to UGB	3533		Steel	12"	No	1960
		Total Area						
Loder	2	Loder from Beavercreek to UGB	303		Ductile Iron	8"	No	1988
Canyon Ridge	6	Canyon Ridge	711		Ductile Iron	6"	Yes	1980
Canyon Ridge	6	Canyon Ridge	712		Ductile Iron	6"	Yes	1980
Canyon Ridge	6	Canyon Ridge	3226		Ductile Iron	6"	Yes	1980
Canyon Ridge	6	Canyon Ridge	3227		Ductile Iron	6"	Yes	1980
Canyon Ridge	6	Canyon Ridge	3228		Ductile Iron	6"	Yes	1980
Canyon Ridge	6	Canyon Ridge	3229		Ductile Iron	6"	Yes	1980
		Total Area						

Transfer Area	Asset ID #	Pipe Length (LF)	Reproduction Cost as of: 2017	ENR Adjustment to Install Year	Est Original Construction Cost	Partial Outside Funding ($)	CRW Original Construction Cost
Leland McCord	709	2,277 LF	$ 446,292	7.7%	$ 34,251	$ -	$ 34,251
Leland McCord	1524	1,658 LF	295,124	7.7%	22,650	-	22,650
Leland McCord	1525	333 LF	$ 65,268	7.7%	$ 5,009	$ -	$ 5,009
Leland McCord	1937	752 LF	147,392	7.7%	11,312	-	11,312
Leland McCord	2262	285 LF	55,860	7.7%	4,287	-	4,287
Total Area		5,305 LF	$ 1,009,936		$ 77,509	$ -	$ 77,509
Holly Lane South to UGB	280	1,292 LF	$ 301,036	7.7%	$ 23,103	$ -	$ 23,103
Holly Lane South to UGB	3533	1,307 LF	304,531	7.7%	23,372	-	23,372
Total Area		2,599 LF	$ 605,567		$ 46,475	$ -	$ 46,475
Loder from Beavercreek to UGB	303	3,686 LF	$ 586,074	42.1%	$ 246,674	$ -	$ 246,674
Canyon Ridge	711	2,016 LF	$ 292,320	30.1%	$ 88,131	$ -	$ -
Canyon Ridge	712	127 LF	18,415	30.1%	5,552	-	-
Canyon Ridge	3226	22 LF	3,190	30.1%	962	-	-
Canyon Ridge	3227	26 LF	3,770	30.1%	1,137	-	-
Canyon Ridge	3228	21 LF	3,045	30.1%	918	-	-
Canyon Ridge	3229	10 LF	1,450	30.1%	437	-	-
Total Area		2,222 LF	$ 322,190		$ 97,137	$ -	$ -

Table 8: Original Cost of Transfer Area When Historical Cost Data is Not Available, continued

Conflict Area	Remun-eration ID #	Transfer Area	Asset ID #	Additional Description	Pipe Material	Pipe Size (inches)	Developer Built?	Installation Year
South End	17	Parkland	2269	Street crossing	Ductile Iron	8"	No	2000
South End	17	Parkland	2385	Original development	Cast Iron	4"	Yes	1970
South End	17	Parkland	3430	Tie-in/hydrant branch-S End Rd CIP	Ductile Iron	6"	No	2000
South End	17	Parkland	3436	Fire hydrant branch	Ductile Iron	6"	No	2000
		Total Area						
Leland McCord	3	Kalal	708		Cast Iron	6"	Yes	1970
Leland McCord	5	Jessie Court	710		Cast Iron	4"	Yes	1970
Leland McCord	10	Jessie Avenue	1030		Cast Iron	6"	Yes	1970
Leland McCord	10	Jessie Avenue	2380		Cast Iron	6"	Yes	1970
Leland McCord	10	Jessie Avenue	3231		Cast Iron	6"	Yes	1970
		Total Area						
South End	12	Salmonberry	1102		Ductile Iron	6"	Yes	1980
South End	12	Salmonberry	1516		Ductile Iron	6"	Yes	1980
South End	12	Salmonberry	1519		Ductile Iron	6"	Yes	1980
South End	12	Salmonberry	1521		Ductile Iron	6"	Yes	1980
South End	12	Salmonberry	N/A	Tie-in - South End Road CIP	Ductile Iron	8"	No	2000
		Total Area						

Transfer Area	Asset ID #	Pipe Length (LF)	Reproduction Cost as of: 2017	ENR Adjustment to Install Year	Est Original Construction Cost	Partial Outside Funding ($)	CRW Original Construction Cost
Parkland	2269	57 LF	$ 9,063	57.9%	$ 5,251	$ -	$ 5,251
Parkland	2385	611 LF	60,489	12.9%	7,780	-	-
Parkland	3430	13 LF	1,885	57.9%	1,092	-	1,092
Parkland	3436	15 LF	2,175	57.9%	1,260	-	1,260
Total Area		696 LF	$ 73,612		$ 15,384	$ -	$ 7,604
Kalal	708	965 LF	$ 111,940	12.9%	$ 14,398	$ -	$ -
Jessie Court	710	242 LF	$ 23,958	12.9%	$ 3,082	$ -	$ -
Jessie Avenue	1030	144 LF	$ 16,704	12.9%	$ 2,149	$ -	$ -
Jessie Avenue	2380	339 LF	39,324	12.9%	5,058	-	-
Jessie Avenue	3231	14 LF	1,624	12.9%	209	-	-
Total Area		497 LF	$ 57,652		$ 7,415	$ -	$ -
Salmonberry	1102	14 LF	$ 2,030	30.1%	$ 612	$ -	$ -
Salmonberry	1516	139 LF	20,155	30.1%	6,077	-	-
Salmonberry	1519	1,162 LF	168,490	30.1%	50,798	-	-
Salmonberry	1521	196 LF	28,420	30.1%	8,568	-	-
Salmonberry	N/A	20 LF	3,180	57.9%	1,843	-	1,843
Total Area		1,531 LF	$ 222,275		$ 67,897	$ -	$ 1,843

Table 8: Original Cost of Transfer Area When Historical Cost Data is Not Available, continued

Conflict Area	Remun-eration ID #	Transfer Area	Asset ID #	Additional Description	Pipe Material	Pipe Size (inches)	Developer Built?	Installation Year
South End	9	South End Court	1028		Steel	4"	Yes	1960
South End	11	Forest Ridge/Maywood Loop	1100	Unsure of location–assume dev built	Asbestos Cement	6"	Yes	1960
South End	11	Forest Ridge/Maywood Loop	1101	Unsure of location–assume dev built	Cast Iron	6"	Yes	1970
South End	11	Forest Ridge/Maywood Loop	1515	Sunnyridge Court	Cast Iron	6"	Yes	1970
South End	11	Forest Ridge/Maywood Loop	1520	Maywood Street	Ductile Iron	6"	Yes	1979
South End	11	Forest Ridge/Maywood Loop	2375	Elizabeth to Sunnyridge	Asbestos Cement	6"	Yes	1960
South End	11	Forest Ridge/Maywood Loop	2376	S. End Road to Elizabeth	Asbestos Cement	6"	Yes	1960
South End	11	Forest Ridge/Maywood Loop	2378	Sunnyridge to Maywood Street	Asbestos Cement	6"	Yes	1960
South End	11	Forest Ridge/Maywood Loop	2386	Elizbeth Court	Cast Iron	4"	Yes	1970
South End	11	Forest Ridge/Maywood Loop	2387	Sunnyridge Court	Cast Iron	4"	Yes	1970
South End	11	Forest Ridge/Maywood Loop	N/A	Tie-in - South End Road CIP	Ductile Iron	8"	No	2000
South End	11	Forest Ridge/Maywood Loop	N/A	Tie-in - South End Road CIP	Ductile Iron	6"	No	2000
		Total Area						
South End	19	Finnegan/Shamrock	N/A	Tie-in - South End Road CIP	Ductile Iron	8"	No	2000
South End	19	Finnegan/Shamrock	2382		Cast Iron	6"	Yes	1970
South End	19	Finnegan/Shamrock	2383		Cast Iron	6"	Yes	1975
South End	19	Finnegan/Shamrock	2384	Shamrock Lane	Cast Iron	6"	Yes	1975
		Total Area						

Transfer Area	Asset ID #	Pipe Length (LF)	Reproduction Cost as of: 2017	ENR Adjustment to Install Year	Est Original Construction Cost	Partial Outside Funding ($)	CRW Original Construction Cost
South End Court	1028	670 LF	$ 102,510	7.7%	$ 7,867	$ -	$ -
Forest Ridge/Maywood Loop	1100	15 LF	$ 1,830	7.7%	$ 140	$ -	$ -
Forest Ridge/Maywood Loop	1101	18 LF	2,088	12.9%	269	-	-
Forest Ridge/Maywood Loop	1515	338 LF	39,208	12.9%	5,043	-	-
Forest Ridge/Maywood Loop	1520	656 LF	95,120	28.0%	26,605	-	-
Forest Ridge/Maywood Loop	2375	336 LF	40,992	7.7%	3,146	-	-
Forest Ridge/Maywood Loop	2376	446 LF	54,412	7.7%	4,176	-	-
Forest Ridge/Maywood Loop	2378	403 LF	49,166	7.7%	3,773	-	-
Forest Ridge/Maywood Loop	2386	267 LF	26,433	12.9%	3,400	-	-
Forest Ridge/Maywood Loop	2387	200 LF	19,800	12.9%	2,547	-	-
Forest Ridge/Maywood Loop	N/A	63 LF	10,017	57.9%	5,804	-	5,804
Forest Ridge/Maywood Loop	N/A	10 LF	1,450	57.9%	840	-	840
Total Area		2,752 LF	$ 340,516		$ 55,743	$ -	$ 6,644
Finnegan/Shamrock	N/A	18 LF	$ 2,862	57.9%	$ 1,658	$ -	$ 1,658
Finnegan/Shamrock	2382	1,911 LF	221,676	12.9%	28,513	-	-
Finnegan/Shamrock	2383	241 LF	27,956	20.6%	5,760	-	-
Finnegan/Shamrock	2384	398 LF	46,168	20.6%	9,512	-	-
Total Area		2,568 LF	$ 298,662		$ 45,442	$ -	$ 1,658

Table 8: Original Cost of Transfer Area When Historical Cost Data is Not Available, continued

Conflict Area	Remuneration ID #	Transfer Area	Asset ID #	Additional Description	Pipe Material	Pipe Size (inches)	Developer Built?	Installation Year
South End	18	Impala	2377	Impala	Ductile Iron	8"	No	2000
South End	7	Rose/Deer	713	Deer Lane	Asbestos Cement	4"	No	1960
South End	7	Rose/Deer	714	Rose	Steel	4"	No	1960
South End	7	Rose/Deer	3091	This line is owned by City				N/A
		Total Area						
South End	16	Forest Ridge/Allen	1980	Allen Court	Steel	4"	Yes	1960
South End	16	Forest Ridge/Allen	2374	Maywood to Allen	Asbestos Cement	6"	Yes	1960
South End	16	Forest Ridge/Allen	2379	Allen west to cul de sac	Asbestos Cement	6"	Yes	1960
		Total Area						
South End	15	Buetel	1979		Steel	6"	No	1960
South End	15	Buetel	2263		Steel	4"	No	1960
		Total Area						

Transfer Area	Asset ID #	Pipe Length (LF)	Reproduction Cost as of: 2017	ENR Adjustment to Install Year	Est Original Construction Cost	Partial Outside Funding ($)	CRW Original Construction Cost
Impala	2377	403 LF	$ 64,077	57.9%	$ 37,128	$ -	$ 37,128
Rose/Deer	713	501 LF	$ 52,104	7.7%	$ 3,999	$ -	$ 3,999
Rose/Deer	714	212 LF	32,436	7.7%	2,489	-	2,489
Rose/Deer	3091	17 LF	-		-	-	-
Total Area		730 LF	$ 84,540		$ 6,488	$ -	$ 6,488
Forest Ridge/Allen	1980	501 LF	$ 76,653	7.7%	$ 5,883	$ -	$ -
Forest Ridge/Allen	2374	212 LF	25,864	7.7%	1,985	-	-
Forest Ridge/Allen	2379	17 LF	-		-	-	-
Total Area		730 LF	$ 102,517		$ 7,868	$ -	$ -
Buetel	1979	501 LF	$ 89,178	7.7%	$ 6,844	$ -	$ 6,844
Buetel	2263	212 LF	32,436	7.7%	2,489	-	2,489
Total Area		713 LF	$ 121,614		$ 9,333	$ -	$ 9,333

Table 8: Original Cost of Transfer Area When Historical Cost Data is Not Available, continued

Conflict Area	Remuneration ID #	Transfer Area	Asset ID #	Additional Description	Pipe Material	Pipe Size (inches)	Developer Built?	Installation Year
South End	13	Navajo	1114	Cul de sac	Ductile Iron	6"	Yes	1979
South End	13	Navajo	1115	South End Rd/Navajo fire hydrant	Ductile Iron	6"	No	1979
South End	13	Navajo	1116	Navajo/S Turquoise Way (north)	Ductile Iron	6"	Yes	1979
South End	13	Navajo	1117	Navajo/S Turquoise Way (south)	Ductile Iron	6"	Yes	1979
South End	13	Navajo	1517	Navajo/S Turquoise to cul de sac	Ductile Iron	6"	Yes	1979
South End	13	Navajo	1518	Navajo/S End Rd to Turquoise Way	Ductile Iron	6"	Yes	1979
South End	13	Navajo	N/A	Tie in - South End Road CIP	Ductile Iron	8"	No	2000
		Total Area						
South End	21	Kelland Court	1209	Kelland Court	Ductile Iron	8"	Yes	1966
South End	21	Kelland Court	3437	Unsure of location–assume dev built	Ductile Iron	8"	Yes	1966
		Total Area						

Transfer Area	Asset ID #	Pipe Length (LF)	Reproduction Cost as of: 2017	ENR Adjustment to Install Year	Est Original Construction Cost	Partial Outside Funding ($)	CRW Original Construction Cost
Navajo	1114	76 LF	$ 11,020	28.0%	$ 3,082	$ -	$ -
Navajo	1115	12 LF	1,740	28.0%	487	-	487
Navajo	1116	140 LF	20,300	28.0%	5,678	-	-
Navajo	1117	229 LF	33,205	28.0%	9,287	-	-
Navajo	1517	801 LF	116,145	28.0%	32,485	-	-
Navajo	1518	626 LF	90,770	28.0%	25,388	-	-
Navajo	N/A	70 LF	11,130	57.9%	6,449	-	6,449
Total Area		1,954 LF	$ 284,310		$ 82,856	$ -	$ 6,936
Kelland Court	1209	1,005 LF	$ 159,795	9.5%	$ 15,166	$ -	$ -
Kelland Court	3437	14 LF	2,226	9.5%	211	-	-
Total Area		1,019 LF	$ 162,021		$ 15,377	$ -	$ -

Table 9: Calculation of Remuneration Value (CRW Original Cost Less Depreciation)

Conflict Area	Remun-eration ID #	Transfer Area	Asset ID #	Original Cost Area/Description	Pipe Material	Pipe Size (inches)	Developer Built?	Installation Year
Park Place	8	Hilltop Road segment	899.1	Donovan Rd-Middle School	Ductile Iron	8"	No	2004
Park Place	8	Donovan Road segment	899	Donovan Rd-Middle School	Ductile Iron	12"	No	2004
		Total Area						
Leland McCord	4	Leland McCord	709		Steel	8"	No	1960
Leland McCord	4	Leland McCord	1524		Steel	6"	No	1960
Leland McCord	4	Leland McCord	1525		Steel	8"	No	1960
Leland McCord	4	Leland McCord	1937		Steel	8"	No	1960
Leland McCord	4	Leland McCord	2262		Steel	8"	No	1960
		Total Area						
Thayer	20	Thayer from Development to UGB	3532	Thayer from Development to UGB	Ductile Iron	12"	No	2003
Park Place	1	Holly Lane South to UGB	280		Steel	12"	No	1960
Park Place	1	Holly Lane South to UGB	3533		Steel	12"	No	1960
		Total Area						
Loder	2	Loder from Beavercreek to UGB	303		Ductile Iron	8"	No	1988

Transfer Area	Asset ID #	Historical Cost Data Available?	CRW Original Construction Cost	Eng/OH Markup 25%	CRW Original Project Cost	Projected Transfer Year	Assumed Useful Life	Annual Depreciation Percentage	Age at Transfer Year	Remaining Useful Life	Remuneration: Value of Remaining Useful Life
		If Yes, formulas refer to Table7 *If No, formulas refer to Table 8*									
Hilltop Road segment	899.1	Yes	$ -	$ -	$ -	2020	100 Years	1.0%	16 Years	84 Years	$ -
Donovan Road segment	899	Yes	128,777	32,194	160,971	2020	100 Years	1.0%	16 Years	84 Years	135,216
Total Area			$ 128,777	$ 32,194	$ 160,971						$ 135,216
Leland McCord	709	No	$ 34,251	$ 8,563	$ 42,814	2020	50 Years	2.0%	60 Years	0 Years	$ -
Leland McCord	1524	No	22,650	5,662	28,312	2020	50 Years	2.0%	60 Years	0 Years	-
Leland McCord	1525	No	5,009	1,252	6,261	2020	50 Years	2.0%	60 Years	0 Years	-
Leland McCord	1937	No	11,312	2,828	14,140	2020	50 Years	2.0%	60 Years	0 Years	-
Leland McCord	2262	No	4,287	1,072	5,359	2020	50 Years	2.0%	60 Years	0 Years	-
Total Area			$ 77,509	$ 19,377	$ 96,886						$ -
Thayer from Development to UGB	3532	Yes	$ 822,725	$ 205,681	$ 1,028,406	2020	100 Years	1.0%	17 Years	83 Years	$ 853,577
Holly Lane South to UGB	280	No	$ 23,103	$ 5,776	$ 28,879	2020	50 Years	2.0%	60 Years	0 Years	$ -
Holly Lane South to UGB	3533	No	23,372	5,843	29,214	2020	50 Years	2.0%	60 Years	0 Years	-
Total Area			$ 46,475	$ 11,619	$ 58,094						$ -
Loder from Beavercreek to UGB	303	No	$ 246,674	$ 61,669	$ 308,343	2020	100 Years	1.0%	32 Years	68 Years	$ 209,673

Table 9: Calculation of Remuneration Value (CRW Original Cost Less Depreciation), continued

Conflict Area	Remuneration ID #	Transfer Area	Asset ID #	Original Cost Area/Description	Pipe Material	Pipe Size (inches)	Developer Built?	Installation Year
Canyon Ridge	6	Canyon Ridge	711		Ductile Iron	6"	Yes	1980
Canyon Ridge	6	Canyon Ridge	712		Ductile Iron	6"	Yes	1980
Canyon Ridge	6	Canyon Ridge	3226		Ductile Iron	6"	Yes	1980
Canyon Ridge	6	Canyon Ridge	3227		Ductile Iron	6"	Yes	1980
Canyon Ridge	6	Canyon Ridge	3228		Ductile Iron	6"	Yes	1980
Canyon Ridge	6	Canyon Ridge	3229		Ductile Iron	6"	Yes	1980
		Total Area						
South End	17	Parkland	2269	Street crossing	Ductile Iron	8"	No	2000
South End	17	Parkland	2385	Original development	Cast Iron	4"	Yes	1970
South End	17	Parkland	3430	Tie-in/hydrant branch-S End Rd CIP	Ductile Iron	6"	No	2000
South End	17	Parkland	3436	Fire hydrant branch	Ductile Iron	6"	No	2000
		Total Area						
Leland McCord	3	Kalal	708		Cast Iron	6"	Yes	1970
Leland McCord	5	Jessie Court	710		Cast Iron	4"	Yes	1970
Leland McCord	10	Jessie Avenue	1030		Cast Iron	6"	Yes	1970
Leland McCord	10	Jessie Avenue	2380		Cast Iron	6"	Yes	1970
Leland McCord	10	Jessie Avenue	3231		Cast Iron	6"	Yes	1970
		Total Area						

Transfer Area	Asset ID #	Historical Cost Data Available?	CRW Original Construction Cost	Eng/OH Markup 25%	CRW Original Project Cost	Projected Transfer Year	Assumed Useful Life	Annual Depreciation Percentage	Age at Transfer Year	Remaining Useful Life	Remuneration: Value of Remaining Useful Life
Canyon Ridge	711	No	$ -	$ -	$ -	2020	100 Years	1.0%	40 Years	60 Years	$ -
Canyon Ridge	712	No	-	-	-	2020	100 Years	1.0%	40 Years	60 Years	-
Canyon Ridge	3226	No	-	-	-	2020	100 Years	1.0%	40 Years	60 Years	-
Canyon Ridge	3227	No	-	-	-	2020	100 Years	1.0%	40 Years	60 Years	-
Canyon Ridge	3228	No	-	-	-	2020	100 Years	1.0%	40 Years	60 Years	-
Canyon Ridge	3229	No	-	-	-	2020	100 Years	1.0%	40 Years	60 Years	-
Total Area			$ -	$ -	$ -						$ -
Parkland	2269	No	$ 5,251	$ 1,313	$ 6,564	2020	100 Years	1.0%	20 Years	80 Years	$ 5,251
Parkland	2385	No	-	-	-	2020	75 Years	1.3%	50 Years	25 Years	-
Parkland	3430	No	1,092	273	1,365	2020	100 Years	1.0%	20 Years	80 Years	1,092
Parkland	3436	No	1,260	315	1,575	2020	100 Years	1.0%	20 Years	80 Years	1,260
Total Area			$ 7,604	$ 1,901	$ 9,505						$ 7,604
Kalal	708	No	$ -	$ -	$ -	2020	75 Years	1.3%	50 Years	25 Years	$ -
Jessie Court	710	No	$ -	$ -	$ -	2020	75 Years	1.3%	50 Years	25 Years	$ -
Jessie Avenue	1030	No	$ -	$ -	$ -	2020	75 Years	1.3%	50 Years	25 Years	$ -
Jessie Avenue	2380	No	-	-	-	2020	75 Years	1.3%	50 Years	25 Years	-
Jessie Avenue	3231	No	-	-	-	2020	75 Years	1.3%	50 Years	25 Years	-
Total Area			$ -	$ -	$ -						$ -

Table 9: Calculation of Remuneration Value (CRW Original Cost Less Depreciation), continued

Conflict Area	Remuneration ID #	Transfer Area	Asset ID #	Original Cost Area/Description	Pipe Material	Pipe Size (inches)	Developer Built?	Installation Year
South End	12	Salmonberry	1102		Ductile Iron	6"	Yes	1980
South End	12	Salmonberry	1516		Ductile Iron	6"	Yes	1980
South End	12	Salmonberry	1519		Ductile Iron	6"	Yes	1980
South End	12	Salmonberry	1521		Ductile Iron	6"	Yes	1980
South End	12	Salmonberry	N/A	Tie-in - South End Road CIP	Ductile Iron	8"	No	2000
		Total Area						
South End	9	South End Court	1028		Steel	4"	Yes	1960
South End	11	Forest Ridge/Maywood Loop	1100	Unsure of location–assume dev built	Asbestos Cement	6"	Yes	1960
South End	11	Forest Ridge/Maywood Loop	1101	Unsure of location–assume dev built	Cast Iron	6"	Yes	1970
South End	11	Forest Ridge/Maywood Loop	1515	Sunnyridge Court	Cast Iron	6"	Yes	1970
South End	11	Forest Ridge/Maywood Loop	1520	Maywood Street	Ductile Iron	6"	Yes	1979
South End	11	Forest Ridge/Maywood Loop	2375	Elizabeth to Sunnyridge	Asbestos Cement	6"	Yes	1960
South End	11	Forest Ridge/Maywood Loop	2376	S. End Road to Elizabeth	Asbestos Cement	6"	Yes	1960
South End	11	Forest Ridge/Maywood Loop	2378	Sunnyridge to Maywood Street	Asbestos Cement	6"	Yes	1960
South End	11	Forest Ridge/Maywood Loop	2386	Elizbeth Court	Cast Iron	4"	Yes	1970
South End	11	Forest Ridge/Maywood Loop	2387	Sunnyridge Court	Cast Iron	4"	Yes	1970
South End	11	Forest Ridge/Maywood Loop	N/A	Tie-in - South End Road CIP	Ductile Iron	8"	No	2000
South End	11	Forest Ridge/Maywood Loop	N/A	Tie-in - South End Road CIP	Ductile Iron	8"	No	2000
		Total Area						

Transfer Area	Asset ID #	Historical Cost Data Available?	CRW Original Construction Cost	Eng/OH Markup 25%	CRW Original Project Cost	Projected Transfer Year	Assumed Useful Life	Annual Depreciation Percentage	Age at Transfer Year	Remaining Useful Life	Remuneration: Value of Remaining Useful Life
Salmonberry	1102	No	$ -	$ -	$ -	2020	100 Years	1.0%	40 Years	60 Years	$ -
Salmonberry	1516	No	-	-	-	2020	100 Years	1.0%	40 Years	60 Years	-
Salmonberry	1519	No	-	-	-	2020	100 Years	1.0%	40 Years	60 Years	-
Salmonberry	1521	No	-	-	-	2020	100 Years	1.0%	40 Years	60 Years	-
Salmonberry	N/A	No	1,843	461	2,303	2020	100 Years	1.0%	20 Years	80 Years	1,843
Total Area			$ 1,843	$ 461	$ 2,303						$ 1,843
South End Court	1028	No	$ -	$ -	$ -	2020	50 Years	2.0%	60 Years	0 Years	$ -
Forest Ridge/Maywood Loop	1100	No	$ -	$ -	$ -	2020	50 Years	2.0%	60 Years	0 Years	$ -
Forest Ridge/Maywood Loop	1101	No	-	-	-	2020	75 Years	1.3%	50 Years	25 Years	-
Forest Ridge/Maywood Loop	1515	No	-	-	-	2020	75 Years	1.3%	50 Years	25 Years	-
Forest Ridge/Maywood Loop	1520	No	-	-	-	2020	100 Years	1.0%	41 Years	59 Years	-
Forest Ridge/Maywood Loop	2375	No	-	-	-	2020	50 Years	2.0%	60 Years	0 Years	-
Forest Ridge/Maywood Loop	2376	No	-	-	-	2020	50 Years	2.0%	60 Years	0 Years	-
Forest Ridge/Maywood Loop	2378	No	-	-	-	2020	50 Years	2.0%	60 Years	0 Years	-
Forest Ridge/Maywood Loop	2386	No	-	-	-	2020	75 Years	1.3%	50 Years	25 Years	-
Forest Ridge/Maywood Loop	2387	No	-	-	-	2020	75 Years	1.3%	50 Years	25 Years	-
Forest Ridge/Maywood Loop	N/A	No	1,843	461	2,303	2020	100 Years	1.0%	20 Years	80 Years	1,843
Forest Ridge/Maywood Loop	N/A	No	1,843	461	2,303	2020	100 Years	1.0%	20 Years	80 Years	1,843
Total Area			$ 3,685	$ 921	$ 4,606						$ 3,685

Table 9: Calculation of Remuneration Value (CRW Original Cost Less Depreciation), continued

Conflict Area	Remuneration ID #	Transfer Area	Asset ID #	Original Cost Area/Description	Pipe Material	Pipe Size (inches)	Developer Built?	Installation Year
South End	19	Finnegan/Shamrock	N/A	Tie-in - South End Road CIP	Ductile Iron	8"	No	2000
South End	19	Finnegan/Shamrock	2382		Cast Iron	6"	Yes	1970
South End	19	Finnegan/Shamrock	2383		Cast Iron	6"	Yes	1975
South End	19	Finnegan/Shamrock	2384	Shamrock Lane	Cast Iron	6"	Yes	1975
		Total Area						
South End	18	Impala	2377	Impala	Ductile Iron	8"	No	2000
South End	7	Rose/Deer	713	Deer Lane	Asbestos Cement	4"	No	1960
South End	7	Rose/Deer	714	Rose	Steel	4"	No	1960
South End	7	Rose/Deer	3091	This line is owned by City				N/A
		Total Area						
South End	16	Forest Ridge/Allen	1980	Allen Court	Steel	4"	Yes	1960
South End	16	Forest Ridge/Allen	2374	Maywood to Allen	Asbestos Cement	6"	Yes	1960
South End	16	Forest Ridge/Allen	2379	Allen west to cul de sac	Asbestos Cement	6"	Yes	1960
		Total Area						
South End	15	Buetel	1979		Steel	6"	No	1960
South End	15	Buetel	2263		Steel	4"	No	1960
		Total Area						

Transfer Area	Asset ID #	Historical Cost Data Available?	CRW Original Construction Cost	Eng/OH Markup 25%	CRW Original Project Cost	Projected Transfer Year	Assumed Useful Life	Annual Depreciation Percentage	Age at Transfer Year	Remaining Useful Life	Remuneration: Value of Remaining Useful Life
Finnegan/Shamrock	N/A	No	$ 1,843	$ 461	$ 2,303	2020	100 Years	1.0%	20 Years	80 Years	$ 1,843
Finnegan/Shamrock	2382	No	-	-	-	2020	75 Years	1.3%	50 Years	25 Years	-
Finnegan/Shamrock	2383	No	-	-	-	2020	75 Years	1.3%	45 Years	30 Years	-
Finnegan/Shamrock	2384	No	-	-	-	2020	75 Years	1.3%	45 Years	30 Years	-
Total Area			$ 1,843	$ 461	$ 2,303						$ 1,843
Impala	2377	No	$ 37,128	$ 9,282	$ 46,410	2020	100 Years	1.0%	20 Years	80 Years	$ 37,128
Rose/Deer	713	No	$ 3,999	$ 1,000	$ 4,998	2020	50 Years	2.0%	60 Years	0 Years	$ -
Rose/Deer	714	No	2,489	622	3,112	2020	50 Years	2.0%	60 Years	0 Years	-
Rose/Deer	3091	No	-	-	-	2020	N/A	N/A	N/A	N/A	-
Total Area			$ 6,488	$ 1,622	$ 8,110						$ -
Forest Ridge/Allen	1980	No	$ -	$ -	$ -	2020	50 Years	2.0%	60 Years	0 Years	$ -
Forest Ridge/Allen	2374	No	-	-	-	2020	50 Years	2.0%	60 Years	0 Years	-
Forest Ridge/Allen	2379	No	-	-	-	2020	N/A	N/A	N/A	N/A	-
Total Area			$ -	$ -	$ -						$ -
Buetel	1979	No	$ 6,844	$ 1,711	$ 8,555	2020	50 Years	2.0%	60 Years	0 Years	$ -
Buetel	2263	No	2,489	622	3,112	2020	50 Years	2.0%	60 Years	0 Years	-
Total Area			$ 9,333	$ 2,333	$ 11,667						$ -

Table 9: Calculation of Remuneration Value (CRW Original Cost Less Depreciation), continued

Conflict Area	Remuneration ID #	Transfer Area	Asset ID #	Original Cost Area/Description	Pipe Material	Pipe Size (inches)	Developer Built?	Installation Year	Historical Cost Data Available?
South End	13	Navajo	1114	Cul de sac	Ductile Iron	6"	Yes	1979	No
South End	13	Navajo	1115	South End Rd/Navajo fire hydrant	Ductile Iron	6"	No	1979	No
South End	13	Navajo	1116	Navajo/S Turquoise Way (north)	Ductile Iron	6"	Yes	1979	No
South End	13	Navajo	1117	Navajo/S Turquoise Way (south)	Ductile Iron	6"	Yes	1979	No
South End	13	Navajo	1517	Navajo/S Turquoise to cul de sac	Ductile Iron	6"	Yes	1979	No
South End	13	Navajo	1518	Navajo/S End Rd to Turquoise Way	Ductile Iron	6"	Yes	1979	No
South End	13	Navajo	N/A	Tie in - South End Road CIP	Ductile Iron	8"	No	2000	No
		Total Area							
South End	21	Kelland Court	1209	Kelland Court	Ductile Iron	8"	Yes	1966	No
South End	21	Kelland Court	3437	Unsure of location–assume dev built	Ductile Iron	8"	Yes	1966	No
		Total Area							
South End Road	22	J McL ES to New Master Meter	0001	South End Rd - Cost Share Part	Ductile Iron	12"	No	2001	Yes
South End Road	23	New Master Meter to Sta 44+85	0002	South End Rd - 100% CRW Part	Ductile Iron	12"	No	2001	Yes
South End Road	23	Sta 44+85 to Sta 56+15	0003	South End Rd - 100% CRW Part	Ductile Iron	12"	No	2001	Yes
South End Road	23	Sta 56+15 to Sta 59+80	0004	South End Rd - 100% CRW Part	Ductile Iron	12"	No	2001	Yes
South End Road	23	Sta 59+8015 to Sta 104+40	0005	South End Rd - 100% CRW Part	Ductile Iron	8"	No	2001	Yes
		Total Area							

Transfer Area	Asset ID #	Historical Cost Data Available?	CRW Original Construction Cost	Eng/OH Markup 25%	CRW Original Project Cost	Projected Transfer Year	Assumed Useful Life	Annual Depreciation Percentage	Age at Transfer Year	Remaining Useful Life	Remuneration: Value of Remaining Useful Life
Navajo	1114	No	$ -	$ -	$ -	2020	100 Years	1.0%	41 Years	59 Years	$ -
Navajo	1115	No	487	122	608	2020	100 Years	1.0%	41 Years	59 Years	359
Navajo	1116	No	-	-	-	2020	100 Years	1.0%	41 Years	59 Years	-
Navajo	1117	No	-	-	-	2020	100 Years	1.0%	41 Years	59 Years	-
Navajo	1517	No	-	-	-	2020	100 Years	1.0%	41 Years	59 Years	-
Navajo	1518	No	-	-	-	2020	100 Years	1.0%	41 Years	59 Years	-
Navajo	N/A	No	1,843	461	2,303	2020	100 Years	1.0%	20 Years	80 Years	1,843
Total Area			$ 2,329	$ 582	$ 2,912						$ 2,202
Kelland Court	1209	No	$ -	$ -	$ -	2020	100 Years	1.0%	54 Years	46 Years	$ -
Kelland Court	3437	No	-	-	-	2020	100 Years	1.0%	54 Years	46 Years	-
Total Area			$ -	$ -	$ -						$ -
J McL ES to New Master Meter	0001	Yes	$ 200,528	$ 50,132	$ 250,660	2020	100 Years	1.0%	19 Years	81 Years	$ 203,035
New Master Meter to Sta 44+85	0002	Yes	$ 13,886	$ 3,471	$ 17,357	2020	100 Years	1.0%	19 Years	81 Years	$ 14,059
Sta 44+85 to Sta 56+15	0003	Yes	35,260	8,815	44,075	2020	100 Years	1.0%	19 Years	81 Years	35,701
Sta 56+15 to Sta 59+80	0004	Yes	11,389	2,847	14,237	2020	100 Years	1.0%	19 Years	81 Years	11,532
Sta 59+8015 to Sta 104+40	0005	Yes	116,949	29,237	146,186	2020	100 Years	1.0%	19 Years	81 Years	118,411
Total Area			$ 177,484	$ 44,371	$ 221,855						$ 179,703
Total Conflict Areas Identified by Murraysmith			$ 1,770,425	$ 442,606	$ 2,213,032						$ 1,635,508

APPENDIX B

Source Data for Standard Costs:

Exhibit B-1: Unit Cost Data from Vallejo, California 2012 Appraisal

Exhibit B-2: Supplemental Unit Cost Assumptions - Lakehaven Water & Sewer District Model

Exhibit B-3: August 3, 2017 Update by Brian Ginter of Murraysmith, Based on Local Data

Exhibit B-1: Data from Vallejo, California 2012 Appraisal

Unit costs originally provided by CH2M-Hill were specific to that time and location
They were used here as a starting point that differentiates different types of materials.

Pipe Size (inches)	Pipe Material	Unit Reproduction Cost	Unit Cost as Multiple of 8" for Given Material	Unit Price as % of DI for Given Size
2.5	CI	98	0.69	N/A
4	CI	112	0.78	N/A
4	PVC	112	0.80	N/A
4	AC	112	0.75	N/A
6	HDPE	110	0.87	71%
6	CI	126	0.88	81%
6	AC	130	0.87	84%
6	PVC	140	1.00	90%
6	DI	155	0.86	100%
6	Steel	199	1.00	129%
8	HDPE	126	1.00	70%
8	PVC	140	1.00	78%
8	CI	143	1.00	80%
8	AC	149	1.00	83%
8	DI	179	1.00	100%
8	Steel	200	1.00	112%
10	CI	155	1.08	N/A
12	HDPE	170	1.35	N/A
12	PVC	170	1.21	N/A
14	PVC	184	1.32	70%
14	DI	263	1.47	100%
14	Steel	337	1.69	128%
24	Steel	526	2.63	N/A
Average % of Ductile Iron (DI) for Applicable Sizes:				
	CI			80%
	AC			84%
	HDPE			70%
	PVC			80%
	DI			100%
	Steel			123%
Average Multiple of 8" for Applicable Materials:				
2.5			0.69	
4			0.78	
6			0.91	
8			1.00	
10			1.08	
12			1.28	
14			1.49	
24			2.63	

Exhibit B-2: Supplemental Assumptions from Lakehaven Water & Sewer District Model

Composite profile drawn from multiple clients over the years, used when reasonable assumptions are needed about cost relationships across wide range of pipe sizes. Used here to fill in gaps for pipe sizes not included in Vallejo data.

Size	Price per Lineal Foot	Unit Price as Multiple of 8"
1"	80	0.43
1.5"	90	0.49
2"	100	0.54
3"	115	0.62
4"	130	0.70
6"	160	0.86
8"	185	1.00
10"	215	1.16
12"	230	1.24
14"	250	1.35
16"	280	1.51
20"	320	1.73
24"	360	1.95
36"	400	2.16

Exhibit B-3: August 3, 2017 Update by Brian Ginter of Murraysmith, Based on Local Data

Benchmark Year: 2017

Size	Material	Construction Cost ($/LF)	Implied Multiple of 8"
8"	Ductile Iron	159	1.00
10"	Ductile Iron	176	1.11
12"	Ductile Iron	189	1.19

APPENDIX C

Backup Data for South End Road 2001 Water Line Construction Project:

Exhibit C-1: Cost of South End Road 2001 Water Line Project – Allocation to Segments

Exhibit C-2: South End Road - Cost Sharing Detail between City and CRW

Exhibit C-1: Cost of South End Road 2001 Water Line Project

Segment #	South End Road Project Costs — Assuming Data from Cost Detail	Length of Pipe: Lineal Feet	Adjusted Lineal Feet	% of Adjusted Lineal Feet	Cost ($): Cost-Share Segment — City Share	CRW Share	Total	100% CRW Segment	Total CRW Cost	Total Project
	Cost-sharing Segment:				50.9%	49.1%	100.0%			
0001	12" DI - J McLoughlin ES to Sta 40+40	4,432 LF			$ 207,669	$ 200,528	$ 408,198	$ -	$ 200,528	$ 408,198
	100% CRW Segments:									
0002	12" DI - Sta 40+40 to Sta 44+85 (2001 UGB)	429 LF	510 LF	7%				13,199	13,199	13,199
0003	12" DI - Sta 44+85 to Sta 56+15 (2006 UGB)	1,089 LF	1,294 LF	19%				33,516	33,516	33,516
0004	12" DI - Sta 56+15 to Sta 59+80 (May Road)	352 LF	418 LF	6%				10,826	10,826	10,826
0005	8" DI Sta 59+8015 to Sta 104+40 (end of project)	4,631 LF	4,631 LF	68%				119,943	119,943	119,943
	Total	10,932 LF	6,853 LF	100%	$ 207,669	$ 200,528	$ 408,198	$ 177,484	$ 378,012	$ 585,682

Adjusted lineal feet is based on standard pipe cost equivalent of 8" Ductile Iron.

Exhibit C-2: Detailed Breakdown for Cost-Share Segment between City and CRW – South End Road

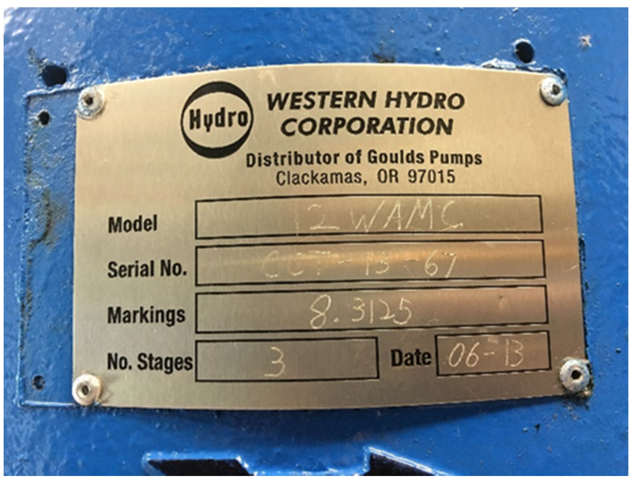
Data from Cost Detail		Lineal Feet			Cost ($)					
Source: Bob George, CRW		Cost-Share Segment	100% CRW Segment	Total Project	Cost-Share Segment: City Share	Cost-Share Segment: CRW Share	Cost-Share Segment: Total	100% CRW	Total CRW Cost	Total Project
Pipe										
12" Ductile Iron:										
Non-restrained	Class A	105 LF	855 LF	960 LF	$ 1,050	$ 1,050	$ 2,100	$ 17,100	$ 18,150	$ 19,200
	Class D	3,589 LF	748 LF	4,337 LF	$ 73,575	73,575	147,149	30,668	104,243	177,817
Restrained	Class D	417 LF	266 LF	683 LF	$ 12,302	12,302	24,603	15,694	27,996	40,297
Total 12" Ductile Iron		4,111 LF	1,869 LF	5,980 LF	$ 86,926	$ 86,926	$ 173,852	$ 63,462	$ 150,388	$ 237,314
8" Ductile Iron:										
Non-restrained	Class A	0 LF	4,211 LF	4,211 LF	$ -	$ -	$ -	$ 71,587	$ 71,587	$ 71,587
	Class D	0 LF	30 LF	30 LF	-	-	-	1,050	1,050	1,050
Restrained	Class A or D	0 LF	390 LF	390 LF	-	-	-	17,550	17,550	17,550
	Class F	240 LF	0 LF	240 LF	8,880	8,880	17,760	-	8,880	17,760
Total 8" Ductile Iron		240 LF	4,631 LF	4,871 LF	$ 8,880	$ 8,880	$ 17,760	$ 90,187	$ 99,067	$ 107,947
6" Ductile Iron:										
Restrained	Class D	67 LF	0 LF	67 LF	1,508	1,508	3,015	$ -	$ 1,508	$ 3,015
	Class F	14 LF	0 LF	14 LF	525	525	1,050	-	525	1,050
Total 6" Ductile Iron		81 LF	0 LF	81 LF	$ 2,033	$ 2,033	$ 4,065	$ -	$ 2,033	$ 4,065
Total Pipe		4,432 LF	6,500 LF	10,932 LF	$ 97,839	$ 97,839	$ 195,677	$ 153,649	$ 251,488	$ 349,326
Other Cost Elements										
Mobilization					$ 14,500	$ 14,500	$ 29,000	$ -	$ 14,500	$ 29,000
Gate valves and boxes					13,750	13,750	27,500	5,550	19,300	33,050
Reconnect hydrant					-	-	-	750	750	750
New hydrants					6,300	6,300	12,600	1,800	8,100	14,400
1" combination air relief valve					250	250	500	1,500	1,750	2,000
MJ adaptors					1,600	1,600	3,200	550	2,150	3,750
Elbows, crosses and tees					7,978	7,978	15,955	3,100	11,078	19,055
Miscellaneous fittings					993	993	1,985	185	1,178	2,170
Replace services					5,925	5,925	11,850	800	6,725	12,650
Transfer existing services					1,350	1,350	2,700	-	1,350	2,700
Hot tapping sleeve and valve					3,800	3,800	7,600	1,800	5,600	9,400
Master meter vault					11,500	11,500	23,000	-	11,500	23,000
Surface restoration					16,164	16,164	32,328	400	16,564	32,728
Tree and stump removal					1,750	1,750	3,500	-	1,750	3,500
General surface restoration					750	750	1,500	-	750	1,500
Water line abandonment					500	500	1,000	-	500	1,000
Connect to existing pipes					2,500	2,500	5,000	-	2,500	5,000
Roadside ditch restoration					-	-	-	7,400	7,400	7,400
Testing/flushing					500	500	1,000	-	500	1,000
Removal of pipes from existing vault					500	500	1,000	-	500	1,000
Sheeting, shoring & traffic control					1,000	1,000	2,000	-	1,000	2,000
Change order #1					8,727	772	9,498	-	772	9,498
Change order #2					7,959	9,959	17,918	-	9,959	17,918
Change order #3					1,536	350	1,886	-	350	1,886
Total Other Cost Elements					$ 109,831	$ 102,690	$ 212,521	$ 23,835	$ 126,525	$ 236,356
Total Project					$ 207,669	$ 200,528	$ 408,198	$ 177,484	$ 378,012	$ 585,682
					50.9%	49.1%	100.0%		64.5%	100.0%

Appendix F

FIELD VISIT PHOTOS

FIELD VISIT: PHOTOS OF FACILITIES

GLEN OAK PUMP STATION:




WARNING

HENRICI RESERVOIRS:

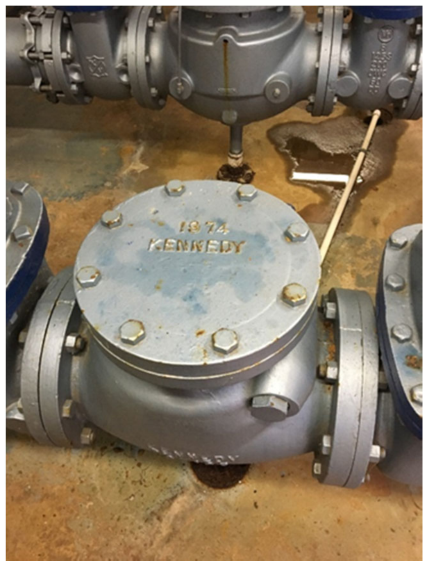
BEAVERCREEK SITE:

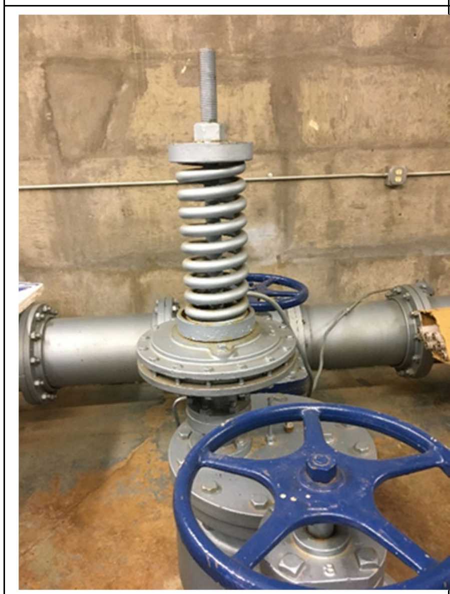






INDUCTION MOTOR
MODEL5K324YK294
HP 40
SERVICE FACTOR 1.15
FL RPM 1755
VOLTS 230/460
CYCLES
FL AMP 104/52
TYPE K FRAME
INSULATION CLASS B
MAX AMBIENT 40
60BC03

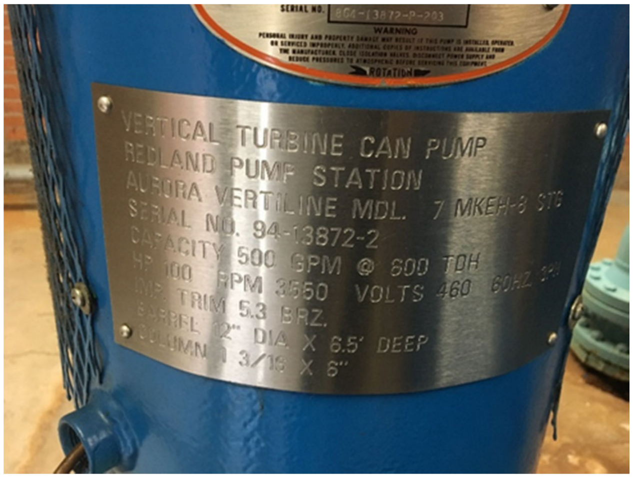

KENNEDY

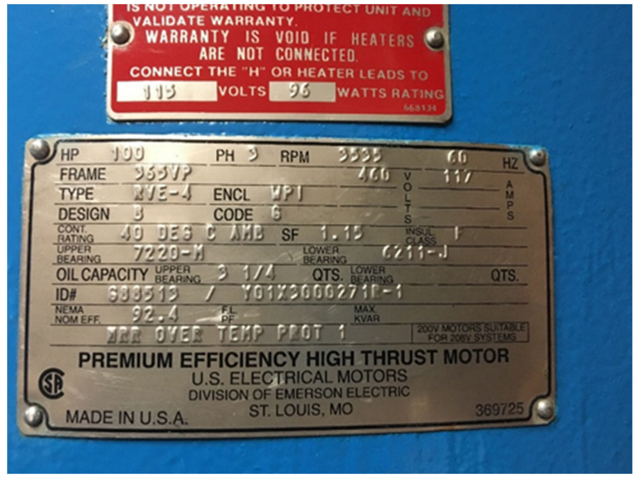


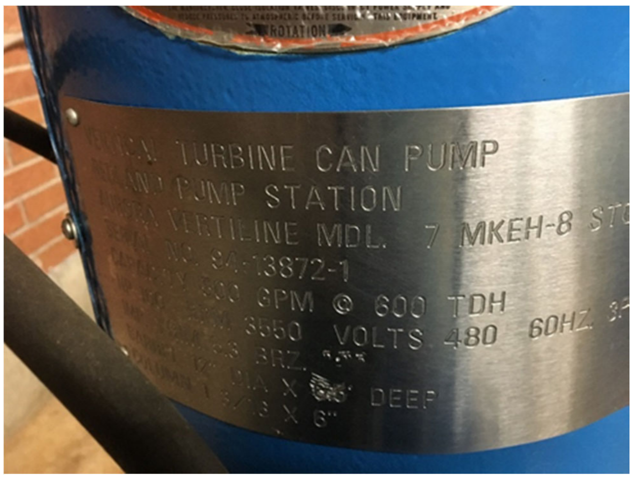
REDLAND RESERVOIRS:

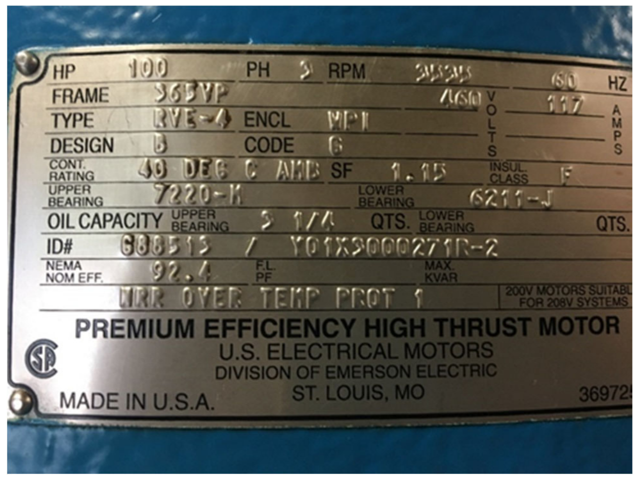
	
	
	

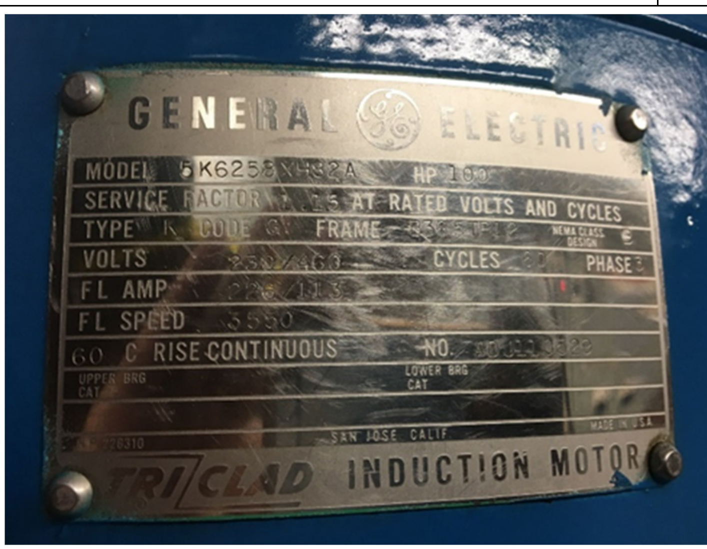
REDLAND PUMP STATION:


WARNING
ROTATION
VERTICAL TURBINE CAN PUMP
REDLAND PUMP STATION
AURORA VERTILINE MDL. 7 MKEH-8 STG
SERIAL NO. 94-13872-2
CAPACITY 500 GPM @ 600 TDH
HP 100 RPM 3550 VOLTS 460 60HZ
IMP TRIM 5.3 BRZ.
BARREL 12" DIA X 6.5' DEEP
X 6"


VALIDATE WARRANTY.
WARRANTY IS VOID IF HEATERS ARE NOT CONNECTED.
CONNECT THE "H" OR HEATER LEADS TO
115 VOLTS 96 WATTS RATING
HP 100 PH 3 RPM 3535 60 HZ
FRAME 365VP 460 VOLTS 117 AMPS
TYPE RVE-4 ENCL WPI
DESIGN B CODE G
CONT. RATING 40 DEG C AMB SF 1.15 INSUL CLASS F
UPPER BEARING 7220-M LOWER BEARING 6211-J
OIL CAPACITY UPPER BEARING 3 1/4 QTS. LOWER BEARING QTS.
ID# 688513 / Y01X3000271R-1
NEMA NOM EFF. 92.4 FL PF MAX KVAR
WRR OVER TEMP PROT 1
200V MOTORS SUITABLE FOR 208V SYSTEMS
PREMIUM EFFICIENCY HIGH THRUST MOTOR
U.S. ELECTRICAL MOTORS
DIVISION OF EMERSON ELECTRIC
ST. LOUIS, MO
MADE IN U.S.A.
369725


ROTATION
TURBINE CAN PUMP
PUMP STATION
VERTILINE MDL. 7 MKEH-8 STG
94-13872-1
GPM @ 600 TDH
3550 VOLTS 480 60HZ
DEEP
X 6"

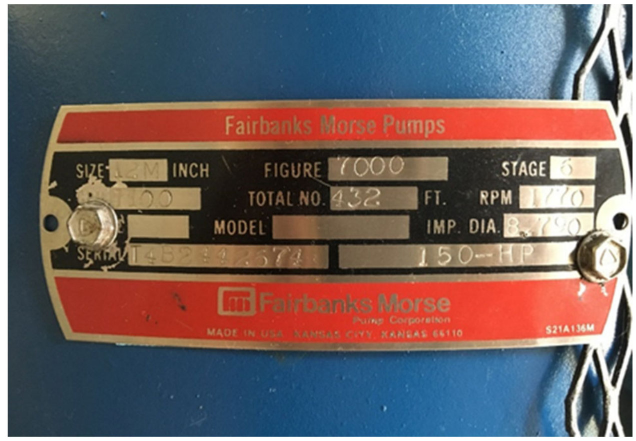

HP 100 PH 3 RPM 3535 60 HZ
FRAME 365VP 460 VOLTS 117 AMPS
TYPE RVE-4 ENCL WPI
DESIGN B CODE G
CONT. RATING 40 DEG C AMB SF 1.15 INSUL. CLASS F
UPPER BEARING 7220-M LOWER BEARING 6211-J
OIL CAPACITY UPPER BEARING 3 1/4 QTS. LOWER BEARING QTS.
ID# 688513 / Y01X3000271R-2
NEMA NOM EFF. 92.4 FL PF MAX KVAR
WRR OVER TEMP PROT 1
200V MOTORS SUITABLE FOR 208V SYSTEMS
PREMIUM EFFICIENCY HIGH THRUST MOTOR
U.S. ELECTRICAL MOTORS
DIVISION OF EMERSON ELECTRIC
ST. LOUIS, MO
MADE IN U.S.A.


GENERAL ELECTRIC
MODEL 5K6258XH82A HP 100
SERVICE FACTOR 1.15 AT RATED VOLTS AND CYCLES
TYPE K CODE G FRAME
NEMA CLASS DESIGN
VOLTS 230/460 CYCLES 60 PHASE 3
FL AMP 226/113
FL SPEED 3550
60 C RISE CONTINUOUS NO.
UPPER BRG CAT
LOWER BRG CAT
SAN JOSE CALIF
MADE IN U.S.A.
TRI/CLAD INDUCTION MOTOR


GENERAL ELECTRIC
TRI/CLAD INDUCTION MOTOR
LUBRICATION AND ASSEMBLY INSTRUCTIONS
USE ONLY OXIDATION-CORROSION INHIBITED TURBINE OIL HAVING A VISCOSITY OF 150 SUS AT 100°F. AND 45 SUS AT 210°F. WITH MOTOR AT STANDSTILL, FILL UNTIL OIL LEVEL IS 1/8 INCH BELOW CENTER OF SIGHT GAGE. CHANGE OIL TWICE YEARLY OR OFTENER DEPENDING ON SERVICE CONDITIONS. AVOID OPERATION WITH OXIDIZED OIL.
OIL CAPACITY-UPPER QTS. LOWER QTS.
USE BALL BEARING GREASE-GE SPEC. D6A2C5
BEARINGS UPPER THRUST CAT
LOWER GUIDE CAT
MOTOR IS BUILT TO RESIST MOMENTARY UPTHRUST. DURING REASSEMBLY OF MOTOR DO THE FOLLOWING TO AVOID DAMAGING LOWER BEARING.
REMOVE ENDPLAY BY TIGHTENING NUT "A" UNTIL LOWER BEARING "B" IS PULLED UP AGAINST ITS COVER "C" AND ROTOR BINDS SLIGHTLY. BACK OFF NUT "A" (USUALLY ABOUT 1/8 TURN) UNTIL ROTOR TURNS FREELY. LOCK NUT "A" WITH ITS LOCK WASHER.
MADE IN U.S.A.

HOLLY LANE PUMP STATION:


MODEL
9 STG 12CS
SERIAL
16972 7½
CORNELL MANUFACTURING CO.
OREGON


Fairbanks Morse Pumps
SIZE 12M INCH
FIGURE 7000
STAGE 6
TOTAL NO. 432 FT.
RPM 1770
MODEL
IMP. DIA. 8.790
150 HP
Fairbanks Morse
Pump Corporation
MADE IN USA KANSAS CITY, KANSAS 66110
S21A136M

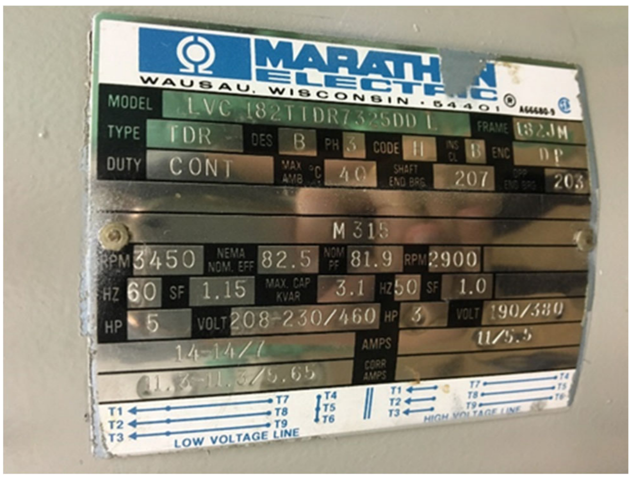

GENERAL ELECTRIC
INDUCTION MOTOR
THERMAL PROTECTION

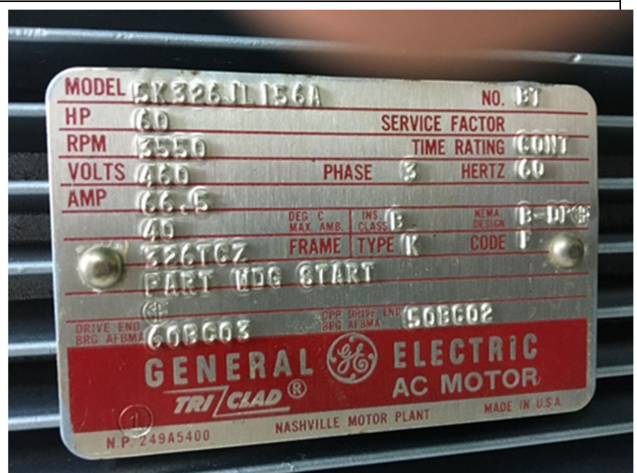

Fairbanks Morse Pumps
SIZE 12M INCH
FIGURE 7000
STAGE 6
TOTAL NO. 432 FT.
RPM 1770
MODEL
IMP. DIA. 8.790
150 HP
Fairbanks Morse
Pump Corporation
MADE IN USA KANSAS CITY, KANSAS 66110
S21A136M

BARLOW CREST PUMP STATION AND RESERVOIR:

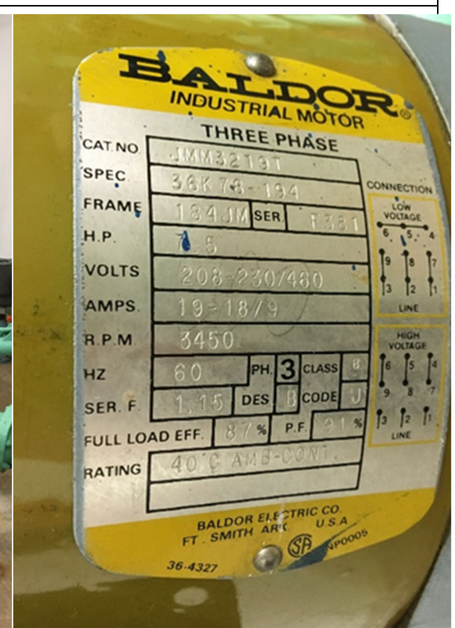

GENERAC

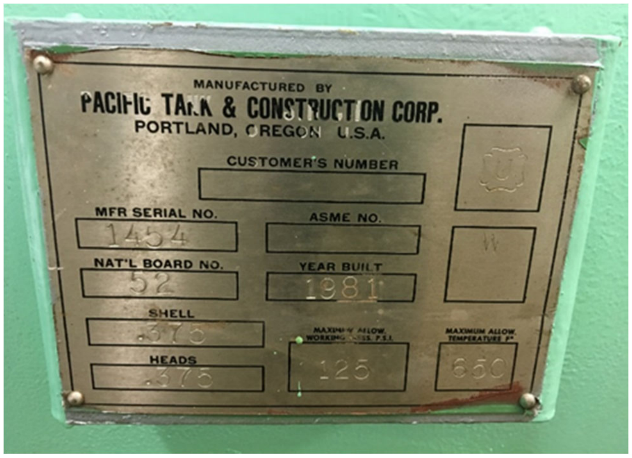
HUNTER HEIGHTS PUMP STATION AND RESERVOIR:


MARATHON ELECTRIC
WAUSAU, WISCONSIN · 54401
MODEL
TYPE TDR
DES B
PH 3
DUTY CONT
FRAME
RPM 3450
NEMA NOM. EFF 82.5
HZ 60
SF 1.15
HP 5
VOLT 208-230/460
AMPS
LOW VOLTAGE LINE
HIGH VOLTAGE LINE


MODEL
NO.
HP 60
SERVICE FACTOR
RPM 3550
TIME RATING
VOLTS 460
PHASE 3
HERTZ 60
AMP
FRAME
TYPE
CODE
PART WDG START
GENERAL ELECTRIC
TRI CLAD
AC MOTOR
NASHVILLE MOTOR PLANT
MADE IN U.S.A.


1
2
3


BALDOR
INDUSTRIAL MOTOR
THREE PHASE
CAT. NO.
SPEC
FRAME
SER
H.P.
VOLTS 208-230/460
AMPS
R.P.M. 3450
HZ 60
PH 3
CLASS
SER. F.
DES
CODE
FULL LOAD EFF.
P.F.
RATING
CONNECTION
LOW VOLTAGE
HIGH VOLTAGE
LINE
BALDOR ELECTRIC CO.
FT. SMITH ARK.
U.S.A.


MANUFACTURED BY
PACIFIC TANK & CONSTRUCTION CORP.
PORTLAND, OREGON U.S.A.
CUSTOMER'S NUMBER
MFR SERIAL NO.
1454
ASME NO.
NAT'L BOARD NO.
52
YEAR BUILT
1981
SHELL
.375
HEADS
.375
125
650


PROPANE

HATTAN ROAD PUMP STATION:

Appendix G

METRO'S HOUSEHOLD AND EMPLOYMENT PROJECTIONS

Row Labels	Sum of # of 2015 HH in Pressure Zone	Sum of # of 2040 HH in Pressure Zone	Sum of # of 2015 Population in Pressure Zone	Sum of # of 2040 Population in Pressure Zone	
BEAVERCREEK	**1,840**	**2,681**	**4,947**	**6,875**	
Non-RES					
RUR	504	777	1,358	1,992	
SFR	1,336	1,904	3,588	4,883	
(blank)					
HENRICI	**1,764**	**2,861**	**5,080**	**7,798**	
MFR	15	18	43	50	
Non-RES					
RUR	561	923	1,618	2,514	
SFR	1,187	1,919	3,419	5,235	
(blank)					
HOLCOMB	**590**	**831**	**1,688**	**2,336**	
Non-RES					
RUR	249	336	714	948	
SFR	341	495	974	1,387	
(blank)					
HOLCOMB - BARLOW	**116**	**206**	**318**	**568**	
Non-RES					
RUR	58	103	158	283	
SFR	59	104	160	285	
(blank)					
HOLCOMB - HUNTER HEIGHTS	**17**	**18**	**46**	**50**	
Non-RES					
RUR	4	4	11	12	
SFR	13	14	35	38	
(blank)					
KIRKWOOD	**34**	**35**	**95**	**94**	
Non-RES					
SFR	34	35	95	94	
(blank)					
MATHER	**5,433**	**6,100**	**14,215**	**15,341**	
MFR	278	305	726	766	
Non-RES					
RUR	637	758	1,637	1,874	
SFR	4,518	5,037	11,852	12,702	
(blank)					
MEYERS	**253**	**409**	**725**	**1,134**	
Non-RES					
RUR	36	60	103	164	
SFR	217	349	621	970	
(blank)					
NCCWC	**124**	**133**	**345**	**351**	
Non-RES					
SFR	124	133	345	351	
(blank)					
Not in Pressure Zone	**0**	**0**	**0**	**1**	
MFR	0	0	0	0	
Non-RES					
RUR	0	0	0	0	
SFR	0	0	0	0	
(blank)					
OAK LODGE	**248**	**280**	**647**	**694**	
MFR	4	4	9	10	
Non-RES					
RUR	0	0	0	0	
SFR	244	275	638	685	
(blank)					
OREGON CITY JOINT USER	**1,508**	**2,069**	**4,240**	**5,696**	Not Included, b/c they are not served water by CRW
MFR	0	0	0	0	Not Included, b/c they are not served water by CRW
Non-RES					Not Included, b/c they are not served water by CRW
RUR	100	171	284	472	Not Included, b/c they are not served water by CRW
SFR	1,408	1,898	3,956	5,224	Not Included, b/c they are not served water by CRW
(blank)					Not Included, b/c they are not served water by CRW
OTTY	**5,652**	**7,343**	**13,784**	**16,765**	
MFR	2,262	3,346	5,089	7,170	
Non-RES					
RUR	290	334	789	864	
SFR	3,100	3,664	7,906	8,730	
(blank)					
REDLAND	**1,224**	**1,535**	**3,615**	**4,346**	
Non-RES					
RUR	606	825	1,787	2,321	
SFR	618	711	1,827	2,025	
(blank)					
SOUTH END	**638**	**1,658**	**1,740**	**4,547**	
Non-RES					
RUR	196	543	534	1,489	
SFR	442	1,115	1,206	3,058	
(blank)					
Grand Total	**19,441**	**26,159**	**51,484**	**66,596**	

Less Oregon City Joint User	17,932	24,090	47,245	60,900
North Region	11,491	13,890	29,086	33,246
South Region	6,441	10,200	18,158	27,654

Recommended Citation:

2015-2040 Distributed Forecast (Scenario #1610) . Oregon Metro Research Center. Metro Region Data Adopted 2016 by Metro Ordinance 16-1371.

Description:

The 2015 and 2040 household and employment allocations have been reviewed by local jurisdictions and adopted by the Metro Council in 2016. More detailed estimates, including HIA and population estimates, are unofficial and used for Metro modeling purposes. Users use at own risk. Metro does not expressly or implicitly guarentee or indemnify the use of this data product by the user(s).

Vintage HH and Emp source: 2040_Distributed_Forecast_20171025.xlsx
Scenario 1610, William 2 forecast
File created 10/25/2017
HIA and employment industry distributions for RTP
Vintage population source: RTP_TAZ_PopSummary_AllYears_KateHIA_20171020.xlsx
File created 10/20/2017 (JF)

Metro has on record the state's confidential release of data for Carollo to use (11/28/17)
emailed to Kevin tice by Dennis Yee on 11/28/17

Appendix H

POLICY TABLE

Clackamas River Water Policies and Planning Criteria - 2018 WSMP			
Type	**Category**	**Policy**	**Source**
Policy	Mission Statement	• *OUR VISION: We believe that an ample supply of high quality water is essential to the vitality of our region.* • *OUR MISSION: We will provide high quality, safe drinking water to our customers at rates consistent with responsible planning for the long term health of our district.*	CRW 2017-19 Budget
Service	Service Area	• CRW's service area is located in Clackamas County and is divided into three sub-areas; one north of Clackamas River, and two south of the river.	CRW WMCP 2011
Service	Wholesale Connections	• CRW will provide wholesale water to neighboring agencies through CRWSC.	
Supply	Water Right	• Use of public water requires water right permit from Oregon Water Resources Department (OWRD). • CRW has surface water and ground water rights.	CRW WMCP 2011
Supply	Source	• Total capacity of supply facilities should meet maximum day demand (MDD) using backup power.	CRWMP 1998 CRWMPU 2005
Supply	Redundancy/ Reliability	• All facilities should have backup power.	
Supply	Inter-connections	• CRW will have emergency interconnections with neighboring water agencies.	
Supply	Water quality	• Meet or exceed water quality regulations.	CRW WMCP 2011

Clackamas River Water Policies and Planning Criteria - 2018 WSMP			
Type	**Category**	**Policy**	**Source**
Supply	System-wide metering	• CRW will require meters for all new customers and will continue to require metering of fire hydrant water used by contractors. • Testing and maintenance: CRW will continue annual testing and repair of production meters and all meters 3-inches and larger.	CRW WMCP 2011
Supply	Leak Detection Program	• Annual leak detection, with entire system surveyed once annually with acoustic leak detection equipment. • CRW desires water loss of less than 10%.	CRW WMCP 2011
Supply	Water Conservation	• Water use will not be wasteful. • Water demand per ERU and peaking factors shall remain constant.	
Supply	Emergency Management Plan	• CRW has prepared a water curtailment plan to deal with water shortages when consumption exceeds production capabilities. The plan is designed to conserve and extend CRW's water supply through conservation, waste reduction, and equitable usage. The plan prioritizes protection supplies for public health, fire protection, and domestic use.	CRW WMCP 2011
System - Transmission	Transmission Pipelines	• Flow less than 5 fps, head loss less than 5 ft per 1000 ft of pipeline. • Pipelines 12-inch diameter and greater are considered to be transmission pipelines.	CRWMP 1998 CRWMPU 2005

Clackamas River Water Policies and Planning Criteria - 2018 WSMP			
Type	**Category**	**Policy**	**Source**
System - Transmission	Pump Stations	• Pump stations serving areas without reservoirs should be sized for a firm capacity equal to the higher of peak hour demand (PHD) or maximum day demand (MDD) plus required fire flow demand. • Pump stations serving areas with reservoirs should be sized for a firm capacity equal to maximum day demand (MDD). • Firm capacity: capacity of pump station w/ largest pump out of service.	CRWMP 1998 CRWMPU 2005
System - Transmission	Pressure Reducing Station	• PRVs should supply peak hour demand within the continuous flow rating of the valve. Fire flows through valve should be delivered within the intermittent flow rating of the valve. • Pressure zones should be served by multiple PRV stations where possible.	CRWMP 1998 CRWMPU 2005
System - Storage	Storage	• Total storage is the sum of operational storage, fire storage, and emergency storage plus dead storage. • Operational storage: 25% of MDD. • Fire storage: Largest fire flow demand. • Emergency: 2 times average day demand for emergencies. • Dead storage: volume of the tank which is unavailable at 20 psi to use due to physical constraints.	CRWMP 1998
System - Storage	Operational Storage	• Operational storage volume is 25% of maximum daily demand (MDD). • This storage meets instantaneous water system demands in excess of the transmission/pumping delivery capacity from the source to the system.	CRWMPU 2005

Clackamas River Water Policies and Planning Criteria - 2018 WSMP			
Type	**Category**	**Policy**	**Source**
System - Storage	Fire Storage	• Provided to meet single most severe fire flow demand within the pressure zone served by storage facility.	CRWMP 1998 CRWMPU 2005
System - Storage	Emergency Storage	• Provided to supply water from storage during emergencies (eg. Power outages, equipment failures, pipeline failures, natural disasters). • 2 x Average day demand (ADD).	CRWMPU 2005
System - Distribution	Distribution Pipelines	• Flow velocity should be below 10 fps and head loss in the pipeline should be below 10 ft per 1000 ft of pipeline under PHD or MDD+Fire demand conditions. • Minimum pipeline diameter will be 8 inches. • Any pipeline below 6 inches should be upgraded before being equipped with fire hydrant. • Pipelines should be looped where possible.	CRWMPU 2005
System - Distribution	Service Pressure	• Minimum pressure to be maintained is 20psi per State of Oregon Health Division (especially during fire flow on MDD). • Desired range of system pressures at connection is between 40 and 90 psig. • Maximum pressure goal is 150 psi.	CRWMP 1998 CRWMPU 2005

<table>
<tr><th colspan="4">Clackamas River Water Policies and Planning Criteria - 2018 WSMP</th></tr>
<tr><th>Type</th><th>Category</th><th>Policy</th><th>Source</th></tr>
<tr><td>Policy</td><td>Fire Protection</td><td>
CRW is responsible for providing conveyance for fire protection to customers within the service areas.
<table>
<tr><th rowspan="2">Type</th><th colspan="2">Minimum Fire Flow</th></tr>
<tr><th>Flow (gpm)</th><th>Duration (hrs)</th></tr>
<tr><td>Residential</td><td>1,500</td><td>2</td></tr>
<tr><td>Commercial</td><td>3,500</td><td>3</td></tr>
<tr><td>Industrial</td><td>5,000</td><td>4</td></tr>
<tr><td>Other</td><td>3,500</td><td>3</td></tr>
</table>
</td><td></td></tr>
<tr><td>Seismic</td><td>Seismic Resilience</td><td>The District will follow the level of service guidelines for water systems as established in the Oregon Resilience Plan.</td><td></td></tr>
<tr><td>Miscellaneous</td><td>Repair and Replacement</td><td>Pipelines should be replaced if there are more than 4 breaks/mile.
The District will plan on replacing infrastructure when they reach the end of its useful life.</td><td></td></tr>
</table>

Appendix I

SURFACE WATER RIGHTS CERTIFICATES

Permit A-2—1M—7-70

STATE OF OREGON

COUNTY OF CLACKAMAS

CERTIFICATE OF WATER RIGHT

This Is to Certify, *That* CLACKAMAS WATER DISTRICT

of P. O. Box 67, Clackamas, *State of* Oregon, *has made proof to the satisfaction of the STATE ENGINEER of Oregon, of a right to the use of the waters of* Clackamas River *a tributary of* Willamette River *for the purpose of* municipal use *under Permit No.* 27925 *of the State Engineer, and that said right to the use of said waters has been perfected in accordance with the laws of Oregon; that the priority of the right hereby confirmed dates from* April 25, 1962;

that the amount of water to which such right is entitled and hereby confirmed, for the purposes aforesaid, is limited to an amount actually beneficially used for said purposes, and shall not exceed 15.0 cubic feet per second

or its equivalent in case of rotation, measured at the point of diversion from the stream. The point of diversion is located in the SE¼ NE¼, Section 16, T. 2 S., R. 2 E., W. M.
Diversion point located: 2130 feet South and 60 feet West from the NE Corner, Section 16,

The amount of water used for irrigation, together with the amount secured under any other right existing for the same lands, shall be limited to -------------- *of one cubic foot per second per acre,*

and shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use under the right hereby confirmed, and to which such right is appurtenant, is as follows:

S½ SW¼
Section 28

NW¼ NE¼
W½
NW¼ SE¼
S½ SE¼
Section 29

NE¼ SE¼
S½ SE¼
Section 31

All
Section 32

W½
Section 33
T. 1 S., R. 2 E., W. M.

N½ NE¼
SE¼ NE¼
Section 1
T. 2 S., R. 1 E., W. M.

N½ NW¼
SW¼ NW¼
SW¼
SW¼ SE¼
Section 4

All
Section 5

N½
N½ SW¼
SE¼ SW¼
SE¼
Section 6

N½ NE¼
SE¼ NE¼
Section 7

All
Section 8

All
Section 9
T. 2 S., R. 2 E., W. M.

S½ NW¼
S½
Section 10

SW¼
NW¼ SE¼
Section 11

NW¼
Section 14

N½
Section 15

N½
N½ SW¼
NW¼ SE¼
Section 16

NE¼
NE¼ NW¼
Section 17
T. 2 S., R. 2 E., W. M.

The right to the use of the water for the purposes aforesaid is restricted to the lands or place of use herein described.

WITNESS the signature of the State Engineer, affixed

this 6th *day of* December , 19 71

CHRIS L. WHEELER
State Engineer

Recorded in State Record of Water Right Certificates, Volume 29 *, page* 37794

STATE OF OREGON

COUNTY OF CLACKAMAS

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CHARLES R. HARRISON, GENERAL MANAGER
CLACKAMAS WATER DISTRICT
9100 SE MANGAN DRIVE
CLACKAMAS, OREGON 97015-9598

confirms the right to use the waters of CLACKAMAS RIVER, a tributary of WILLAMETTE RIVER, for the purpose of MUNICIPAL USE.

The right has been perfected under Permit 33586. The date of priority is MAY 20, 1968. The right is limited to not more than 25.0 CUBIC FEET PER SECOND or its equivalent in case of rotation, measured at the point of diversion from the source.

The point of diversion is located as follows:

SE 1/4 NE 1/4, SECTION 16, T 2 S, R 2 ~~W~~ E, W.M.; 2130 FEET SOUTH AND 60 FEET WEST FROM THE NE CORNER, SECTION 16.

The right shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use under the right, and to which such right is appurtenant, is as follows:

SE 1/4 SE 1/4
SECTION 35

S 1/2 SW 1/4
SECTION 36

TOWNSHIP 1 SOUTH, RANGE 1 EAST, W.M.

E 1/2 SW 1/4
SE 1/4
SECTION 24

NE 1/4 NE 1/4
W 1/2 NE 1/4
W 1/2
W 1/2 SE 1/4
SE 1/4 SE 1/4
SECTION 25

E 1/2
E 1/2 NW 1/4
SW 1/4 NW 1/4
SW 1/4
SECTION 26

ALL
SECTIONS 27, 28, AND 29

E 1/2
SECTION 30

SE 1/4 SE 1/4
SECTION 31

E 1/2
NW 1/4
N 1/2 SW 1/4
SE 1/4 SW 1/4
SECTION 32

ALL
SECTIONS 33 THROUGH 36

TOWNSHIP 1 SOUTH, RANGE 2 EAST, W.M.

SW 1/4
SECTION 31
TOWNSHIP 1 SOUTH, RANGE 3 EAST, W.M.

THAT PORTION OF THE FOLLOWING SECTIONS LYING NORTH AND EAST
OF THE WILLAMETTE RIVER
SECTIONS 1, 2, 11, 12, 13, AND 24
TOWNSHIP 2 SOUTH, RANGE 1 EAST, W.M.

SEE NEXT PAGE

ALL SECTIONS 1 THROUGH 11	SW 1/4 NE 1/4 NW 1/4 N 1/2 SW 1/4 NW 1/4 SE 1/4 SECTION 12

THAT PORTION OF THE FOLLOWING SECTIONS LYING NORTH
OF THE WILLAMETTE RIVER
SECTIONS 14 THROUGH 20, 29 AND 30
TOWNSHIP 2 SOUTH, RANGE 2 EAST, W.M.

The right to the use of the water for the above purpose is restricted to beneficial use on the lands or place of use described. The right is subject to minimum flows established by the Water Resources Commission with an effective date prior to this right.

WITNESS the signature of the Water Resources Director, affixed this date OCTOBER 31, 1990.

/s/ WILLIAM H. YOUNG

Water Resources Director

Recorded in State Record of Water Right Certificates numbered 64979.

44939.SCB

STATE OF OREGON

COUNTIES OF CLACKAMAS AND MULTNOMAH

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CLACKAMAS RIVER WATER
PO BOX 2439
CLACKAMAS OR 97015

confirms the right to use the waters of CLACKAMAS RIVER, a tributary of the WILLAMETTE RIVER for MUNICIPAL USE.

This right was perfected under Permit 34426. The date of priority is MAY 23, 1969. The amount of water to which this right is entitled is limited to an amount actually used beneficially, and shall not exceed 6.50 CUBIC FEET PER SECOND or its equivalent in case of rotation with other water users, measured at the point of diversion.

The point of diversion is located as follows:

Twp	Rng	Mer	Sec	Q-Q	GLot	DLC	Survey Coordinates
2 S	2 E	WM	16	SE NE			2131 FEET SOUTH & 173 FEET WEST FROM NE CORNER, SECTION 16

A description of the place of use to which this right is appurtenant is as follows:

MUNICIPAL USE				
Twp	**Rng**	**Mer**	**Sec**	**Q-Q Portion**
1 S	1 E	WM	25	S ½
1 S	1 E	WM	35	SE ¼
1 S	1 E	WM	36	ALL
1 S	2 E	WM	23	SE ¼
1 S	2 E	WM	23	SE ¼ NE ¼
1 S	2 E	WM	23	SE ¼ SW ¼
1 S	2 E	WM	24	SW ¼
1 S	2 E	WM	24	SW ¼ NW ¼
1 S	2 E	WM	24	SE ¼ SE ¼
1 S	2 E	WM	24	W ½ SE ¼
1 S	2 E	WM	25	W ½

NOTICE OF RIGHT TO PETITION FOR RECONSIDERATION OR JUDICIAL REVIEW

This is an order in other than a contested case. This order is subject to judicial review under ORS 183.484. Any petition for judicial review must be filed within the 60-day time period specified by ORS 183.484(2). Pursuant to ORS 536.075 and OAR 137-004-0080, you may either petition for judicial review or petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied. In addition, under ORS 537.260 any person with an application, permit or water right certificate subsequent in priority may jointly or severally contest the issuance of the certificate at any time before it has issued, and after the time has expired for the completion of the appropriation under the permit, or within three months after issuance of the certificate.

MUNICIPAL USE				
Twp	**Rng**	**Mer**	**Sec**	**Q-Q Portion**
1 S	2 E	WM	25	NW ¼ NE ¼
1 S	2 E	WM	25	S ½ SE ¼
1 S	2 E	WM	26	ALL
1 S	2 E	WM	27	ALL
1 S	2 E	WM	28	ALL
1 S	2 E	WM	29	ALL except the NW ¼ SW ¼
1 S	2 E	WM	30	W ½
1 S	2 E	WM	30	S ½ SE ¼
1 S	2 E	WM	31	ALL
1 S	2 E	WM	32	ALL
1 S	2 E	WM	33	ALL
1 S	2 E	WM	34	ALL
1 S	2 E	WM	35	ALL
1 S	2 E	WM	36	ALL
2 S	1 E	WM	1	ALL
2 S	1 E	WM	2	E ½
2 S	1 E	WM	11	E ½
2 S	1 E	WM	12	ALL
2 S	1 E	WM	13	E ½
2 S	1 E	WM	24	NE ¼
2 S	2 E	WM	1	ALL
2 S	2 E	WM	2	ALL
2 S	2 E	WM	3	ALL
2 S	2 E	WM	4	ALL
2 S	2 E	WM	5	ALL
2 S	2 E	WM	6	ALL
2 S	2 E	WM	7	ALL
2 S	2 E	WM	8	ALL
2 S	2 E	WM	9	ALL
2 S	2 E	WM	10	ALL
2 S	2 E	WM	11	ALL North of the Clackamas River
2 S	2 E	WM	12	ALL North of the Clackamas River
2 S	2 E	WM	14	ALL North of the Clackamas River
2 S	2 E	WM	15	ALL North of the Clackamas River
2 S	2 E	WM	16	ALL North of the Clackamas River except the SW ¼ SW ¼
2 S	2 E	WM	17	ALL
2 S	2 E	WM	18	ALL
2 S	2 E	WM	19	NW ¼
2 S	3 E	WM	6	SW ¼ NW ¼

Water may be applied to lands which are not specifically described above, provided the holder of this right complies with ORS 540.510(3).

The use of water allowed herein may be made only at times when sufficient water is available to satisfy all prior rights, including prior rights for maintaining instream flows.

Issued APR 0 9 2008.

Dwight French for

Phillip C. Ward, Director
Water Resources Department

STATE OF OREGON

COUNTY OF CLACKAMAS

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CLACKAMAS WATER DISTRICT
9100 SE MANGAN DRIVE
CLACKAMAS, OREGON 97015-9598

confirms the right to use the waters of CLACKAMAS RIVER, a tributary of WILLAMETTE RIVER, for MUNICIPAL USE.

This right was perfected under Permit 33586. The date of priority is MAY 20, 1968. The amount of water to which this right is entitled is limited to an amount actually beneficially used and shall not exceed 25.0 CUBIC FEET PER SECOND, or its equivalent in case of rotation, measured at the point of diversion from the source.

The point of diversion is located as follows:

SE 1/4 NE 1/4, SECTION 16, TOWNSHIP 2 SOUTH, RANGE 2 EAST, W.M.; 2130 FEET SOUTH AND 60 FEET WEST FROM THE NE CORNER, SECTION 16.

The use shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use to which this right is appurtenant is as follows:

SE 1/4 SE 1/4
SECTION 35

S 1/2 SW 1/4
SECTION 36
TOWNSHIP 1 SOUTH, RANGE 1 EAST, W.M.

E 1/2 SW 1/4
SE 1/4
SECTION 24

NE 1/4 NE 1/4
W 1/2 NE 1/4
W 1/2
W 1/2 SE 1/4
SE 1/4 SE 1/4
SECTION 25
TOWNSHIP 1 SOUTH, RANGE 2 EAST, W.M.

This is a final order in other than contested case. This order is subject to judicial review under ORS 183.484. Any petition for judicial review of the order must be filed within the 60 days of the date of service.

44939COR.SB

Certificate Number 79899

E 1/2
E 1/2 NW 1/4
SW 1/4 NW 1/4
SW 1/4
SECTION 26

ALL
SECTIONS 27, 28 AND 29

E 1/2
SECTION 30

SE 1/4 SE 1/4
SECTION 31

E 1/2
NW 1/4
N 1/2 SW 1/4
SE 1/4 SW 1/4
SECTION 32

ALL
SECTIONS 33 THROUGH 36
TOWNSHIP 1 SOUTH, RANGE 2 EAST, W.M.

SW 1/4
SECTION 31
TOWNSHIP 1 SOUTH, RANGE 3 EAST, W.M.

THAT PORTION OF THE FOLLOWING SECTIONS LYING NORTH AND EAST OF THE WILLAMETTE RIVER
SECTIONS 1, 2, 11, 12, 13 AND 24
TOWNSHIP 2 SOUTH, RANGE 1 EAST, W.M.

ALL
SECTIONS 1 THROUGH 11

SW 1/4 NE 1/4
NW 1/4
N 1/2 SW 1/4
NW 1/4 SE 1/4
SECTION 12

THAT PORTION OF THE FOLLOWING SECTIONS LYING NORTH OF THE WILLAMETTE RIVER
SECTIONS 14 THROUGH 20, 29 AND 30
TOWNSHIP 2 SOUTH, RANGE 2 EAST, W.M.

The right is subject to minimum flows established by the Water Resources Commission with an effective date prior to this right.

THIS CERTIFICATE IS ISSUED TO CORRECTLY DESCRIBE THE LOCATION OF THE POINT OF DIVERSION AND SUPERSEDES CERTIFICATE 64979.

WITNESS the signature of the Water Resources Director, affixed February 28, 2003.

Paul R. Cleary

Recorded in State Record of Water Right Certificates Number 79899.

44939cor.SB

Appendix J

AQUIFER STORAGE AND RECOVERY LIMITED LICENSE 003

BEFORE THE WATER RESOURCES DEPARTMENT
OF THE STATE OF OREGON

In the Matter of Aquifer Storage and Recovery (ASR) Limited License Application #003, Clackamas County	))	SUMMARY ORDER APPROVING RENEWED ASR TESTING

AUTHORITY

Oregon Revised Statute (ORS) 537.534 and Oregon Administrative Rule (OAR) 690-350-0020 establish the process by which an application for ASR testing under an ASR limited license may be submitted and approved. Oregon Administrative Rule (OAR) 690-350-0010 describes general provisions for ASR under Oregon law.

BACKGROUND

On October 10, 2001, the Department issued ASR Limited License # 003 to Clackamas River Water. That license authorized ASR testing for five years at up to six wells in a Columbia River Basalt aquifer. That license was renewed on October 20, 2006. Condition 1 of ASR LL # 003 provides for renewal pursuant to OAR 690-350-0020(5)(c), and describes the following terms for renewal: The license may be renewed if the licensee demonstrates to the Director's satisfaction that further testing is necessary, and that the licensee complied with the terms of the license.

FINDINGS OF FACT

1. On October 21, 2016, Clackamas River Water submitted a request for a five-year time extension (renewal) for ASR LL #003.
2. The Department provided public notice of the application in the Department's weekly public notice on November 1, 2016. A 30-day comment period followed.
3. The Department received no adverse comments related to the possible renewal of an ASR limited license.
4. The Department sought comments and recommendations from Oregon Department of Environmental Quality and Oregon Health Authority Drinking Water Services related to the possible renewal. Comments were received from Oregon Department of Environmental Quality and Oregon Health Authority Drinking Water Program supporting renewal of ASR LL #003.
5. The Department evaluated the renewal request and comments, and determined the proposed renewal is consistent with Condition 1 of the license and OAR 690-350-0020(5)(c). The licensee has demonstrated to the Director's satisfaction that further testing is necessary, and that the licensee complied with the terms of the license. The request letter presented reasons for the renewal and also provided specific details that addressed compliance with the license.

CONCLUSIONS OF LAW

The request to renew ASR LL #003 for five years is consistent with the requirements of OAR 690-350-0020(5)(c) and Condition 1 of ASR LL #003.

ORDER

Now, THEREFORE, it is ORDERED, ASR Limited License #003 shall be valid through the fifth anniversary of its issuance, pursuant to ORS 537.534, OAR 690-350-0020(5)(c), and Condition 1 of the original ASR license.

Except as modified by other provisions of this license, the licensee is authorized to pursue the project schedule, monitoring, and other features noted in the ASR pilot test work plan for ASR Well #1 (also called CRW-1, CLAC 4396/57301). That plan may be amended and approved pursuant to condition (5)(A)(iii). The project schedule in the ASR test plan may be reasonably adjusted by the licensee to reflect the license issuance date or other delays. Features of that ASR testing plan are provided in the application document entitled:

Final Review Plan
Aquifer Storage and Recovery
Pilot Test Work Plan
Prepared for Clackamas River Water
Prepared by Montgomery Watson & Golder Associates
September 22, 2000

And

Montgomery Watson Technical Memorandum
Dated February 15, 2001
From: Kathryn Mallon
To: Greg Drechsler
Subject: Limited License Application Supplemental Information

The ASR testing must provide data that address the following: the appropriate target storage volume; loss of stored ASR water and natural water by virtue of ASR activities; water quality changes due to ASR activities; well construction sufficiency for ASR purposes; water level response in the ASR well, aquifer, springs and nearby wells; accounting of ASR inputs, withdrawals, and storage; water quality testing needs; and well hydraulics at the ASR well.

The licensee may divert up to 3 cfs from the Clackamas River, a tributary of the Willamette River, using authorization of either water right Permit S-22581, held by South Fork Water Board for municipal use, or Certificate 84072, held by Clackamas River Water for municipal use, or this ASR license for ASR testing as a non-municipal use. (Limitations on this non-municipal diversion are noted in Condition 3).

The point of diversion (POD)on the Clackamas River for Permit S-22581 is located at T2S/R2E, Section 21, NW1/4 SW1/4, and the POD on the Clackamas River for Certificate 84072 is located at T2S/R2E, Section 16, SE1/4 NE1/4. For non-municipal use, the licensee may divert at the same PODs.

The licensee may store up to 200 million gallons in a basalt aquifer. The maximum storage duration is the five-year duration of this license. With the authorization of individual ASR well test plans. up to six ASR wells are potentially allowed at a combined rate up to 12,000 gpm for injection and recovery. These wells consist of the following:

Well Name	*Well Location in 2S/2E*
CRW-1 (CLAC 4396/57301)	625' North, 4225' East from SW corner of Section 29
(Any five of the following six)	
Additional well by CRW-1 (proposed)	650' North, 1100' West from SE corner of Section 29
Redland Road Pump Station (proposed)	1800' South, 350' East from NW corner of Section 34
Holcomb Lane Pump Station (proposed)	1470' South, 400' East from NW corner of Section 28
Holly Lane Pump Station (proposed)	580' South, 2250' East from NW corner of Section 33
Housing Authority Well #2 (proposed)	460' South, 2295' East from NW corner of Section 28
Old Park Place Well #18 (proposed)	1625' South, 1400' East from NW corner of Section 28

Other Conditions:

1) **License Renewal**. The license may be renewed if the licensee demonstrates to the Director's satisfaction that further testing is necessary, and that the licensee complied with the terms of the license.

2) **Notice Prior to Injection and Recovery**. The licensee shall give notice, in writing, to the watermaster not less than 15 days in advance of either initiating any injection under the license or recovering stored water. The licensee shall also provide DEQ's Northwest Region Solid Waste Engineer with this notification. The injection notice shall include the license number, the location of the injection source water diversion, the quantity of water to be diverted from that source, the time of injection, and the place of injection. The recovery notice shall include the license number, the location of the recovery well(s), the time of recovery, and the quantity of water to be recovered.

3) **Non-municipal diversion**. This diversion occurs when the resulting stored water is not recovered to Clackamas River Water's distribution system. The period of use for non-municipal diversion is limited to November 1 through June 30.

4) **Record of Use**. The licensee shall maintain a record of injection and recovery, including the total number of hours of injection and recovery, and the total metered quantity injected and recovered. The record of use may be reviewed by Department staff upon request.

5) **Modification/Revocation**. The Department shall notify the licensee in writing and allow the licensee to respond when considering the following actions:

(A) The Director may modify the ASR license for any of the following reasons:

(i) to reflect changes in Oregon Health Authority Drinking Water Program (OHA) and Oregon Department of Environmental Quality (DEQ) water quality or treatment standards;

(ii) to address needed technological changes as requested by DEQ or OHA to minimize constituents regulated under OAR 333-61-030 (ORS 448.131 and .273) or OAR 340-40 (ORS 468B.165);

(iii) upon written request from the applicant for minor adjustments to the authorization in the limited license.

(B) The Director may revoke or modify the ASR license for any of the following reasons:

(i) to prevent or mitigate injury to other water rights, minimum perennial streamflows or aquifer water quality;

(ii) to address any other unintended, injurious effects of the ASR activity; or

(iii) failure to maintain compliance with all conditions of this license.

(C) The Department may offer an additional public comment opportunity consistent with the notice and comment provisions of OAR 690-350-020 prior to modifying the license.

6) **Priority/Protection**. This license does not receive a priority date, and is not protected under ORS 540.045.

7) **Compliance with Other Laws**. The injection of acceptable water into the aquifer, as well as its storage and recovery under this license, shall comply with all applicable local, state or federal laws. This shall include but not be limited to compliance with the Oregon Department of Environmental Quality's Underground Injection Control registration program as authorized under the Safe Drinking Water Act (40 CFR 144.26). Also, all pilot test discharges to waterways must be covered by a DEQ National Pollution Discharge Elimination System (NPDES) permit.

8) **Detailed Testing Plans**. The licensee shall submit a detailed testing plan for each injection well as the project develops. The plan shall include precise well location and construction information, in addition to other testing features. The licensee shall obtain Departmental approval of a detailed plan before injection testing at a well may begin. The Department may approve, condition, or reject a detailed plan.

9) **Water Quality Conditions and Limits**:

(A) The licensee shall minimize, to the extent technically feasible, practical and cost-effective, the concentration of constituents in the injection source water that are not naturally present in the aquifer;

(B) Except as otherwise provided in (C) of this condition, if the injection source water contains constituents regulated under OAR 333-61-030 (ORS 448.131 and .273) or OAR 340-40 (ORS 468B.165) that are detected at greater than 50 percent of the established levels (MCLs or MMLs in the cited rules), the licensee shall employ technically feasible, practical and cost-effective methods to minimize concentrations of such constituents in the injection source water;

(C) Constituents that have a secondary contaminant level or constituents that are associated with disinfection of the injection source water may be injected into the aquifer up to the standards established under OAR 333-61-030 (ORS 448.131 and .273);

(D) The Department may, based upon valid scientific data, further limit certain constituents in the injection source water if the Department finds that those constituents will interfere with or pose a threat to the maintenance of the water resources of the state for present or future beneficial uses;

(E) If during the course of ASR testing, a constituent which is regulated under OAR 333-61-030 (ORS 448.131 and .273) or OAR 340-40 (ORS 468B.165) is detected above the 50% level prescribed in condition (9)(B) or the 100% level prescribed in condition (9)(C), the licensee shall stop injection activities immediately upon receipt of lab data and notify the Department within five days.

10) **Water Quality Sampling**.

(A) Injection Water. The licensee shall sample and analyze injection water for the constituents regulated under OAR 333-61-030 (ORS 448.131 and .273) or OAR 340-40 (ORS 468B.165) as well as other constituents as described in the pilot test plan dated September 22, 2000. After cycle 3, if ASR injection occurs over a period to exceed 90 days, then sampling at CRW-1 will be required on a quarterly basis, the sampling interval not to exceed 90 days.

(B) Receiving Aquifer Water. The licensee shall sample receiving aquifer water at the well prior to any storage at the well. The licensee shall sample for the constituents regulated under OAR 333-61-030 (ORS 448.131 and .273) or OAR 340-40 (ORS 468B.165) as well as other constituents as described for wells in the pilot test plan dated September 22, 2000.

(C) Withdrawal of Stored Water. The licensee shall analyze water withdrawn from storage for the constituents regulated under OAR 333-61-030 (ORS 448.131 and .273) or OAR 340-40 (ORS 468B.165) as well as other constituents as described in the pilot test work plan September 22, 2000 and OAR 690-350-020(3)(b)(F)(iv).

11) **Water Level Monitoring**. The licensee shall monitor water levels in wells in the manner described in the pilot test plan dated September 22, 2000. The licensee shall submit a detailed water level monitoring plan for testing at each subsequent injection well. The licensee shall obtain Departmental approval of a detailed plan before injection testing at a well may begin. The Department may approve, condition, or reject a detailed plan.

12) **Well Construction**. Injection and recovery wells shall be open to a single aquifer in the Columbia River Basalt Group, and shall meet applicable well construction standards (e.g., OAR 690-200 and OAR 690-210). Following well completion, wells drilled <u>after</u> the issuance of this renewed license shall be thoroughly developed to remove cuttings and drilling fluids. A video log of the wells shall be collected to demonstrate to the satisfaction of the Department that each well is open only to a single aquifer. Additional data that help characterize the water bearing zone characteristics, including water quality and temperature, may also be provided to the Department. The wells shall be designed to limit the irretrievable loss of injected water to unsaturated zones.

13) **Cuttings**. During drilling of new project wells, the licensee shall collect cuttings at a minimum of 10-foot intervals and at major changes in lithology. The licensee shall describe and analyze them to the degree necessary to determine the formation, member and flow unit within the Columbia River Basalt Group of the water-bearing zone, and provide a split of the washed cuttings to the Department.

14) **Recovery**. The availability of stored water for recovery is based on the following factors:

(A) Available stored water is determined on a well-by-well basis. The licensee may recover up to 100% of the quantity injected under this license for testing cycles 1, 2, and 3. Thereafter, the licensee may recover up to 95% of the quantity injected under this license during the water year that the water was injected. After that water year, the availability of stored water shall be further diminished each water year such that the licensee may only recover up to 95% of any water-year-to-water-year storage carryover. For example, water year 2012 lasts from October 1, 2011 through September 30, 2012. Data collected by the licensee may be useful in consideration of proposed modifications to this recovery provision under the license.

(B) Any water withdrawn from an ASR well identified in this license shall first be debited against the quantity available in the aquifer by virtue of ASR storage. When the ASR storage is depleted at an ASR well, any water withdrawn from an ASR well shall be considered a draft of natural ground water, requiring separate additional authorization. This license does not authorize withdrawal of more water than was available from injection.

(C) The availability of stored water is a running account that is subject to determination at any time.

15) **Annual Reporting**.

(A) Except as otherwise noted, the licensee shall provide the Department a written report of the results of ASR testing for each water year by February 15th of the following water year. The report shall detail the several kinds of data collected during the water year (including the water quality results in condition 10, in a DEQ-specified format), analyze those data to show the ASR project impacts on the aquifer, analyze for loss, indicate the testing/development progress made under the terms of the license, and account for the injection of stored water, withdrawals of stored and natural water, and the new-year carryover storage at each well. Annual reports shall be sealed and signed by a professional(s) registered or allowed, under Oregon law, to practice geology.

(B) As pertinent, annual reporting shall include the formatting and additional information cited in Condition 16 below.

16) **Special Reporting Condition**. The licensee shall provide the following information to the Department:

(A) Submission of any and all hydrogeologic data collected and reports developed for the project, including but not limited to cuttings analysis, video logs, geophysical logs, aquifer tests and step tests.

(B) Submission of digital water level data for all ASR wells and any other wells measured in conjunction with the project (in a Department-specified format), including annual report data.

(C) Submission of annual reports with locations and elevations for all project wells (actual locations of built wells and proposed locations for proposed locations) and locations and elevations for all non-project wells that have been used for collecting water levels or other data pertinent to the project (in a Department-specified format).

(D) Notification in the annual report of any changes in well construction to the ASR limited license file.

(E) Associating all project well data with the Department Well Identification Number (Well ID Number), the Department Well Log ID, if available, and the project Well Name.

17) **Well Tag Condition for Licensee Wells**. The licensee shall ensure that their wells have been assigned a Department Well Identification Number (Well ID Number). A tag showing the Well ID Number shall be permanently attached to the well. If a well does not have a Well ID Number, the licensee shall apply for one from the Department and attach it to the well. The Well ID Number shall be used as a reference in any correspondence regarding the well, including any reports of water use, water level, or pump test data.

18) **Protection for Existing Users**. In the event of conflicts with existing appropriators, the licensee shall conduct all testing so as to mitigate the injurious effects. In addition, the licensee shall cooperate with the efforts of the Department to protect existing water rights and the water quality of existing users that rely upon the receiving aquifer and the injection source water.

19) **Use of Recovered Water**. The licensee shall use any recovered water for the use allowed in the diversion authorization. Specifically, the licensee shall use any recovered water for the purposes described in the appropriate diversion authorization.

20) **Additional Conditions on an Informal Basis**. The Department may suggest additional conditions to the licensee. Provided that those conditions are agreed to and undertaken by the licensee, the Department may forego formal changes to this license. This informal process does not extend to condition reductions. These additional conditions may be part of any license renewal or permit.

21) **Publicity.** The licensee shall maintain a public information program about the ASR project, which may include press releases, neighborhood meetings, brochures, or other activities. This program shall include information on potential project impacts, and how to report possible impacts to the licensee. The licensee shall share such reports with the watermaster within five days of receipt.

22) **Other Measures**. The licensee shall take any additional measures, as appropriate, to address ASR-related issues such as landslide activation, seepage, streamflow increases, interference with nearby wells, aquifer storage limitations, and water quality protection. The licensee shall resolve these issues prior to submittal of an ASR permit application.

23) **Carryover Storage**. At the end of testing under this license, the licensee shall provide an accounting to the Department of the residual stored water based on the methods of determination given in this license. The Department shall consider this residual for carryover to a permanent ASR permit based on information which discloses the aquifer's ability to retain stored water.

Dated at Salem, Oregon on December 23, 2016.

E. Timothy Wall

E. Timothy Wallin *for* Thomas M. Byler, Director
Water Resources Department

This order was produced by Jen Woody. If you have other questions about the Department or any of its programs please contact our Customer Service Group at 503-986-0801. Address all other correspondence to: Ground Water Section, Oregon Water Resources Department, 725 Summer St NE, Suite A, Salem OR 97301-1266, Fax: 503-986-0902.

Appendix K

GROUNDWATER PERMIT #G-6728 AQUIFER

Oregon Water Resources Department
Water Rights Division

Water Rights Application
Number G-6228

Final Order Incorporating Settlement Agreement
Extension of Time for Permit Number G-6728

Application History

Permit G-6728 was issued by the Department on June 23, 1976. The permit called for completion of construction by October 1, 1977 and complete application of water to beneficial use by October 1, 1978. On March 2, 2009 Clackamas River Water submitted an application to the Department for an extension of time for Permit G-6728. In accordance with OAR 690-315-0050(2), on August 4, 2009 the Department issued a Proposed Final Order proposing to extend the time to complete construction to October 1, 2029 and to extend the time to fully apply water to beneficial use to October 1, 2029. The protest period closed September 18, 2009, in accordance with OAR 690-315-0060(1). Clackamas River Water filed a timely protest.

The August 4, 2009 Proposed Final Order, Finding of Fact #12, incorrectly stated Peak Water Demand in Clackamas River Water's service area boundaries in 2007 is 2.05 cfs. Find of Fact # 12 is hereby corrected to read "Peak Water Demand in Clackamas River Water's service area boundaries in 2007 is approximately 23.0 cfs".

The August 4, 2009 Proposed Final Order, Finding of Fact # 14, incorrectly stated the projected Peak Day Demand in 2029 for Service Areas 2 and 3 is 15.36 cfs. Finding of Fact # 14 is hereby corrected to read "Peak Day Demand in 2029 for Service Areas 2 and 3 is approximately 17.5 cfs".

A settlement agreement was executed by the applicant/protestant on December 2, 2009. The terms of said Settlement Agreement are incorporated into this Final Order. A copy of the Settlement Agreement is attached hereto and made a part of hereof as if set forth in full, and is included below.

At time of issuance of the Proposed Final Order the Department concluded that, based on the factors demonstrated by the applicant, the permit may be extended subject to the following conditions:

CONDITIONS

1. Annual Measurement Condition

The Department requires the water user to measure and report annual static water levels for each well on the permit. The static water level shall be measured in the month of March. Reports shall be submitted to the Department within 30 days of measurement. Annual measurements are required whether or not the well is used.

All measurements shall be made by a certified water rights examiner, registered professional geologist, registered professional engineer, licensed well constructor or pump installer licensed by the Construction Contractors Board. Measurements shall be submitted on forms provided by, or specified by, the Department. Measurements shall be made with equipment that is accurate to at least the standards specified in OAR 690-217-0045. The Department requires the individual performing the measurement to:

A. Associate each measurement with an owner's well name or number and a Department well log ID; and

B. Report water levels to at least the nearest tenth of a foot as depth-to-water below ground surface; and

C. Specify the method of measurement; and

D. Certify the accuracy of all measurements and calculations submitted to the Department.

2. Development Limitations

Diversion of any water beyond 2.05 cfs under Permit G-6728 shall only be authorized upon issuance of a final order approving a Water Management and Conservation Plan (WMCP) under OAR Chapter 690, Division 86. The required WMCP shall be submitted to the Department within 3 years of an approved extension application. Use of water under Permit G-6728 must be consistent with this and subsequent WMCP's approved under OAR Chapter 690, Division 86 on file with the Department.

The deadline established in this PFO for submittal of a WMCP shall not relieve a permit holder of any existing or future requirement for submittal of a WMCP at an earlier date as established through other orders of the Department. A WMCP submitted to meet the requirements of this order may also meet the WMCP submittal requirements of other Department orders

The applicant has demonstrated good cause for the permit extension pursuant to ORS 537.630, 539.010(5) and OAR 690-315-0080(3).

Order

The extension of time for Application G-6228, Permit G-6728, therefore, is approved subject to conditions contained herein. The deadline for completing construction is extended to October 1, 2029. The deadline for applying water to full beneficial use is extended to October 1, 2029.

DATED: December 15, 2009

Dwight French, Administrator of
Water Rights and Adjudications
for
Phillip C. Ward, Director

If you have any questions about statements contained in this document, please contact Scott Kudlemyer at (503) 986-0813.

If you have other questions about the Department or any of its programs, please contact our Water Resources Customer Service Group at (503) 986-0900.

Oregon Water Resources Department
Water Rights Information Query

Permit: G 6728 *

Main Help
Return Contact Us

Contact Information (Click to Collapse...)

Current contact information

OWNER:
CLAIRMONT WATER DISTRICT
15223 S HENRICI RD
OREGON CITY, OR 97045

OWNER:
CLACKAMAS RIVER WATER
PO BOX 2439
CLACKAMAS, OR 97015-2439

Workflow (Click to Collapse...)

Application: G 6228

Permit: G 6728 document , paper map

Signature: 6/23/1976

Permit Workflow

Action	Date	Result	Complete[
Completion Date [C Date]	10/1/1997		
Extension Application Received	3/2/2009		SCOTT KUE
Extension Comment Period Ends	3/10/2009		SCOTT KUE
Extension PFO 315 Issued	8/4/2009	Propose to Approve	SCOTT KUE
Extension PFO Protest Period Ends	9/18/2009		SCOTT KUE
Extension FO Issued	12/15/2009	Extended	SCOTT KUE
Extended Completion Date [Extension C Date]	10/1/2029		SCOTT KUE

Order(s)

Order Origin	Volume-Page	Signature	Description
Special	33-702	9/22/1980	EXTENDS TIME FOR B & C ON 212 PERMITS
Special	37-258	5/10/1983	EXTENDS 300 PERMITS
Special	42-281	7/8/1988	EXTENSION OF TIME FOR CERTAIN PERMITS
Special	47-15	1/6/1993	EXTENDED TIME LIMITED ON PERMITS
Special	85-986	1/30/2012	APPROVING WMCP CLACKAMAS RIVER WATER

View right with Web Mapping

View Places of Use from Water Rights in the Same Area

View Reported Water Use

Water Right Information (Click to Collapse...)

Status: Non-Cancelled
County: Clackamas
File Folder Location: Salem
Watermaster District: 20

Scanned Documents (Click to Expand...)

Point(s) of Diversion (Click to Collapse...)

POD 1 - A WELL > ABERNATHY CREEK

Place(s) of Use (Click to Collapse...)

Add TRS grc

Use - MUNICIPAL USES (Primary); Priority Date: 7/13/1973

Water Right Genealogy (Click to Collapse...)

--No genealogy records available for this water right, try the family link below instead.

View Water Rights in same Family **Report Errors with Water Right Data**

RECEIVED
JUL 13 1973
STATE ENGINEER
SALEM OREGON

Permit No. G- G 6728

APPLICATION FOR A PERMIT

To Appropriate the Ground Waters of the State of Oregon

I, CLAIRMONT WATER DISTRICT
(Name of applicant)

of 15223 S. Henrici Road, Oregon City, Oregon 97045 *, county of* Clackamas *,*
(Postoffice Address)

state of Oregon *, do hereby make application for a permit to appropriate the following described ground waters of the state of Oregon, SUBJECT TO EXISTING RIGHTS:*

If the applicant is a corporation, give date and place of incorporation

1. *Give name of nearest stream to which the well, tunnel or other source of water development is situated* Abernathy Creek
(Name of stream)
tributary of Willamette River

2. *The amount of water which the applicant intends to apply to beneficial use is* .... *cubic feet per second or* 4,000 *gallons per minute.*

3. *The use to which the water is to be applied is* municipal water supply

4. *The well or other source is located* 625 *ft.* North (N. or S.) *and* 4225 *ft.* East (E. or W.) *from the* SW *corner of* Section 29
(Section or subdivision)

(If preferable, give distance and bearing to section corner)

(If there is more than one well, each must be described. Use separate sheet if necessary)

being within the SE 1/4 of the SE 1/4 *of Sec.* 29 *, Twp.* 2 South *, R.* 2 East *, W. M., in the county of* Clackamas

5. *The* .... (Canal or pipe line) *to be* .... *miles in length, terminating in the* .... (Smallest legal subdivision) *of Sec.* .... *, Twp.* .... *, R.* .... *, W. M., the proposed location being shown throughout on the accompanying map.*

6. *The name of the well or other works is* Clairmont Well No. 1

DESCRIPTION OF WORKS

7. *If the flow to be utilized is artesian, the works to be used for the control and conservation of the supply when not in use must be described.*

8. *The development will consist of* one well (Give number of wells, tunnels, etc.) *having a diameter of* 16 *inches and an estimated depth of* 560 *feet. It is estimated that* 302 *feet of the well will require* 16" steel (Kind) *casing. Depth to water table is estimated* 69 (Feet)

CANAL SYSTEM OR PIPE LINE—

9. (a) *Give dimensions at each point of canal where materially changed in size, stating miles from headgate. At headgate: width on top (at water line) .... feet; width on bottom .... feet; depth of water .... feet; grade .... feet fall per one thousand feet.*

(b) *At .... miles from headgate: width on top (at water line) .... feet; width on bottom .... feet; depth of water .... feet; grade .... feet fall per one thousand feet.*

(c) *Length of pipe, ... ft.; size at intake, ... in.; in size at .... ft. from intake .... in.; size at place of use .... in.; difference in elevation between intake and place of use, ... ft. Is grade uniform? .... Estimated capacity, ... sec. ft.*

10. *If pumps are to be used, give size and type* 16" vertical turbine line shaft pump.

Give horsepower and type of motor or engine to be used 350 HP Electric

11. *If the location of the well, tunnel, or other development work is less than one-fourth mile from a natural stream or stream channel, give the distance to the nearest point on each of such channels and the difference in elevation between the stream bed and the ground surface at the source of development*

300 feet to Abernathy Creek. Elevation differential 50 feet.

12. *Location of area to be irrigated, or place of use* ....

Township N. or S.	Range E. or W. of Willamette Meridian	Section	Forty-acre Tract	Number Acres To Be Irrigated
See attached list				

(If more space required, attach separate sheet)

Character of soil ....

Kind of crops raised ....

CLAIRMONT - REDLAND
Water Rights

T. 3 S., R 1 E. W.M.
Sec. 1 - S 1/2
2 - S.E. 1/4 of S.E. 1/4
11 - All
12 - All
13 - N.W. 1/4 of N.W. 1/4
14 - All except S.E. 1/4

T. 3 S., R 2 E. W.M.
Sec. 1 - All
2 - All
3 - All
4 - All
5 - All of S 1/2 & S 1/2 of N.E. 1/4
6 - S 1/2
7 - All
8 - All
9 - All
10 - All
11 - All
12 - All
13 - All except W 1/2 of S.W. 1/4
14 - All
15 - All
16 - All
17 - All of N 1/2 & E 1/2 of S.E. 1/4
18 - All of N 1/2 & N.E. 1/4 of S.E. 1/4
20 - E 1/2 of N.E. 1/4 & E 1/2 of S.E. 1/4
21 - All
22 - All
23 - All of W 1/2 & N 1/2 of N.E. 1/4 & S 1/2 of S.E. 1/4
24 - S.W. 1/4 of S.W. 1/4
25 - W 1/2 of N.W. 1/4
26 - All of N 1/2 & N.E. 1/4 of S.E. 1/4
27 - All of N 1/2 & N 1/2 of S.W. 1/4
28 - N 1/2 of N.E. 1/4 & N.E. 1/4 of N.W. 1/4

Application No. G-6228
Permit No. G 6728

RECEIVED
JUL 13 1973
STATE ENGINEER
SALEM, OREGON

T. 2 S., R 2 E., W.M.
Sec. - 13 - E 1/2 of S.E. 1/4
24 - E 1/2 of N.E. 1/4 & all of S.E. 1/4
25 - All of N.E. 1/4 & all of S.E. 1/4 & E 1/2 of S.W. 1/4 & SW 1/4 of SW 1/4
26 - S 1/2 of S.E. 1/4 & S 1/2 of S.W. 1/4
28 - S 1/2 of S.E. 1/4 & S 1/2 of S.W. 1/4
33 - All
34 - All
35 - All
36 - All

T. 2 S., R 3 E, W.M.
Sec.- 18 - W 1/2 of S.W. 1/4
19 - All of W 1/2
30 - All of N.W. 1/4 & W 1/2 of S.W. 1/4
31 - W 1/2 of N.W. 1/4, All of S.W. 1/4 & S 1/2 of S.E. 1/4
32 - All of S.W. 1/4 & S 1/2 of S.E. 1/4

T. 3 S., R 3 E., W.M.
Sec. 4 - All of N.W. 1/4 & N 1/2 of S.W. 1/4
5 - All
6 - All
7 - W 1/2 of N.W. 1/4
19 - N.W. 1/4 of N.W. 1/4
8 - N.W. 1/4 of N.W. 1/4

Application No. G-6228
Permit No. G 6728

G 6728

MUNICIPAL SUPPLY—

13. *To supply the city of* Clairmont Water District and Redland Water District

in Clackamas *county, having a present population of* 7,665

and an estimated population of 15,000 *in 19*85

ANSWER QUESTIONS 14, 15, 16, 17 AND 18 IN ALL CASES

14. *Estimated cost of proposed works, $* 75,000.00

15. *Construction work will begin on or before* April 23, 1973

16. *Construction work will be completed on or before* September 30, 1973

17. *The water will be completely applied to the proposed use on or before* 1980

18. *If the ground water supply is supplemental to an existing water supply, identify any application for permit, permit, certificate or adjudicated right to appropriate water, made or held by the applicant.* None held by the applicant. Water presently is purchased from the South Fork Water Board which has water rights on the Clackamas River.

Clairmont Water District
(Signature of applicant)
[signature]

Remarks:

STATE OF OREGON, }
County of Marion, } *ss.*

This is to certify that I have examined the foregoing application, together with the accompanying maps and data, and return the same for correction and completion

In order to retain its priority, this application must be returned to the State Engineer, with corrections on or before April 5, *19*74

WITNESS my hand this 5th *day of* February, *19*74.

CHRIS L. WHEELER
STATE ENGINEER

By [signature]
Thomas E. Shook
ASSISTANT

G 6728

STATE OF OREGON, }
} ss. PERMIT
County of Marion, }

This is to certify that I have examined the foregoing application and do hereby grant the same, SUBJECT TO EXISTING RIGHTS and the following limitations and conditions:

The right herein granted is limited to the amount of water which can be applied to beneficial use and shall not exceed 8.9 *cubic feet per second measured at the point of diversion from the well or source of appropriation, or its equivalent in case of rotation with other water users, from* a well

The use to which this water is to be applied is municipal purposes

If for irrigation, this appropriation shall be limited to .... *of one cubic foot per second or its equivalent for each acre irrigated and shall be further limited to a diversion of not to exceed* .... *acre feet per acre for each acre irrigated during the irrigation season of each year;*

and shall be subject to such reasonable rotation system as may be ordered by the proper state officer.

The well shall be cased as necessary in accordance with good practice and if the flow is artesian the works shall include proper capping and control valve to prevent the waste of ground water.

The works constructed shall include an air line and pressure gauge or an access port for measuring line, adequate to determine water level elevation in the well at all times.

The permittee shall install and maintain a weir, meter, or other suitable measuring device, and shall keep a complete record of the amount of ground water withdrawn.

The priority date of this permit is July 13, 1973

Actual construction work shall begin on or before June 23, 1977 *and shall thereafter be prosecuted with reasonable diligence and be completed on or before October 1, 19*77.

Extended to Oct. 1, 1982 Extended to October 1987 Extended to October 1, 1992 10-1-97

*Complete application of the water to the proposed use shall be made on or before October 1, 19*78.

Extended to Oct. 1, 1982 Extended to October 1987 Extended to October 1, 1992 10-1-97

WITNESS my hand this 23rd *day of* June *, 19*76.

James E. Sexson

WATER RESOURCES DIRECTOR

Application No. G- 6228

Permit No. G- G 6728

PERMIT

TO APPROPRIATE THE GROUND WATERS OF THE STATE OF OREGON

This instrument was first received in the office of the State Engineer at Salem, Oregon, on the 13th *day of* July*, 19*73*, at* 8:00 *o'clock* A *M.*

Returned to applicant:

Approved:

STATE ENGINEER

Recorded in book No. .... *of Ground Water Permits on page* G 6728

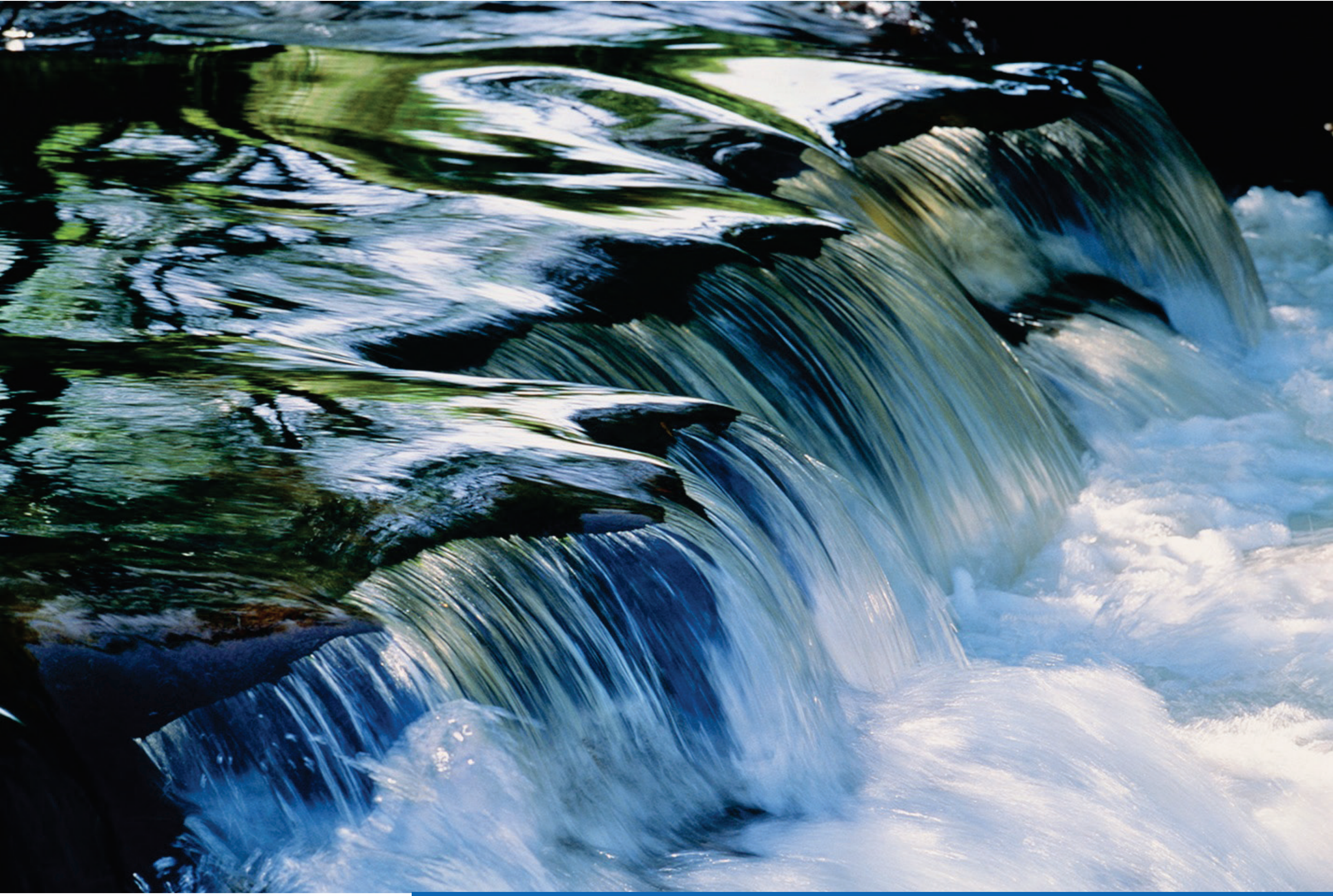
Drainage Basin No. 2 *page* 133

State Printing

$46.00

Appendix L

TECHNICAL MEMORANDUM 2 – CALIBRATION PLAN



Clackamas River Water

Water System Plan Update

TECHNICAL MEMORANDUM 2
CALIBRATION PLAN

FINAL | April 2019

Clackamas River Water

Water System Plan Update

TECHNICAL MEMORANDUM 2

CALIBRATION PLAN

Digitally signed by Matthew M. Huang
Contact Info: Carollo Engineers, Inc.
Date: 2019.04.11 12:12:45-07'00'

REGISTERED PROFESSIONAL
ENGINEER
91512
OREGON
SEP 13, 2016
MATTHEW M. HUANG
EXPIRES: 06/30/19

Contents

Technical Memorandum 2 - Calibration Plan

Attachments

Tables

Figures

Abbreviations

Carollo	Carollo Engineers, Inc.
CRW	Clackamas Water River
EPS	extended period simulation

Technical Memorandum 2

CALIBRATION PLAN

2.1 Overview

This calibration plan covers each of the calibration processes, specifically focusing on data gathering needs for an accurate and complete calibration of Clackamas River Water's (CRW) water system hydraulic model.

2.1.1 Schedule

Field testing and data gathering for the model calibration will tentatively take place from August 23, 2017 through September 6, 2017. This will allow our team to start the model calibration as soon as possible following the calibration data gathering.

2.2 Model Review and System Controls

2.2.1 Model Review

Carollo will conduct a review of the hydraulic model delivered by CRW to ensure the model is ready for Extended Period Calibration.

It is our understanding that the model should include existing water system demands (based on geocoded billing data for year 2015 or similar), model node elevations, identifications of closed isolation valves, and water system facilities with attribute data on all elements (pumps, reservoirs, etc.), and that the mode is calibrated under static conditions to recent fire hydrant tests.

It is assumed that the facility controls for pump stations and other dynamic facilities are not input in the model.

2.2.2 Water System Controls

This task will enable Carollo to meet with CRW's water system operation staff to discuss the water system operations philosophy and controls. It is important to understand the overall operations objectives regarding prioritization of various water supply sources and key system facilities prior to input of model controls. Once the big picture of the system's operation is well understood, the operation of each pump station, reservoir, pressure reducing station, and other valve structures will be discussed. Carollo will provide a data list prior to this site visit and develop a facility control matrix to record system facilities, control settings, and control points. This field visit is scheduled for September 8, 2017.

2.3 Extended Period Calibration

2.3.1 Overview of Extended Period Calibration Process

The extended period calibration is intended to calibrate the extended period simulation (EPS) capabilities of the hydraulic model by closely matching the model pressures, flows, and tank levels to field conditions over a 24-hour period of similar demand and system boundary conditions. Pressure data, tank levels, and flows from the water supplies, booster stations, and the pressure reducing stations will be recorded for several days in order to obtain EPS calibration data. The primary varied parameters for this step of the calibration might include operational controls and pipeline roughness coefficients; although other parameters may also be adjusted as calibration results are generated.

2.3.2 Data Required for Extended Period Calibration

The calibration data required for the extended period calibration consists of records of system pressures, tank levels, and flows from CRW's supplies, CRW interconnections, pump stations, and the pressure reducing stations throughout the distribution system. These system pressures will be gathered by temporary pressure loggers, which will be attached to hydrants throughout the distribution system, and provided by Carollo. Additional data, including system controls and operational details, will be required to establish boundary conditions for the model. This data will be gathered over the course of seven (7) days

A target system interval of hourly data will be used for data gathering. If any facilities listed lack the capabilities for hourly interval data gathering (e.g., they use circular charts or flow totalizers), assumptions will be necessary to interpolate data for the calibration.

2.3.3 Temporary Pressure Loggers

Carollo will provide 15 temporary pressure loggers to be attached to hydrants within CRW’s distribution system. Our team has indicated general locations for the 15 pressure loggers on Figure 1. CRW staff will install near these locations as local meters and appurtenances allow. The respective hydrant number is listed on Table 1 and Attachment A.

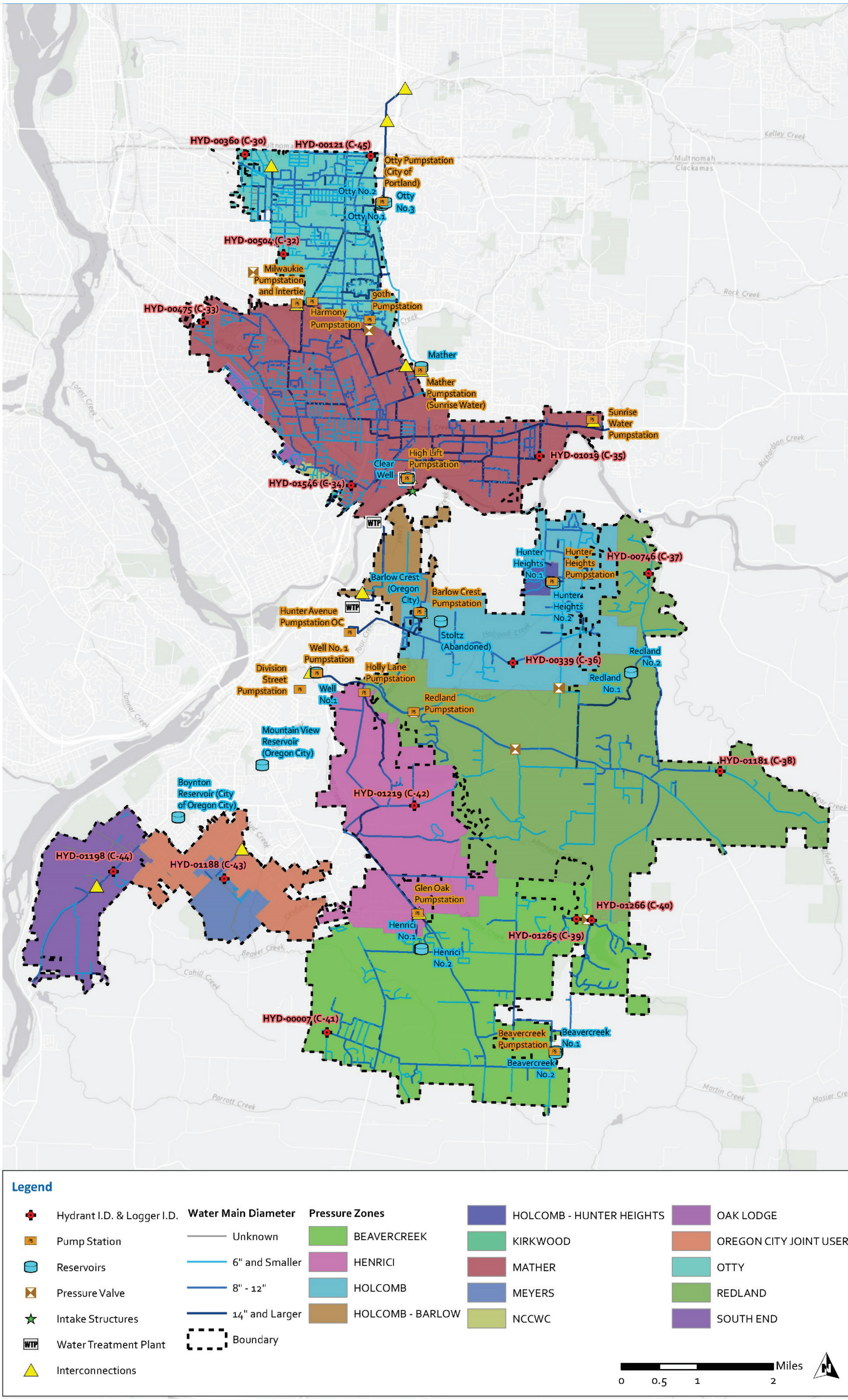


Figure 2.1 Temporary Pressure Loggers Locations

Table 2.1 Temporary Pressure Logger Summary

Logger Site	Hydrant ID	Logger ID	Pressure Zone ID	Hydrant Location
1	HYD_00360	C-30	OTTY	Springwater Corridor and Southeast Stanley Avenue
2	HYD_00121	C-45	OTTY	Southeast Fuller Road and Southeast Gray Street
3	HYD_00504	C-32	OTTY	SE Charles Street, south of Southeast 66th Avenue
4	HYD_00475	C-33	MATHER	Southeast Chelsea Street and Southeast Freeman Road
5	HYD_015246	C-34	MATHER	Southeast Strawberry Lane and Cason Road
6	HYD_01019	C-35	MATHER	Southeast Jennifer Street and Southeast 135th Avenue
7	HYD_00339	C-36	HOLCOMB	South Holcomb Blvd, 1,500 feet east of South Memory Lane
8	HYD_00746	C-37	REDLAND	South Hattan Road and South Edgewood Street
9	HYD_01181	C-38	REDLAND	South Princess Ct and South Fischers Mill Road
10	HYD_01265	C-39	BEAVERCREEK	South Henrici Road, 490 feet west of South Creek Road
11	HYD_01266	C-40	BEAVERCREEK	South Henrici Road, 250 feet east of South Creek Road
12	HYD_00007	C-41	BEAVERCREEK	Leland Road and South Foothills Ave
13	HYD_01219	C-42	HENRICI	South Maplelane Road and South Waldow Road
14	HYD_01188	C-43	MEYERS	Leland Road and South Kala Court
15	HYD_01198	C-44	SOUTH END	South End Road and Finnegans Way

2.3.4 Manual Facilities

For any manually operated facilities operated during the EPS data gathering period, an operational log should be substituted for the requested facility parameters. It is assumed that flow totalizers are used to take daily readings of the amount of water pumped during each 24-hour period. For any manually operated pump used during the extended period calibration week, the hours that the pump is on or off, along with the flow rate during each operation period will be needed. Photocopies of the log sheets for these pumps would be sufficient. If CRW finds it more convenient, a handwritten or electronic log of all sites would also be sufficient.

2.3.5 Required Equipment / Staff

2.3.5.1 Required Staff (CRW)

Carollo will mail the loggers to CRW by August 23, 2017. CRW employees will place all of the pressure loggers in the field one day prior the testing (tentatively August 23, 2017 or August 24, 2017). CRW staff shall be responsible for installation/removal of data loggers on hydrants, driving CRW vehicles or any other function involving CRW property. At the end of the testing (tentatively September 3, 2017 or September 6, 2017), CRW staff shall remove the loggers and Carollo will have a courier pick up the pressure loggers.

2.3.5.2 Required Equipment (CRW)

- Appropriate wrenches and equipment to place loggers at each location.

2.3.5.3 Required Equipment (Carollo)

- 15 pressure loggers – Track-IT 150 and Dickson PR125 (C-30 through C-46).

2.3.6 Models and Intermediate Readings

The sampling interval for all pressure loggers should be set to 5 minutes. Each pressure logger will require approximately 2,016 data points (12 data points per hour over 7 days).

The internal capacity of the Dickson PR125 pressure loggers is limited to 60,000 data points, and the internal capacity of Track-IT 150 pressure loggers is limited to 64,000 data points, all of which are sufficient to record seven days of data in 5-minute intervals.

Attachment A

TEMPORARY PRESSURE LOGGER SUMMARY

Temporary Pressure Logger Summary
Model Calibration Plan
Clackamas River Water

Logger Site	Hydrant ID	Logger ID	Pressure Zone ID	Hydrant Location	Comments
1	HYD_00360	C-30	OTTY	Springwater Corridor and SE Stanley Ave	
2	HYD_00121	C-45	OTTY	SE Fuller Rd and SE Gray St	
3	HYD_00504	C-32	OTTY	SE Charles St, south of SE 66th Ave	
4	HYD_00475	C-33	MATHER	SE Chelsea St and SE Freeman Rd	
5	HYD_01546	C-34	MATHER	SE Strawberry Ln and Cason Rd	
6	HYD_01019	C-35	MATHER	SE Jennifer St and SE 135th Ave	
7	HYD_00339	C-36	HOLCOMB	S Holcomb Blvd 1,500 feet east of S Memory Ln	
8	HYD_00746	C-37	REDLAND	S Hattan Rd and S Edgewood St	
9	HYD_01181	C-38	REDLAND	S Princess Ct and S Fischers Mill Rd	
10	HYD_01265	C-39	BEAVERCREEK	S Henrici Rd, 490 feet west of S Creek Rd	
11	HYD_01266	C-40	BEAVERCREEK	S Henrici Rd, 250 feet east of S Creek Rd	
12	HYD_00007	C-41	BEAVERCREEK	Leland Rd and S Foothills Ave	
13	HYD_01219	C-42	HENRICI	S Maplelane Rd and S Waldow Rd	
14	HYD_01188	C-43	MEYERS	Leland Rd and S Kala Ct	
15	HYD_01198	C-44	SOUTH END	South End Rd and Finnegans Way	

Appendix M

TECHNICAL MEMORANDUM 1 – SEISMIC HAZARD EVALUATION

Technical Memorandum

To:	Lara Kammereck, PE, and Matt Huang, PE, Carollo Engineers	Project:	Clackamas River Water System Seismic Hazard Evaluation
From:	Wolfe Lang, PE, GE	cc:	Kevin Tice, PE, Carollo Engineers
Prepared by:	Farid Sariosseiri, PE	Job No.:	5784.0
Date:	April 5, 2019		
Subject:	Seismic Hazard Evaluation – Final		

1.0 Introduction

Clackamas River Water (CRW) is conducting a study to evaluate the seismic hazards of the wastewater system in conjunction with the Oregon Resilience Plan (ORP). CRW has contracted Carollo Engineers to provide professional engineering services for the resilience study. McMillen Jacobs Associates has been retained by Carollo Engineers to provide geotechnical engineering services.

This memorandum presents the results of our evaluation. The following tasks were completed in accordance with our scope of work:

1. Review of DOGAMI seismic hazard maps for a magnitude 9.0 CSZ event in the CRW's service area;
2. Review of available geological information;
3. Review of available geotechnical boring information provided by CRW to verify DOGAMI seismic hazard maps;
4. Site reconnaissance to address key geological and geotechnical assumptions and to examine areas that are potentially prone to failures from lateral spreading and seismic landslide hazards;
5. Develop estimates of strong ground shaking, liquefaction-induced settlement, lateral spreading displacement, seismic landslide slope instability, and develop maps illustrating these hazards in relation to the CRW's service area; and
6. Develop this memorandum summarizing the results of our evaluations and including updated hazard maps.

These tasks were completed at the identified CRW facilities as shown on Figures 2 to 5. In the following sections, we present the results of the data review, seismic hazards evaluation, and a summary of geotechnical hazards along the backbone system.

2.0 Data Review

We reviewed previous geotechnical reports and subsurface data for various projects in the area conducted between 1973 and 2018. A list of reviewed documents is provided below:

- Geotechnical Data Report, S Springwater Road and S Hattan Road Pipeline, Clackamas County, Oregon, October 20, 2016, Shannon and Wilson, Inc.
- Geotechnical Data Report, Proposed Redland Reservoir, Clackamas County, Oregon, November 9, 2016, Shannon and Wilson, Inc.
- Subsurface Exploration Data Report, Proposed Hattan Road Waterline, Clackamas, Oregon, January 16, 2018, Northwest Geotech, Inc.
- Geotechnical Investigation for Temporary Construction-Access Road, Clackamas River Water SE 152nd Avenue Reservoir, Clackamas, Oregon, March 31, 2017, GRI.
- Geotechnical Investigation and Site-Specific Seismic Hazard Evaluation, Clackamas River Water SE 152nd Avenue Reservoir, Clackamas, Oregon, March 15, 2017, GRI.
- Geotechnical Design Recommendations and Seismic Hazard, Clackamas River Water 152nd Avenue Reservoir, Clackamas, Oregon, May 3, 2003, CH2M Hill.
- Mather Road 10 MG Reservoir No. 1, Clackamas Water District, Clackamas, Oregon, January 1973, CH2M Hill.
- Geotechnical Engineering Report, Butterfield Lane Transmission Main, Clackamas County, Oregon, July 22, 2016, Shannon and Wilson, Inc.
- Geotechnical Investigation and Seismic Hazard Study, CRW Power Generation Facility, Clackamas County, Oregon, November 29, 2007, Foundation Engineering, Inc.

3.0 Site Reconnaissance

On April 9, 2018 Farid Sariosseiri, PE, performed geotechnical reconnaissance of the following sites within the CRW's service area:

- Well No. 1 Pump Station and Reservoir
- Holly Lane Pump Station
- Redland Pump Station
- High lift Pump Station, Clear Well Reservoir, and Clackamas River Water Treatment Plant
- 90th Pump Station
- Milwaukie Pump Station and Intertie
- Harmony Pump Station

We selected these facilities for site visit because they are within the mapped seismic hazard zones (Figures 3, 4 and 5). During the reconnaissance, we noted site conditions, surface or exposed soil conditions, site topography, proximity to bodies of water, and features (i.e. culverts). Selected photographs from the site visits are provided in Appendix A. Our assessment results from the site visits and review of available data are discussed in Section 7.

4.0 Geology and Seismic Setting

4.1 Geologic Setting

The Portland basin is a structural depression created by complex folding and faulting of the basement rocks, a sequence of middle Miocene age, about 17 to 6 Ma ("Mega annum" or million years ago), lava flows of the Columbia River Basalt Group (CRBG). An extensive sedimentary fill has then accumulated in the basin and overlies the CRBG basement (Trimble, 1963; Tolan and Beeson, 1984). The Tertiary sedimentary units include up to 1,300 feet of the Sandy River Mudstone, which directly overlies the CRBG, and 100 to 350 feet of sandstone and conglomerate of the Troutdale Formation, which overlies the Sandy River Mudstone (Pratt et al., 2001).

Unconsolidated sediments at the top of the basin fill sequence consist primarily of catastrophic flood sediment deposited near the end of the last ice age, between 15,300 and 12,800 radiocarbon years ago (Mullineaux et. al., 1978; Waitt, 1987; Allen et al., 2009). Forty or more catastrophic floods occurred at intervals of several decades on the Columbia River system. The flood waters swept across the Portland basin and deposited tremendous loads of sediment. Boulders, cobbles, and gravels were deposited near the mouth of the Columbia River Gorge and along the main channel of the Columbia River, while great cobble and gravel bars stretched westward across the Portland basin, grading to thick blankets of micaceous sand. Within the Portland basin, the flood deposits mantle the Troutdale Formation at elevations below about 350 feet above mean sea level. The flood deposits generally consist of unconsolidated gravel topped by fine sand and silt and range from a few feet to more than 200 feet thick.

During the late Pliocene epoch, fluvial conglomerate, volcaniclastic sandstone, siltstone and debris flow deposits, originating in the Cascade Range, were deposited in a broad fan in the Boring Hills area at the southern margin of the Portland Basin (Tolan and Beeson, 1984). These deposits, the Springwater Formation, interfingered with the late Troutdale Formation sediments. Deposition of the Springwater Formation continued into the Pleistocene (Madin, 1994).

During the middle to late Pleistocene (after about 2 Ma), Boring Lava erupted from several local vents in the Portland basin and in the Boring Hills south of Gresham, intruding the Sandy River Mudstone, Troutdale Formation, and Springwater Formation sediments (Trimble, 1963; Madin, 1994). The lava flows were relatively thin and apparently of small volume, because they do not appear to have flowed far from their source. Both the Springwater Formation and the Boring Lavas are very deeply weathered and decomposed.

During the late Pleistocene, wind-blown silt, or "loess", was funneled westward through the Columbia River gorge and accumulated on hilltops around the Portland basin. The loess deposits were named "Portland Hills Silt" for the thick accumulation that mantled Portland's West Hills, but the loess is also present over the Boring Hills in the southern part of the Portland basin. Lentz (1977) observed Boring Lava interbedded in loess deposits near Elk Point in the West Hills helping to bracket the age of the silt between 36,000 and 700,000 years before the present time.

During the Holocene epoch (the last 10,000 years), minor alluvial deposits have accumulated along the several creeks and streams that drain the area. These young alluvial sediments are largely reworked from older materials in the Boring Hills and from the catastrophic flood deposits on the basin floor. Other active geologic processes include soil creep and land sliding.

4.2 Seismic Setting

The Pacific Northwest is located near an active tectonic plate boundary. Off the coast, the Juan de Fuca oceanic plate is subducting beneath the North American crustal plate. This tectonic regime has resulted in seismicity in the Pacific Northwest occurring from three primary sources:

- Shallow crustal faults within the North American plate;
- CSZ intraplate faults within the subducting Juan de Fuca plate; and
- CSZ megathrust events generated along the boundary between the subducting Juan de Fuca plate and the overriding North American plate.

Among these three sources, CSZ megathrust events are considered as having the most hazard potential due to the anticipated magnitude and duration of associated ground shaking. Recent studies indicate that the CSZ can potentially generate large earthquakes with magnitudes ranging from 8.0 to 9.2 depending on rupture length. The recurrence intervals for CSZ events are estimated at approximately 500 years for the mega-magnitude full rupture events (magnitude 9.0 to 9.2) and 200 to 300 years for the large-magnitude partial rupture events (magnitude 8.0 to 8.5). Additionally, current research indicates a probability of future occurrence because the region is “past due” based on historic and prehistoric recurrence intervals documented in ocean sediments. For example, over the next 50 years, the CSZ earthquake has an estimated probability of occurrence off the Oregon Coast on the order of 16 to 22 percent (Goldfinger et. al., 2016).

In 2013, the State of Oregon developed the Oregon Resilience Plan (ORP, 2013) to prepare for the magnitude 9.0 CSZ event. We understand that this earthquake scenario is selected as the seismic source in the CRW’s seismic hazard study.

5.0 Subsurface Conditions

The subsurface within the project area is dominated by the following geologic units:

- Alluvial Deposits: Generally consist of soft fine grained material near existing surface water locations and low lying areas. This material is highly variable in its susceptibility to seismic liquefaction and lateral spreading hazards.
- Fine Grained Missoula Flood Deposits: Generally consist of very soft to stiff silt with varying concentrations of clay and sand. When saturated, this material is generally prone to seismic liquefaction and lateral spreading hazards.
- Coarse Grained Missoula Flood Deposits: Generally consist of medium dense to very dense sand and gravel with varying concentrations of silt. This material is generally seismically stable and not susceptible to liquefaction and lateral spreading permanent ground deformations.
- Troutdale Formation: Generally consists of very dense silty sand and gravel. This material is seismically stable and not susceptible to liquefaction and lateral spreading permanent ground deformations.

- Boring Lava: Generally consists of basalt in varying states of weathering. This material is seismically stable and not susceptible to liquefaction and lateral spreading permanent ground deformations.

A geologic map, provided in Figure 1, shows the overall distribution of these geologic units. In general, the subsurface conditions vary across the CRW service area.

6.0 Geotechnical Seismic Hazards

The effect seismic hazards including strong ground shaking, liquefaction settlement, lateral spreading, seismic-induced landslide was analyzed. These hazards have the potential to damage facilities (i.e., pipelines, reservoirs, pump stations, treatment plants) through either permanent ground deformation (PGD) or intense shaking. Our analysis of these seismic hazards is based on information provided from existing geotechnical explorations, DOGAMI hazard maps, and our knowledge of the geotechnical conditions of the area. In our seismic analyses we assumed a magnitude 9.0 earthquake and a peak ground acceleration (PGA) of 0.2 g to represent the effects of a M9 CSZ seismic event in the project area. No significant geotechnical data was available for pump stations and reservoirs within the CRW service areas. Therefore, DOGAMI hazard maps were used for evaluation.

6.1 Ground Shaking

6.1.1 Seismic Ground Shaking Parameters for CSZ Earthquake

To assess the hazard potential of ground shaking in the project area, we reviewed the peak ground velocity (PGV) map published by DOGAMI for the Portland Metro Area in the event of a M9 CSZ earthquake (DOGAMI O-18-02, Bauer et. al., 2018).

The estimated ground shaking intensity (PGV) depends on the subsurface materials. The ground shaking near the surface will be amplified by thick soil units. Generally, the PGV values are estimated to range between 7 and 16 inches per second. The PGV map is shown in Figure 2.

6.2 Liquefaction

Liquefaction is a phenomenon affecting saturated, granular soils in which cyclic, rapid shearing from an earthquake results in a drastic loss of shear strength and a transformation from a granular solid mass to a viscous, heavy fluid mass. The results of soil liquefaction include loss of shear strength, loss of soil materials through sand boils, flotation of buried chambers/pipes, and post liquefaction settlement.

To evaluate the hazard potential of soil liquefaction in the project area, we reviewed liquefaction hazard maps published by DOGAMI for the Portland Metro Area in the event of a M9 CSZ earthquake (Bauer, et. al., 2018). Where geotechnical data was available, we conducted site specific analyses based on the subsurface conditions shown in previous geotechnical explorations listed in Section 2, using the latest SPT-based liquefaction susceptibility and settlement assessment procedures (Boulanger and Idriss, 2014; Idriss and Boulanger, 2008). Based on our evaluation, the primary zones of liquefaction hazard are within the Fine-Grained Missoula Flood Deposits in the north side of the service area and in areas between

Gladstone and Oregon City. Additionally, Alluvium Deposits along the Clackamas River are mapped as liquefiable.

6.3 Lateral Spreading

Liquefaction can result in progressive deformation of the ground known as lateral spreading. The lateral movement of liquefied soil breaks the non-liquefied soil crust into blocks that progressively move downslope or toward a free face in response to the earthquake generated ground accelerations. Seismic movement incrementally pushes these blocks downslope as seismic accelerations overcome the strength of the liquefied soil column. The potential for and magnitude of lateral spreading depends on the liquefaction potential of the soil, the magnitude and duration of earthquake ground accelerations, the site topography, and the post-liquefaction strength of the soil.

To assess the hazard potential of lateral spreading in the project area we reviewed a lateral spreading hazard map published by DOGAMI for the Portland Metro Area in the event of a M9 CSZ earthquake (Bauer et. al., 2018). The primary zones of lateral spreading hazard areas are at northern part of the service area, areas along the Clackamas River, and areas along the Abernathy Creek. Lateral spreading is anticipated to be in the order of 6 to 24 inches.

6.4 Seismic Landslides

Earthquake induced landslides can occur on slopes due to the inertial force from an earthquake adding load to a slope. The ground movement due to landslides can be extremely large and damaging to pipelines and other structures.

To assess the hazard potential of seismic landslides in the project area, we reviewed a landslide deformation map published by DOGAMI for the Portland Metro Area in the event of a M9 CSZ earthquake (Bauer et. al., 2018). We reviewed the topography of the project area in conjunction with a visual assessment of slopes during our site visit.

The sites are generally located on relatively flat or gently sloped ground, except 90th Pump Station, Milwaukie Pump Station and Intertie, and Well No.1 Pump Station and Reservoir that are located at the top of steep slopes. Previous geotechnical explorations were not available for these sites to perform further evaluation.

7.0 Seismic Hazard Assessment and Recommendations for Critical Facilities

In addition to the seismic hazard study for the overall service area, we conducted site visits to seven pump stations and reservoirs which are located within the mapped liquefaction and landslide areas. These facilities are listed in Table 1 and shown in Figures 3, 4, & 5 (along with other facilities). Summaries of site visits, document review, and the geotechnical opinions regarding the seismic hazards and geotechnical concerns at these locations are presented in Table 1. Recommendations for future studies and mitigations are also provided in Table 1.

Seismic hazards for the rest of the sites are relatively low. We recommend further evaluation of these sites to be combined with future improvement projects for the sites.

MCMILLEN JACOBS ASSOCIATES

REGISTERED PROFESSIONAL ENGINEER
86968
OREGON
Mar. 12, 2013
FARID SARIOSSEIRI
EXPIRES: 6/30/2020

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Senior Project Engineer

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Senior Associate

Table 1. Preliminary Seismic Hazard Assessment Summary for Critical Facilities

Structure Name	Available or Nearby Geotechnical Information	Mapped Seismic Hazards and Levels	Anticipated Subsurface Conditions and Site Topography	Preliminary Geotechnical Seismic Concerns & Issues	Recommendations/Notes
Well No. 1 Pump Station and Reservoir	No geotechnical data available.	Liquefaction settlement: 6 to 8 inches, Lateral spreading displacement: > 24 inches,	Located at the top of a hill. The hill side slope is estimated to be 1:1 (H:V), sloping toward the S Redland Road. Abernathy Creek is located on the opposite side of the road from the pump station and reservoir, approximately 20 to 30 feet from the road. The geologic map indicates the site is underlain by Alluvial Deposits and/or Missoula Flood Deposits.	Lack of subsurface information.	Perform subsurface investigation and site-specific stability evaluation.
Holly Lane Pump Station	No geotechnical data available.	Liquefaction settlement: 6 to 8 inches, Lateral spreading displacement: > 24 inches,	Located on a gently sloped ground toward the Abernathy Creek. The Abernathy Creek is approximately 200 feet northeast of the site. The geologic map indicates the site is underlain by Terrace Deposits.	Lack of subsurface information.	Perform subsurface investigation and site-specific stability evaluation.
Redland Pump Station	No geotechnical data available.	Liquefaction settlement: 0 to 2 inches.	Located on a relatively flat site but general area is gently sloped toward the west. The Abernathy Creek and Hidden Lake are approximately 1,200 feet south of the site. The geologic map indicates the site is near the limits of Missoula Flood Deposits and Terrace Deposits.	Lack of subsurface information.	In comparison with other facilities, this site has a relatively low liquefaction hazard. From a seismic hazard risk perspective, site-specific study for this pump station may not need to be prioritized, and can be combined with future site improvement design.
High Lift Pump Station, Clear Well Reservoir, and Clackamas Water Treatment Plant	Geotechnical data for the upper bench is available.	Liquefaction settlement: 0 to 2 inches, Lateral spreading displacement: 0 to 6 inches	Located on a gently sloped ground toward south. The Clackamas river is approximately 1,000 feet south of the site. The geologic map indicates the site is underlain by Alluvial and/or Terrace Deposits.	Lack of subsurface information for the lower bench.	Perform subsurface investigation and site-specific stability evaluation for the lower bench.
90th Pump Station	No geotechnical data available.	Liquefaction settlement: 0 to 2 inches, Lateral spreading displacement: 6 to 12 inches	Located at the top a 40-foot high slope. A creek runs through a culvert on the west side of the site. The side slope toward the creek is approximately 1:1 (H:V). Ground slope toward the south ranges between 2:1 to 3:1. A wetland is located at the bottom of the slope. An area that appear to be slope instability observed at the southwest corner of the site. A manhole cover and an access vault cover appeared to be slightly tilted. Geologic map indicates the site is underlain by Missoula Flood Deposits.	Lack of subsurface information.	Perform subsurface investigation and site-specific stability evaluation.
Milwaukie Pump Station and Intertie	No geotechnical data available.	Liquefaction settlement: 0 to 2 inches, Lateral spreading displacement: 6 to 12 inches	The site is located on a ridge with a steep slope toward a creek on the north and a gentle slope toward the Three Creeks Natural Area. The slope toward the creek is approximately 1:1 (H:V) and 30 feet high. The Three Creeks Natural Area is located on the opposite side of the road from the site and the average slope is estimated to be 4:1 (H:V). The geologic map indicates the site is underlain by Missoula Flood Deposits.	Lack of subsurface information.	Perform subsurface investigation and site-specific stability evaluation.
Harmony Pump Station	No geotechnical data available.	Liquefaction settlement: 0 to 2 inches, Lateral spreading displacement: 6 to 12 inches	The site is relatively flat, however, the general topography has gentle slope toward the Three Creeks Natural Area, which is located approximately 1,000 feet south of the site. The geologic map indicates the site is underlain by Missoula Flood Deposits.	Lack of subsurface information.	Perform subsurface investigation and site-specific stability evaluation.

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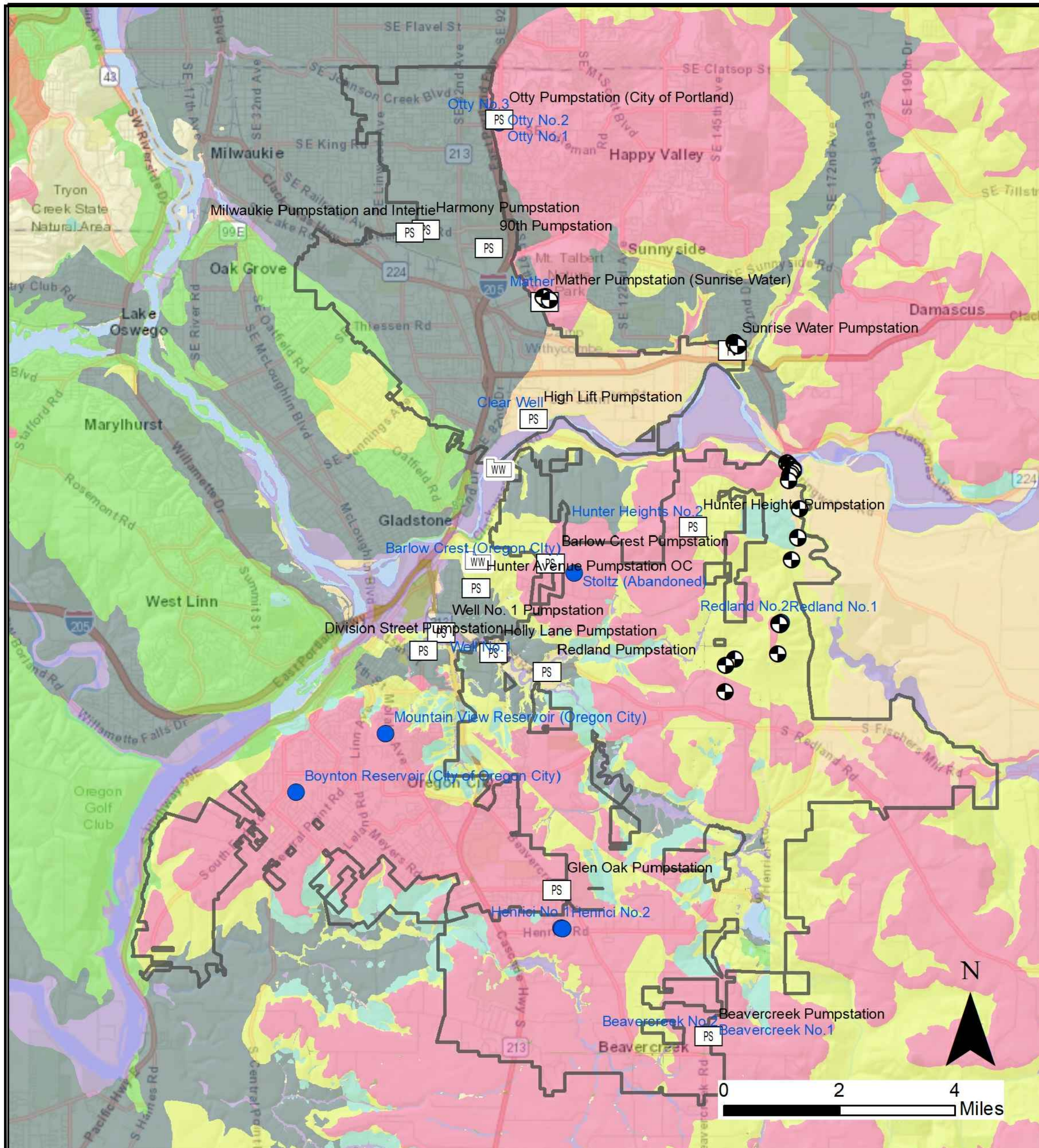
Figures



Legend

- Analyzed Boreholes
- PS Pump Stations
- WW Water Treatment Plant
- Reservoirs
- Existing Service Area

Geology

- Alluvial Deposits
- Columbia River Basalt Group
- Hillsboro Formation
- Landslide Deposits
- Man-Made Fill Deposits
- Missoula Flood Deposits
- Portland Basin Volcanoes
- Terrace Deposits
- Troutdale Formation

GEOLOGIC MAP

NOTES:

1. GEOLOGY DATA SOURCE: DOGAMI OGDC-6.

McMILLEN JACOBS ASSOCIATES

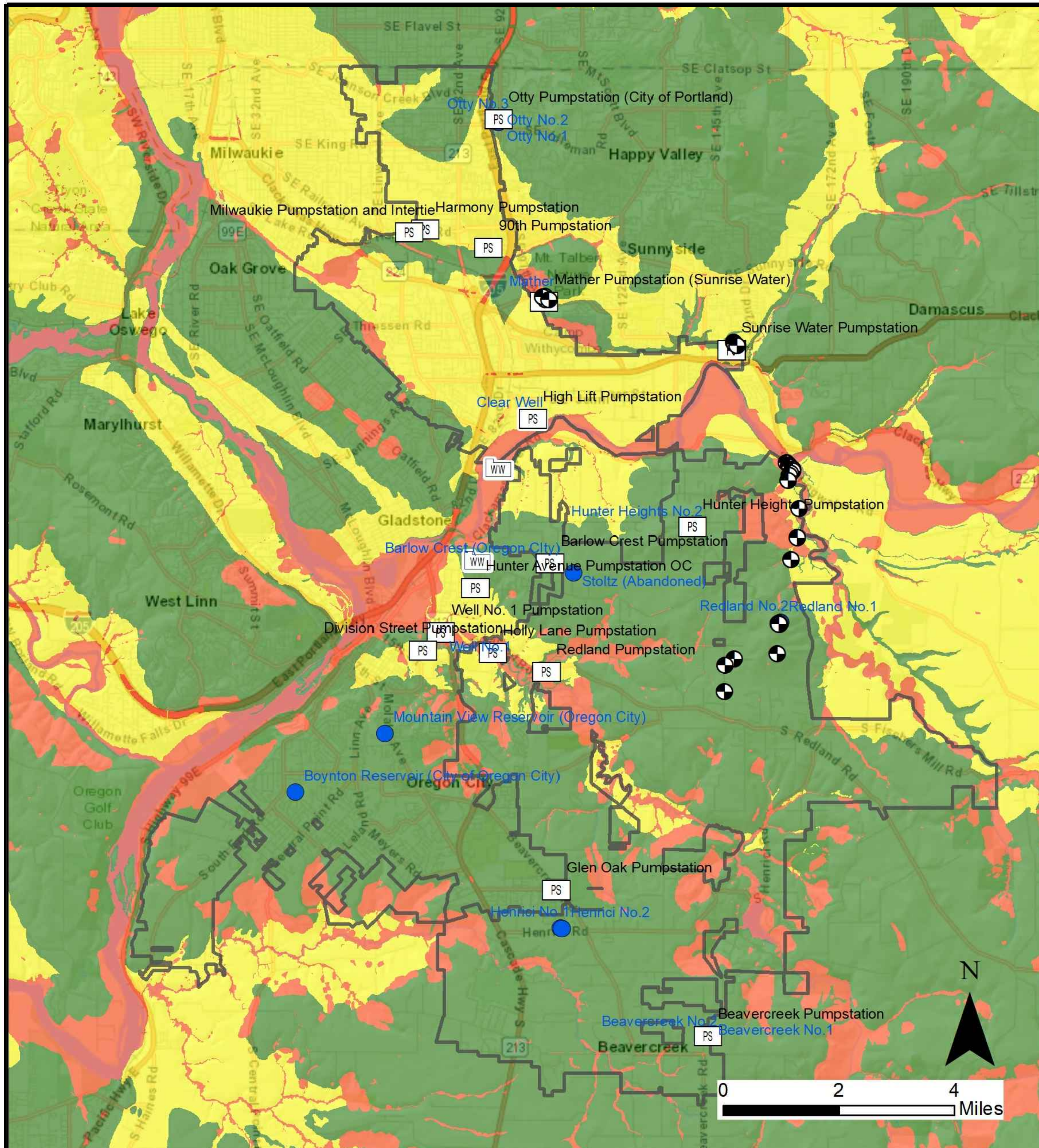
CLACKAMAS RIVER WATER SYSTEM

SEISMIC HAZARD EVALUATION

SEISMIC HAZARDS TECHNICAL MEMORANDUM
GEOLOGIC MAP

FIG.1

APRIL 2019



Legend

- Analyzed Boreholes
- Pump Stations (PS)
- Water Treatment Plant (WW)
- Reservoirs
- Existing Service Area

Estimated Peak Ground Velocity

- 7 - 10 in/sec
- 10 - 13 in/sec
- 13 - 16 in/sec

PEAK GROUND VELOCITY

NOTES:

1. PEAK GROUND VELOCITY ESTIMATES ARE BASED ON HAZARD DATA FROM DOGAMI OPEN FILE REPORT O-18-02 AND DATA FROM EXISTING BORINGS. AREAS OUTSIDE OF EXISTING BORING LOCATIONS HAVE NOT BEEN VERIFIED.

McMILLEN JACOBS ASSOCIATES

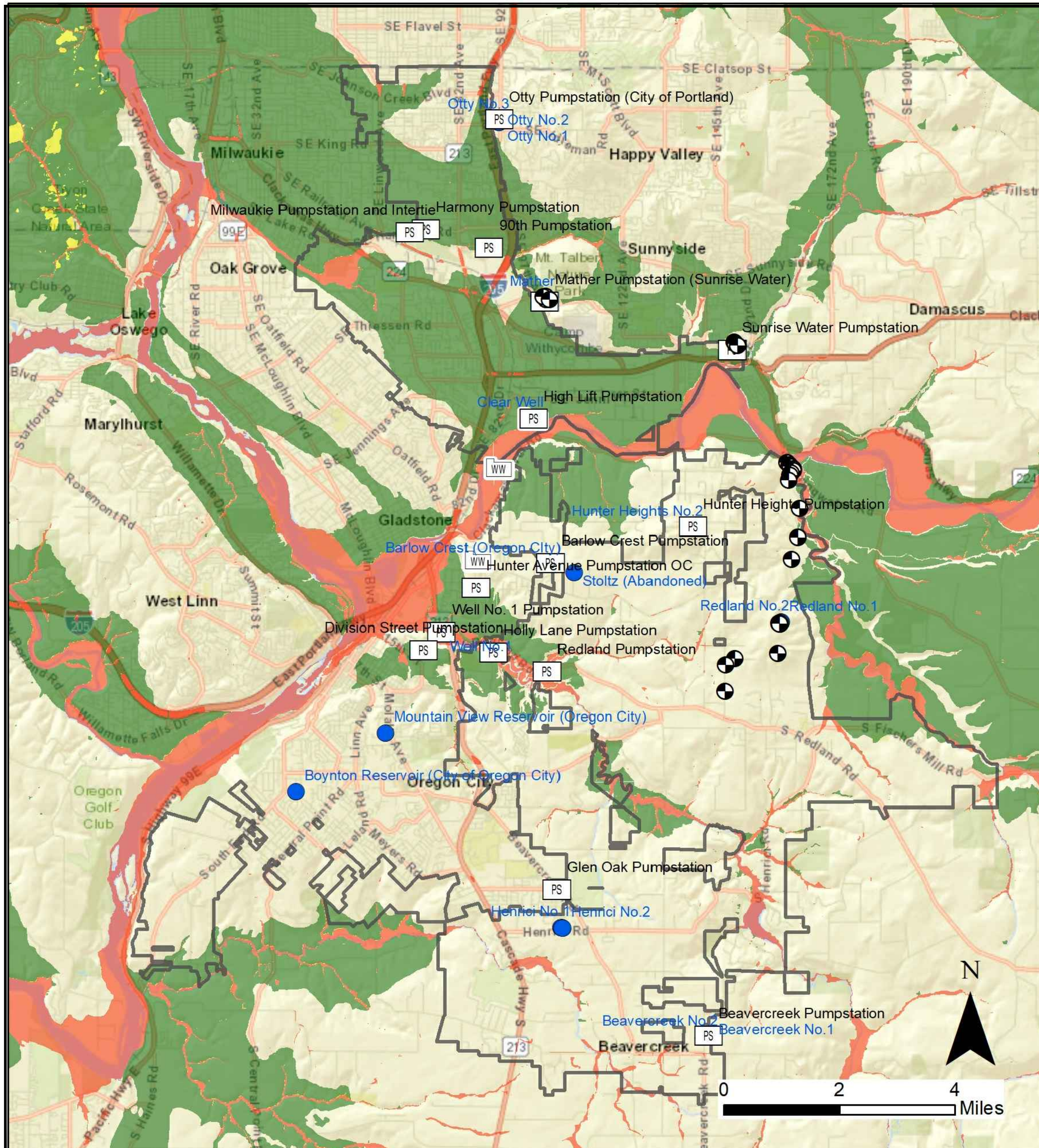
CLACKAMAS RIVER WATER SYSTEM

SEISMIC HAZARD EVALUATION

SEISMIC HAZARDS TECHNICAL MEMORANDUM
PEAK GROUND VELOCITY MAP

FIG.2

APRIL 2019



Legend

- Analyzed Boreholes
- PS Pump Stations
- WW Water Treatment Plant
- Reservoirs
- Existing Service Area

Estimated Liquefaction Settlement

- 0" - 2"
- 2" - 6"
- 6" - 8"

LIQUEFACTION INDUCED SETTLEMENT MAP

NOTES:

1. LIQUEFACTION SETTLEMENT ESTIMATES ARE BASED ON HAZARD DATA FROM DOGAMI OPEN FILE REPORT O-18-02 AND DATA FROM EXISTING BORINGS. AREAS OUTSIDE OF EXISTING BORING LOCATIONS HAVE NOT BEEN VERIFIED.

McMILLEN JACOBS ASSOCIATES

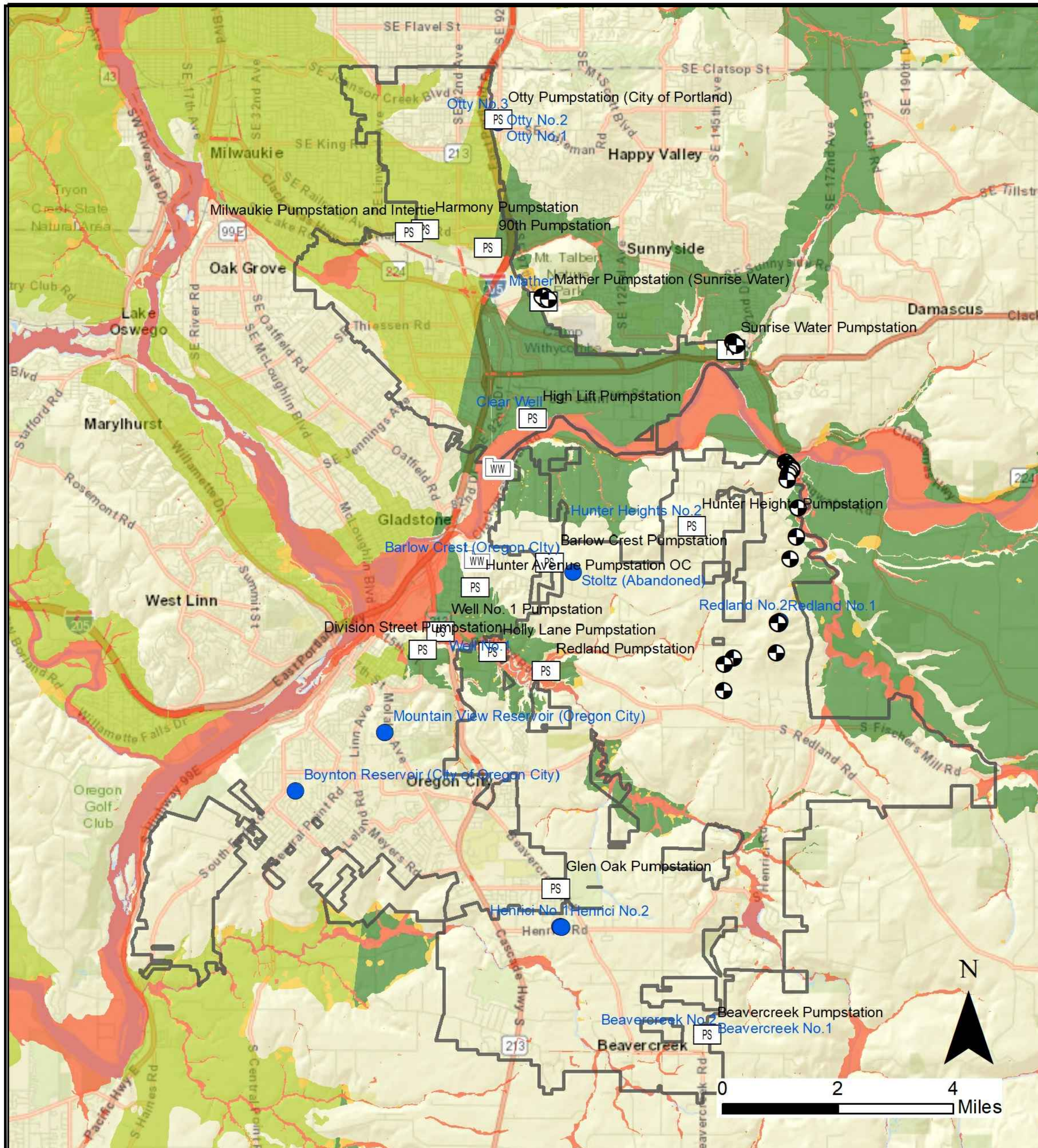
CLACKAMAS RIVER WATER SYSTEM

SEISMIC HAZARD EVALUATION

SEISMIC HAZARDS TECHNICAL MEMORANDUM
LIQUEFACTION INDUCED SETTLEMENT MAP

FIG.3

APRIL 2019



Legend

- Analyzed Boreholes
- PS Pump Stations
- WW Water Treatment Plant
- Reservoirs
- Existing Service Area

Estimated Lateral Spreading Displacement

- 0" - 6"
- 6" - 12"
- 12" - 24"
- > 24"

LATERAL SPREADING DISPLACEMENT MAP

NOTES:

1. LATERAL SPREADING DISPLACEMENT ESTIMATES ARE BASED ON HAZARD DATA FROM DOGAMI OPEN FILE REPORT O-18-02 AND DATA FROM EXISTING BORINGS. AREAS OUTSIDE OF EXISTING BORING LOCATIONS HAVE NOT BEEN VERIFIED.

McMILLEN JACOBS ASSOCIATES

CLACKAMAS RIVER WATER SYSTEM	FIG.4
SEISMIC HAZARD EVALUATION	
SEISMIC HAZARDS TECHNICAL MEMORANDUM LATERAL SPREADING DISPLACEMENT MAP	APRIL 2019

Legend

- Analyzed Boreholes
- PS Pump Stations
- WW Water Treatment Plant
- Reservoirs
- Existing Service Area

Estimated Landslide Displacement

- 0" - 12"
- 12" - 24"
- 24" - 48"
- > 48"

SEISMIC LANDSLIDE DISPLACEMENT MAP

NOTES:

1. SEISMIC LANDSLIDE DISPLACEMENT ESTIMATES ARE BASED ON HAZARD DATA FROM DOGAMI OPEN FILE REPORT O-18-02 AND DATA FROM EXISTING BORINGS. AREAS OUTSIDE OF EXISTING BORING LOCATIONS HAVE NOT BEEN VERIFIED.

McMILLEN JACOBS ASSOCIATES

CLACKAMAS RIVER WATER SYSTEM

SEISMIC HAZARD EVALUATION

SEISMIC HAZARDS TECHNICAL MEMORANDUM
SEISMIC LANDSLIDE DISPLACEMENT MAP

FIG.5

APRIL 2019

Appendix A Site Visit Photos

Photo 1: Well No. 1 Pump Station and Reservoir, looking north (April 9, 2018).

Photo 2: Well No. 1 Pump Station and Reservoir, looking northeast form S Redland Road, (April 9, 2018).

Photo 3: Holly Lane Pump Station, looking north (April 9, 2018).

Photo 4: Redland Pump Station, looking west, (April 9, 2018).

Photo 5: High Lift Pump Station, Clear Water Reservoir, and Treatment Plant, looking north from the Clackamas River (April 9, 2018).

Photo 6: 90^{th} Pump Station, looking southwest, (April 9, 2018).

Photo 7: 90th Pump Station, looking south along the western limit of the site, (April 9, 2018).

Photo 8: 90th Pump Station, tilted manhole and access vault (April 9, 2018).

Photo 9: 90^{th} Pump Station, potential slide along the western limit of the site, looking south, (April 9, 2018).

Photo 10: Milwaukie Pump Station and Intertie, looking west (April 9, 2018).

Photo 11: Milwaukie Pump Station and Intertie, Creek and culvert at the north side of the site, looking west, (April 9, 2018).

Photo 12: Milwaukie Pump Station and Intertie, looking south toward Three Creeks Natural Area, (April 9, 2018).

Appendix N

CAPITAL IMPROVEMENT SUMMARY AND PROJECT SHEETS

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: G-01
Project Name: Water Treatment Plant and Seismic Facility Plan
Facility Type:
Pressure Zone:

Go to CIP Summary Table

Project Description:

Develop a Water Treatment Plant and Seismic Facility Plan
Purpose: This plan would help CRW be prepared for seismic events and increase seismic resiliency of the system

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Water Treatment Plant and Seismic Facility Plan	1	LS	$ 250,000	$ 250,000				$ 250,000
Total Project Cost								$ 250,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 250,000
Total Project Cost	100%	$ 250,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
Facility Plans	2019		$ 250,000
Total Project Cost			$ 250,000

Project Location:

Notes:
General projects - no specific location

Go to Maps Tab

Project ID: G-02
Project Name: 2028 Water System Master Plan
Facility Type:
Pressure Zone:

Go to CIP Summary Table

Project Description:

Develop an updated Water System Master Plan
Purpose: 10-year master plan update

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Water System Master Plan	1	LS	$ 200,000	$ 200,000				$ 200,000

Total Project Cost	$ 200,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 200,000
Total Project Cost	100%	$ 200,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
Water System Master Plan	2028		$ 200,000

Total Project Cost	$ 200,000

Project Location:

Notes:
General projects - no specific location

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: G-03
Project Name: 2038 Water System Master Plan
Facility Type:
Pressure Zone:

Go to CIP Summary Table

Project Description:
Develop an updated Water System Master Plan
Purpose: 20-year master plan update

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
2038 Water System Master Pl	1	LS	$ 200,000	$ 200,000				$ 200,000

Total Project Cost	$ 200,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 200,000
Total Project Cost	100%	$ 200,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
2038 Water System Master Pl	Long-term		$ 200,000
Total Project Cost			$ 200,000

Project Location:

Notes:
General projects - no specific location

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	P-01
Project Name:	Remaining Useful Life Pipeline Program
Facility Type:	Pipe
Pressure Zone:	

Go to CIP Summary Table

Project Description:

Replace pipelines that are past their useful life based on pipe material and pipe installation year. Pipes listed in this program will reach their remaining useful life within the planning horizon (2019-2038).

Project Cost Estimate:

Project Element	Short -Term Quantity	Long-Term Quantity	Unit	Unit Cost ($/Unit)	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Short-Term Cost	Long-Term Cost	Total Cost
6-in to 8-in Replacement	14,774		LF	$ 230	$ 1,019,406	$ 849,505	$ 679,604	$ 5,946,535		$ 5,946,535
8-in Replacement	22,091		LF	$ 230	$ 1,524,279	$ 1,270,233	$ 1,016,186	$ 8,891,628		$ 8,891,628
12-in Replacement	12,736		LF	$ 260	$ 993,408	$ 827,840	$ 662,272	$ 5,794,880		$ 5,794,880
14-in Replacement	4,054		LF	$ 310	$ 377,022	$ 314,185	$ 251,348	$ 2,199,295		$ 2,199,295
4-in (and smaller) replaced with 8-in		2,460	LF	$ 230	$ 169,740	$ 141,450	$ 113,160		$ 990,150	$ 990,150
6-in to 8-in Replacement		3,352	LF	$ 230	$ 231,288	$ 192,740	$ 154,192		$ 1,349,180	$ 1,349,180
8-in Replacement		5,838	LF	$ 230	$ 402,822	$ 335,685	$ 268,548		$ 2,349,795	$ 2,349,795
Total Length	53,655	11,650	LF							
Total Project Cost								$ 22,832,338	$ 4,689,125	$ 27,521,463

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent		Cost
Capacity:	0%		$ -
Repair & Replacement:	100%		$ 27,521,462.50
Improvement:	0%		$ -
Total Project Cost	100%		$ 27,521,463

Project Completed?	No

Project Timing:

Project Element	Timing			Cost
Cost Per Year	2019			$ 2,283,234
Cost Per Year	2020			$ 2,283,234
Cost Per Year	2021			$ 2,283,234
Cost Per Year	2022			$ 2,283,234
Cost Per Year	2023			$ 2,283,234
Cost Per Year	2024			$ 2,283,234
Cost Per Year	2025			$ 2,283,234
Cost Per Year	2026			$ 2,283,234
Cost Per Year	2027			$ 2,283,234
Cost Per Year	2028			$ 2,283,234
Cost For Long Term	Long-term			$ 4,689,125
Total Project Cost				$ 27,521,463

Project Location:

Notes:

See pipelines locations in Chapter 8 - CIP of the Plan.

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: P-02
Project Name: Seismic System Pipe Program
Facility Type: Pipe
Pressure Zone:

Go to CIP Summary Table

Project Description:

This project is CRW's planned seismic system. Each pipe segment is flagged as high-risk or low-risk. High-risk pipes will require a higher construction cost ude to the additional material cost and difficulting of installation.
Purpose: This project is required to complete CRW's planned seismic system.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8-in pipe (high-risk)	4,155	LF	$ 299	$ 1,242,345	$ 372,704	$ 310,586	$ 248,469	$ 2,174,104
12-in pipe (high-risk)	11,898	LF	$ 338	$ 4,021,524	$ 1,206,457	$ 1,005,381	$ 804,305	$ 7,037,667
14-in pipe (high-risk)	4,054	LF	$ 400	$ 1,623,222	$ 486,966	$ 405,805	$ 324,644	$ 2,840,638
18-in pipe (high-risk)	208	LF	$ 481	$ 100,048	$ 30,014	$ 25,012	$ 20,010	$ 175,084
6-in pipe (low-risk)	3,959	LF	$ 200	$ 791,800	$ 237,540	$ 197,950	$ 158,360	$ 1,385,650
8-in pipe (low-risk)	5,761	LF	$ 230	$ 1,325,030	$ 397,509	$ 331,258	$ 265,006	$ 2,318,803
12-in pipe (low-risk)	26,358	LF	$ 260	$ 6,853,080	$ 2,055,924	$ 1,713,270	$ 1,370,616	$ 11,992,890
16-in pipe (low-risk)	23,359	LF	$ 330	$ 7,708,470	$ 2,312,541	$ 1,927,118	$ 1,541,694	$ 13,489,823
18-in pipe (low-risk)	867	LF	$ 370	$ 320,790	$ 96,237	$ 80,198	$ 64,158	$ 561,383
Total Project Cost								$ 41,976,040

Notes on Cost Estimation:

The construction costs for high-risk seismic pipelines is 30% higher than the pipe unit cost assumpytions to account for the additional material cost and difficulty of installation

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 41,976,040
Improvement:	0%	$ -
Total Project Cost	100%	$ 41,976,040

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
Seismic System Pipe Program	Long-term		$ 41,976,040
Total Project Cost			$ 41,976,040

Project Location:

Notes:

See pipelines locations in Chapter 8 - CIP of the Plan.

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	BB-02
Project Name:	Backbone Phase 2
Facility Type:	Pipe, Storage, Pump Station
Pressure Zone:	Redland and Holcomb and Beaver Creek

Go to CIP Summary Table

Project Description:

(8) Install new 16" Transmission Main on Grasle Rd
(9) Install new 3 MGD Beaver Lake Pump Station
(10) Install new 12" Transmission Main on Bradley Rd
(11) Install new 1.25-MGD Bradley Rd Pump Station
(12) Install new 5-MG Beavercreek Elevated Reservoir

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
(8) Grasle Rd - 16" pipe	13,295	LF	$ 330	$ 4,387,350	$ 1,316,205	$ 1,096,838	$ 877,470	$ 7,677,863
(9) Beaver Lake PS - 3 MGD	4.5	MG	$ 5,200	$ 586,219	$ 175,866	$ 146,555	$ 117,244	$ 1,025,884
(10) Bradley Rd - 12" pipe	5,321	LF	$ 260	$ 1,383,460	$ 415,038	$ 345,865	$ 276,692	$ 2,421,055
(11) Bradley Rd PS - 1.25 MGD	1.9	MG	$ 5,200	$ 247,515	$ 74,254	$ 61,879	$ 49,503	$ 433,151
(12) 5-MG Beaverlake Res.	2,500,000	gal	$ 4	$ 10,000,000	$ 3,000,000	$ 2,500,000	$ 2,000,000	$ 17,500,000
Total Project Cost								$ 29,057,952

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 29,057,952
Total Project Cost	100%	$ 29,057,952

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
(8) Grasle Rd - 16" pipe	2022		$ 7,677,863
(9) Beaver Lake PS - 3 MGD	2022		$ 1,025,884
(10) Bradley Rd - 12" pipe	2021		$ 2,421,055
(11) Bradley Rd PS - 1.25 MGD	2021		$ 433,151
(12) 5-MG Beaverlake Res.	2020		$ 5,833,333
(12) 5-MG Beaverlake Res.	2021		$ 5,833,333
(12) 5-MG Beaverlake Res.	2023		$ 5,833,333
Total Project Cost			$ 29,057,952

Project Location:

Notes:

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	PZ-02
Project Name:	New Beavercreek Pressure Zone
Facility Type:	Pressure Zone
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Install new 4" pipe parallel to existing 8" pipe on S Yeoman Rd from the PS south to S Steiner Rd
Purpose: A new pressure zone in the Beavercreek service area is recommended due to low pressures in locations south of S Steiner Rd.

Install new Beavercreek BPS to serve new Beavercreek Pressure Zone south of S Steiner Rd.
Purpose: A new pressure zone in the Beavercreek service area is recommended due to low pressures in locations south of S Steiner Rd.

Install new 8"pipe parallel to existing 6" pipe on S Beavercreek Rd from S Steiner Rd to S Williams Rd.
Purpose: This project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
4" Pipe	1,136	LF	$ 192	$ 218,112	$ 65,434	$ 54,528	$ 43,622	$ 381,696
Beavercreek BPS	2	MG	$ 5,200	$ 260,542	$ 78,163	$ 65,135	$ 52,108.39	$ 455,948
S Beavercreek Rd - 8" Pipe	2,588	LF	$ 230	$ 595,240	$ 178,572	$ 148,810	$ 119,048	$ 1,041,670
Total Project Cost								$ 1,879,314

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 1,879,314
Total Project Cost	100%	$ 1,879,314

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
4" Pipe	Long-term		$ 381,696
Beavercreek BPS	Long-term		$ 455,948
S Beavercreek Rd - 8" Pipe	Long-term		$ 1,041,670
Total Project Cost			$ 1,879,314

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: ST-01
Project Name: Seismic Isolation Valves at Existing Tanks
Facility Type:
Pressure Zone:

Go to CIP Summary Table

Project Description:
Install seismic isolation valves at the Hunter Heights Reservoir and the Henrici Reservoir
Purpose: Seismic isolation valves are required to provide seismic resiliency to the reservoirs

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Hunter Heights Reservoir	1	LS	$ 200,000	$ 200,000	$ 60,000	$ 50,000	$ 40,000	$ 350,000
Henrici Reservoir	1	LS	$ 200,000	$ 200,000	$ 60,000	$ 50,000	$ 40,000	$ 350,000

Total Project Cost	$ 700,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 700,000
Total Project Cost	100%	$ 700,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
Hunter Heights Reservoir	2028		$ 350,000
Henrici Reservoir	2028		$ 350,000

Total Project Cost	$ 700,000

Project Location:

Notes:
See full map on "Maps" tab.

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: ST-02
Project Name: Storage Condition Evaluation
Facility Type: Storage
Pressure Zone:

Go to CIP Summary Table

Project Description:
Condition evaluation of existing storage reservoirs
Purpose: This project is recommended due to age of storage reservoirs. The project includes performing a condition assessment of the existing reservoirs to determine if repairs are necessary.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Storage Condition Evaluation		LS	$ 250,000	$ -				$ 250,000
Total Project Cost								$ 250,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 250,000
Improvement:	0%	$ -
Total Project Cost	100%	$ 250,000
Project Completed?	No	

Project Timing:

Project Element	Timing		Cost
Storage Condition Evaluation	Long-term		$ 250,000
Total Project Cost			$ 250,000

Project Location:

Notes:
See full map on "Maps" tab.

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	ST-03
Project Name:	Storage Repair & Rehabilitation
Facility Type:	Storage
Pressure Zone:	

Go to CIP Summary Table

Project Description:

Repair and rehabilitation of the existing storage reservoirs.
Purpose: This project is recommended due to age of storage reservoirs. The project includes potential coating, repair, and rehabilitation of the existing reservoirs.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Storage Improvements		LS	$ 5,000,000	$ -				$ 5,000,000
Total Project Cost								$ 5,000,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 5,000,000
Improvement:	0%	$ -
Total Project Cost	100%	$ 5,000,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
Storage Improvements	Long-term		$ 5,000,000
Total Project Cost			$ 5,000,000

Project Location:

Notes:
See full map on "Maps" tab.

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	PS-03
Project Name:	Hunter Heights Pump Station
Facility Type:	Pump Station
Pressure Zone:	Holcomb-Hunter Heights

Go to CIP Summary Table

Project Description:

Add redundant fire flow pump (700 gpm) to Hunter Heights Pressure Zone.
Purpose: Increase firm capacity of Hunter Heights Pump Station

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Add Redundant Fire Flow Pum	1	LS	$ 200,000	$ 200,000	$ 60,000	$ 50,000	$ 40,000	$ 350,000
Total Project Cost								$ 350,000

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 350,000
Total Project Cost	100%	$ 350,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
Add Redundant Fire Flow Pum	Long-term		$ 350,000
Total Project Cost			$ 350,000

Project Location:

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: PS-04
Project Name: Pump Station Condition Evaluation
Facility Type: Pump Station
Pressure Zone:

Go to CIP Summary Table

Project Description:
Condition evaluation of existing pump stations
Purpose: This project is recommended due to age of the pump stations. The project includes performing a condition assessment of the existing pump stations to determine if repairs are necessary.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Pump Station Improvements		LS	$ 250,000	$ -				$ 250,000
Total Project Cost								$ 250,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 250,000
Improvement:	0%	$ -
Total Project Cost	100%	$ 250,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
Pump Station Improvements	Long-term		$ 250,000
Total Project Cost			$ 250,000

Project Location:

Notes:
See full map on "Maps" tab.

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

carollo

Project ID: PS-05
Project Name: Pump Station Repair & Rehabilitation
Facility Type: Pump Station
Pressure Zone:

Go to CIP Summary Table

Project Description:
Repair and rehabilitation of the existing pump stations.
Purpose: This project is recommended due to age of pump stations. The project includes repair and rehabilitation of the existing pump stations.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Pump Station Improvements		LS		$ -				$ -
Total Project Cost								$ -

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ -
Improvement:	0%	$ -
Total Project Cost	100%	$ -

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
Pump Station Improvements	Long-term		$ -
Total Project Cost			$ -

Project Location:

Notes:
See full map on "Maps" tab.

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-31
Project Name:	Barlow Crest New Pipe
Facility Type:	Pipe
Pressure Zone:	Holcomb and Holcomb-Barlow

Go to CIP Summary Table

Project Description:

Install new 12" pipe on S Mason Heights Dr parallel to existing 12" pipe from the Barlow Crest PS to Forsythe Rd.
Purpose: Project is required to meet peak hour pressures to the surrounding area.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
12" Pipe	2,625	LF	$ 260	$ 682,500	$ 204,750	$ 170,625	$ 136,500	$ 1,194,375

Total Project Cost	$ 1,194,375

Go to Assumptions Tab

Cost Allocation:

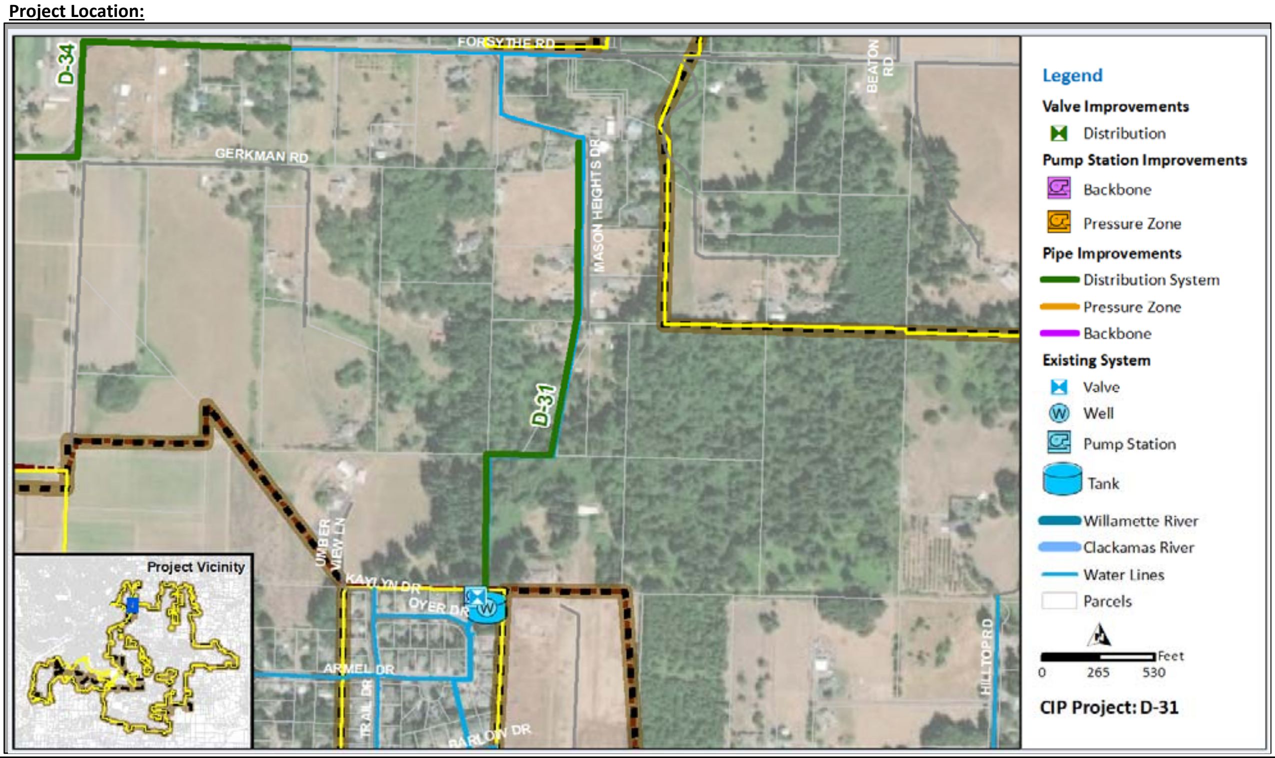
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 1,194,375
Total Project Cost	100%	$ 1,194,375

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
12" Pipe	Long-term		$ 1,194,375
Total Project Cost			$ 1,194,375

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-32
Project Name:	S Brunner Rd Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Holcomb-Barlow

Go to CIP Summary Table

Project Description:

Replace existing 4" pipe with 8" pipe on S Brunner Rd from S Forsythe Rd north to end of pipe.
Purpose:
1. Project is required to provide fire flow.
2. This pipeline will reach its remaining useful life by the year 2019.
3. This pipeline has been flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	2,998	LF	$ 230	$ 689,540	$ 206,862.00	$ 172,385	$ 137,908.00	$ 1,206,695
Total Project Cost								$ 1,206,695

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 603,348
Improvement:	50%	$ 603,348
Total Project Cost	100%	$ 1,206,695

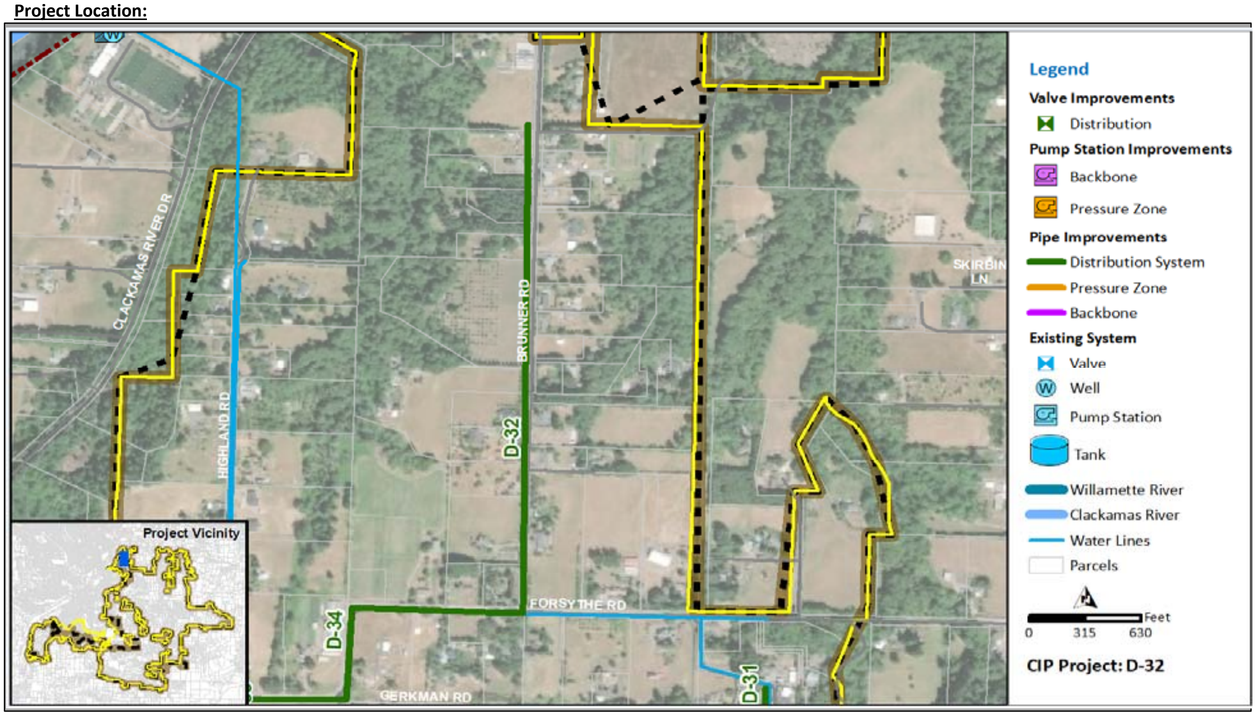
Project Completed?	No

Go to Assumptions Tab

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-Term		$ 1,206,695
Total Project Cost			$ 1,206,695

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-33
Project Name:	Forsythe Road (1)
Facility Type:	Pipe
Pressure Zone:	Holcom-Barlow

Go to CIP Summary Table

Project Description:

Forsythe Road (Hunter Avenue to Highland Road) upsizing current 6" pipe to 8" Pipe.
Purpose:
1. This pipeline will reach its remaining useful life by the year 2019.
2. This pipeline has been flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	2,400	LF	$ 230	$ 552,000	$ 165,600	$ 138,000	$ 110,400	$ 966,000
Total Project Cost								$ 966,000

Go to Assumptions Tab

Cost Allocation:

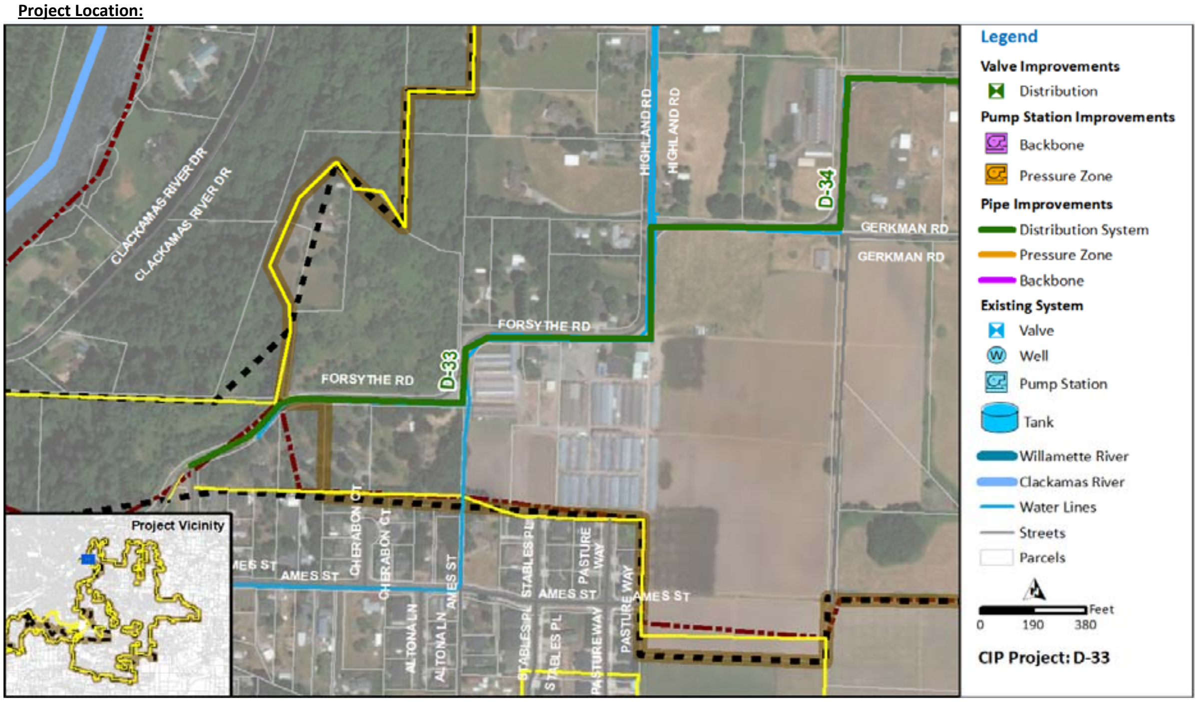
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 966,000
Improvement:	0%	$ -
Total Project Cost	100%	$ 966,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	2024		$ 966,000
Total Project Cost			$ 966,000

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-34
Project Name: Forsythe Road (2)
Facility Type: Pipe
Pressure Zone: Holcomb-Barlow

Go to CIP Summary Table

Project Description:
Forsythe Road (Highland Road to Brunner Road) upsizing current 6" pipe to 8".
Purpose:
1. This pipeline will reach its remaining useful life by the year 2019
2. This pipeline has been flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	2,200	LF	$ 230	$ 506,000	$ 151,800	$ 126,500	$ 101,200	$ 885,500
Total Project Cost								$ 885,500

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 885,500
Improvement:	0%	$ -
Total Project Cost	100%	$ 885,500

Project Completed?	No

Go to Assumptions Tab

Project Timing:

Project Element	Timing		Cost
8" Pipe	2024		$ 885,500
Total Project Cost			$ 885,500

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-35
Project Name:	Bradley Road
Facility Type:	Pipe
Pressure Zone:	Holcomb

Go to CIP Summary Table

Project Description:

Bradley Road (North from Forsythe Road) upsizing current 2", 4", and 6" pipe to 8" pipe.
Purpose:
1. This pipeline will reach its remaining useful life by the year 2020.
2. This pipeline has been flagged by CRW as a pipeline with reported leakage.
3. Portions of this pipeline are undersized.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency	Engineer/ Legal/Admin	Project Contingency	Total Cost
					30%	25%	20%	
8" Pipe	1,650	LF	$ 230	$ 379,500	$ 113,850	$ 94,875	$ 75,900	$ 664,125
Total Project Cost								$ 664,125

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 664,125
Improvement:	0%	$ -
Total Project Cost	100%	$ 664,125

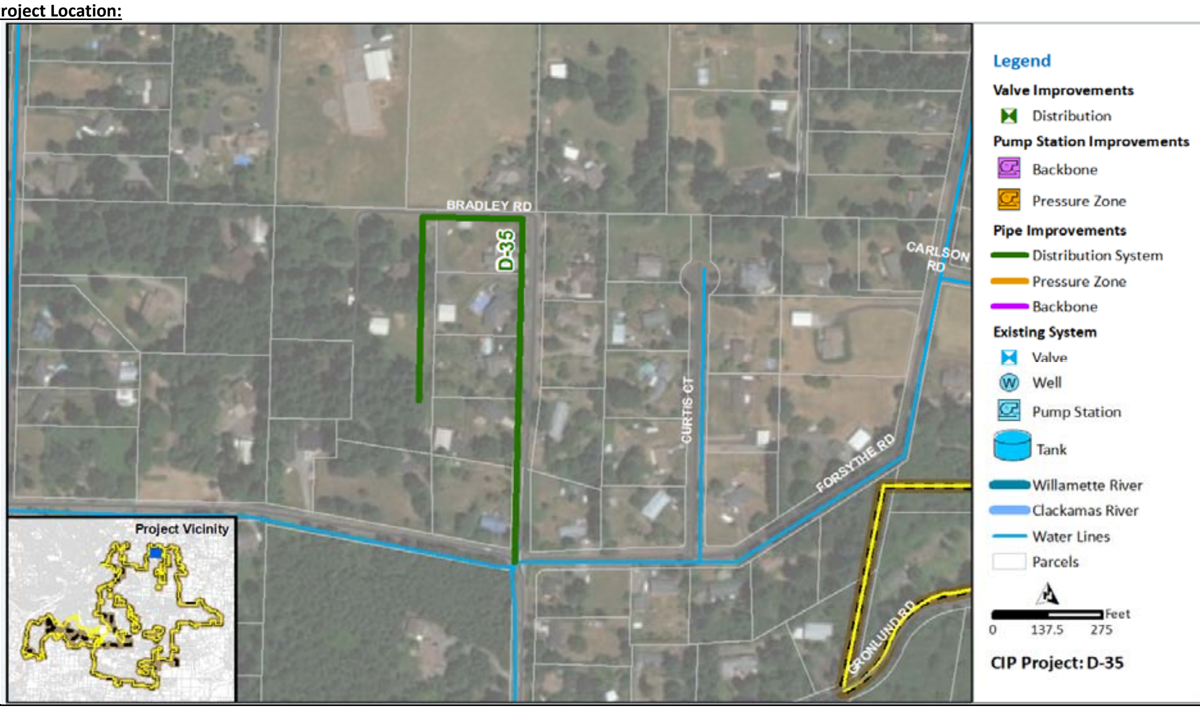
Project Completed?	No

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
8" Pipe	2024		$ 664,125
Total Project Cost			$ 664,125

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-36
Project Name:	S Overlook Rd Pipe
Facility Type:	Pipe
Pressure Zone:	Holcomb

Go to CIP Summary Table

Project Description:

Install new 6-in diameter pipe parallel to existing 2-in diameter pipe on S Overlook Rd from S Sky Ranch Rd east to end of pipe.
Purpose: The project is required to increase low pressures in the area.

Install new 8-in diameter pipe on S Overlook Rd from S Bradley Rd to S Outlook Terrace, and north on S Outlook Terrance to connect with pipe at north end of Sky Ranch Ln.
Purpose: The project is required to provide fire flows.

Additional Purpose: Portion of this pipeline will reach its remaining useful life by the year 2037.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
6" Pipe	370	LF	$ 200	$ 74,000	$ 22,200	$ 18,500	$ 14,800.00	$ 129,500
8" Pipe	2,026	LF	$ 230	$ 465,980	$ 139,794	$ 116,495	$ 93,196	$ 815,465
Total Project Cost								$ 944,965

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 472,483
Improvement:	50%	$ 472,483
Total Project Cost	100%	$ 944,965

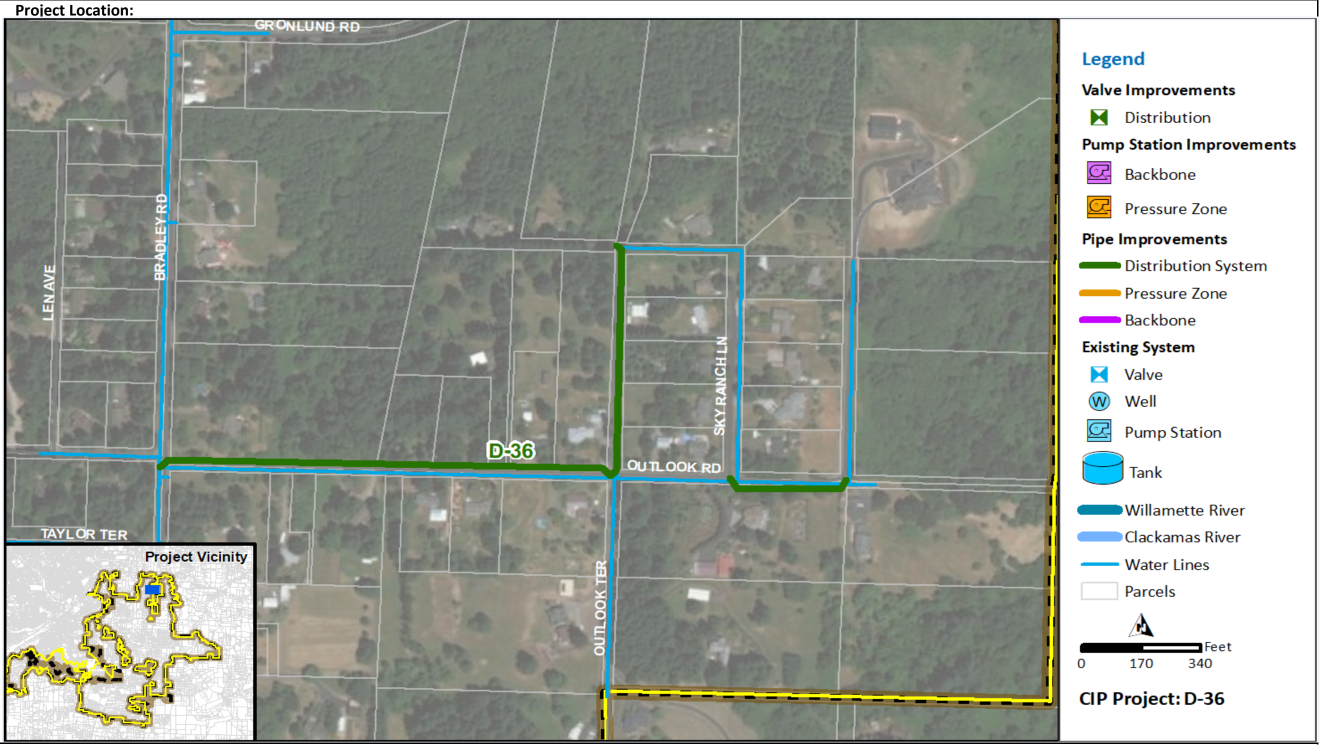
Project Completed?	No

Go to Assumptions Tab

Project Timing:

Project Element	Timing		Cost
6" Pipe	Long-term		$ 129,500
8" Pipe	Long-term		$ 815,465
Total Project Cost			$ 944,965

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-37
Project Name:	S Archer Dr Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Holcomb-Hunter Heights

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe on S Archer Dr from S Fawn Dr north to S Outlook Rd.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency	Engineer/ Legal/Admin	Project Contingency	Total Cost
					30%	25%	20%	
8" Pipe	333	LF	$ 230	$ 76,590	$ 22,977	$ 19,148	$ 15,318.00	$ 134,033
Total Project Cost								$ 134,033

Go to Assumptions Tab

Cost Allocation:

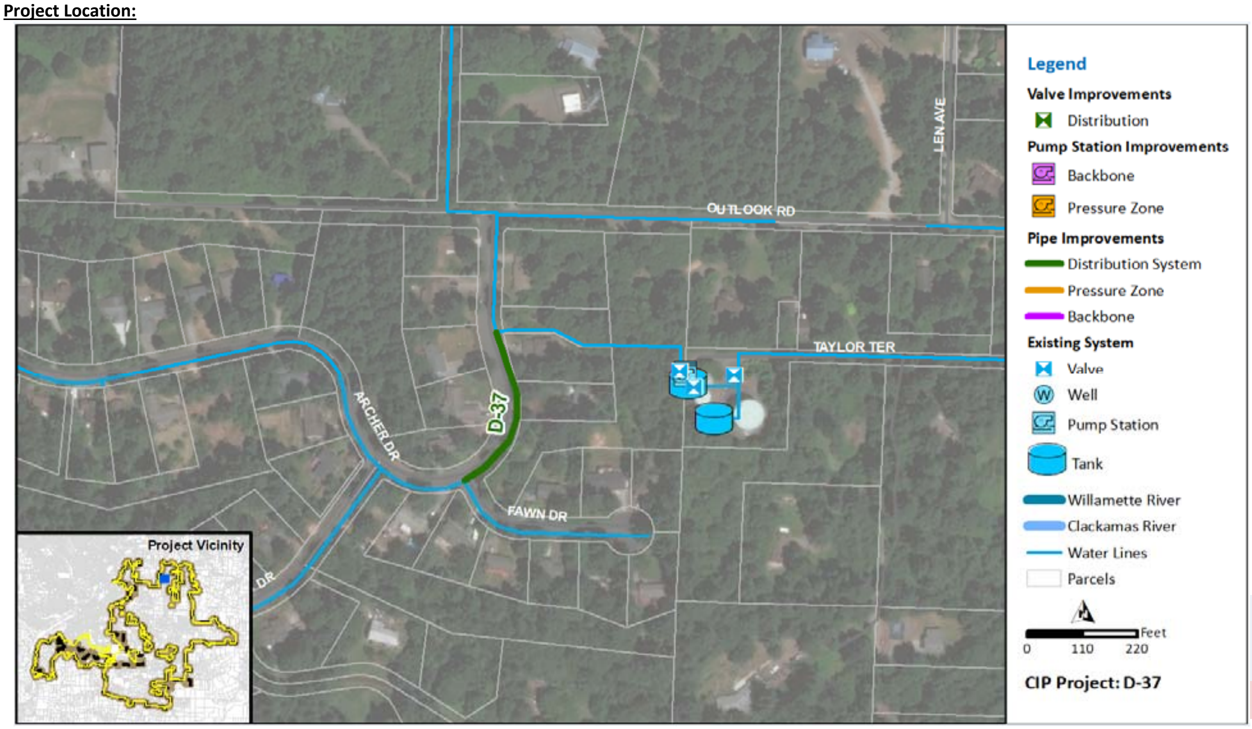
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 134,033
Total Project Cost	100%	$ 134,033

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 134,033
Total Project Cost			$ 134,033

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-38
Project Name: S Holcomb Blvd Pipe Upsize
Facility Type: Pipe
Pressure Zone: Holcomb

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe on S Holcomb Blvd from S Bradley Rd to S Timberdark Ln.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,678	LF	$ 230	$ 385,940	$ 115,782.00	$ 96,485	$ 77,188.00	$ 675,395
Total Project Cost								$ 675,395

Go to Assumptions Tab

Cost Allocation:

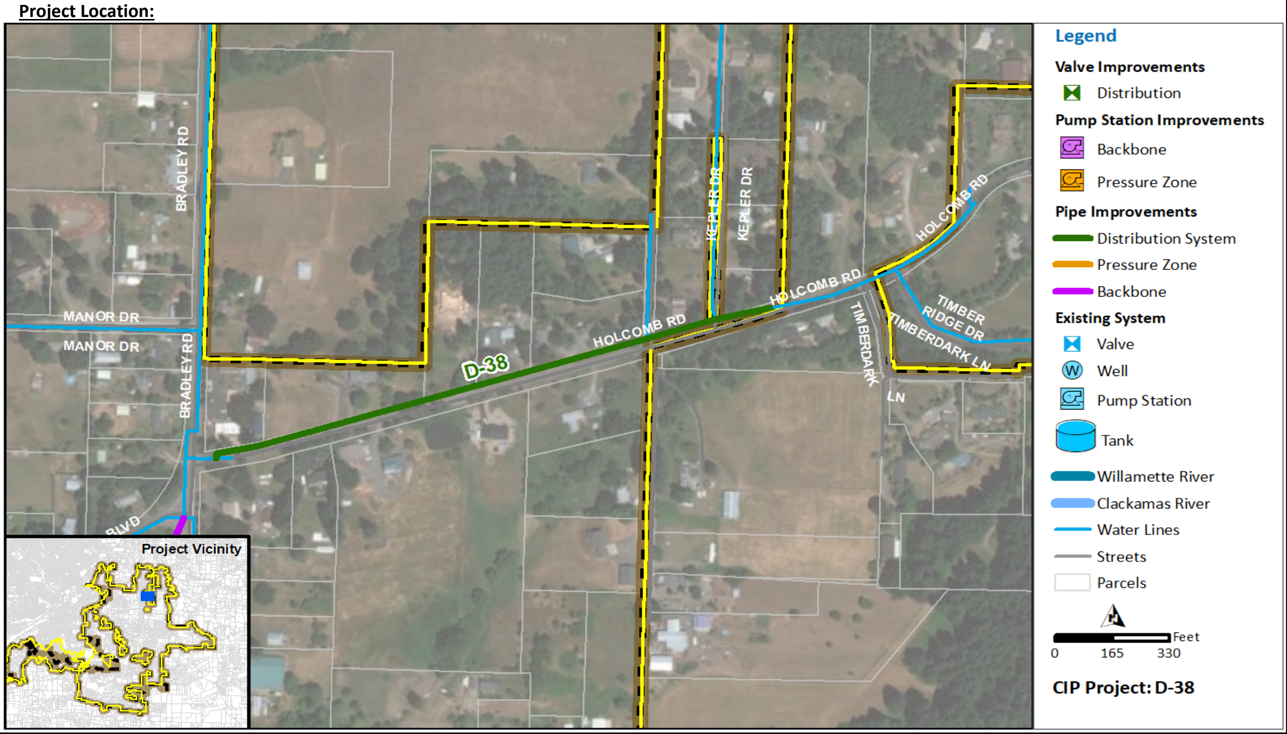
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 675,395
Total Project Cost	100%	$ 675,395

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 675,395
Total Project Cost			$ 675,395

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-39
Project Name:	S Edgewood St Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Redland

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe on S Edgewood St from S Edgewood Ln west to end of street.
Purpose:
1. This Project is required to provide fire flow.
2. This pipeline will reach its remaining useful life by 2019.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	967	LF	$ 230	$ 222,410	$ 66,723.00	$ 55,603	$ 44,482.00	$ 389,218
Total Project Cost								$ 389,218

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 194,609
Improvement:	50%	$ 194,609
Total Project Cost	100%	$ 389,218

Project Completed?	No

Go to Assumptions Tab

Project Timing:

Project Element	Timing		Cost
8" Pipe	2024		$ 389,218
Total Project Cost			$ 389,218

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-40
Project Name:	S Dick Dr and S Lucky Ln Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Redland

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe on S Dick Dr from S Hattan Rd west to end of street and S Lucky Ln from S Dick Dr to end of street.

Purpose:

1. Project is required to provide fire flow
2. This pipeline has been flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	3,978	LF	$ 230	$ 914,940	$ 274,482.00	$ 228,735	$ 182,988.00	$ 1,601,145
Total Project Cost								$ 1,601,145

Go to Assumptions Tab

Cost Allocation:

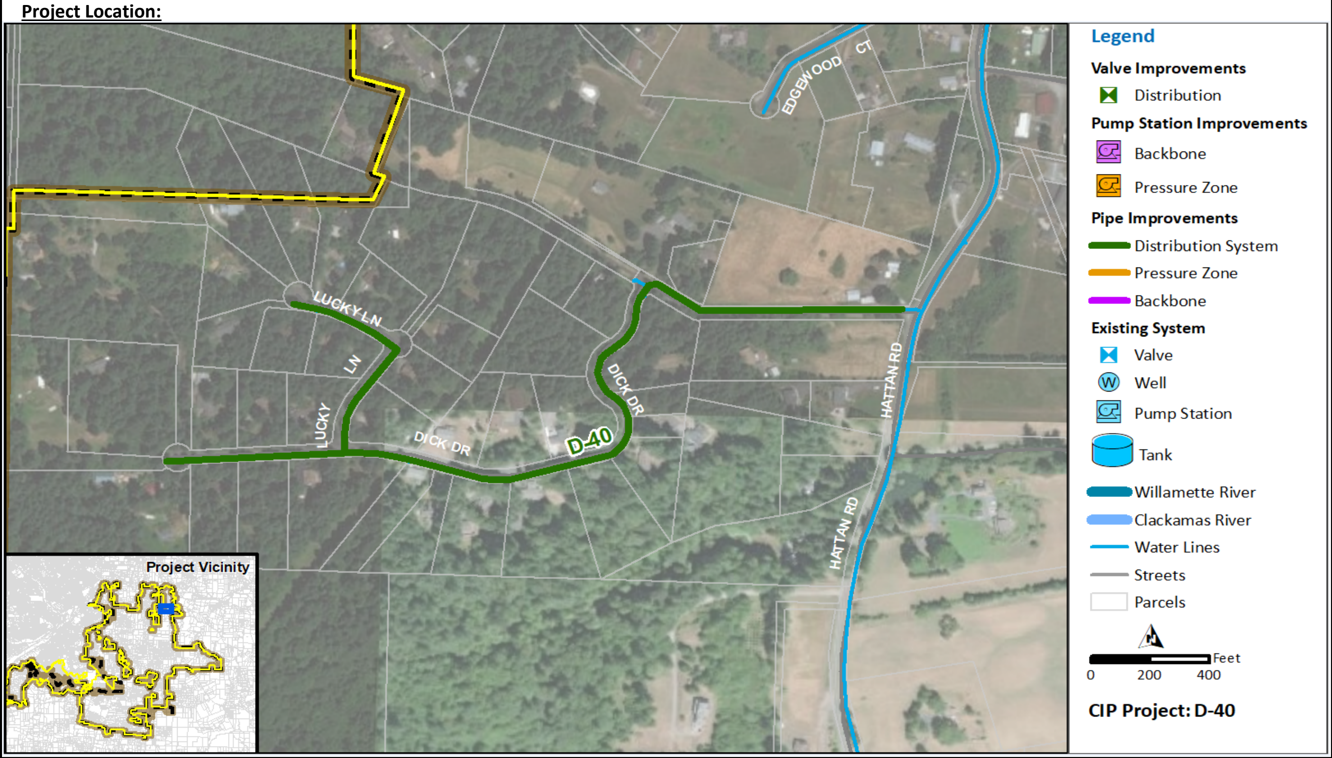
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 800,573
Improvement:	50%	$ 800,573
Total Project Cost	100%	$ 1,601,145

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 1,601,145
Total Project Cost			$ 1,601,145

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-41
Project Name: S Clear Acres Dr Pipe Upsize
Facility Type: Pipe
Pressure Zone: Redland

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe
Purpose: Project is required to provide fire flow

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	865	LF	$ 230	$ 198,950	$ 59,685.00	$ 49,738	$ 39,790.00	$ 348,163
Total Project Cost								$ 348,163

Go to Assumptions Tab

Cost Allocation:

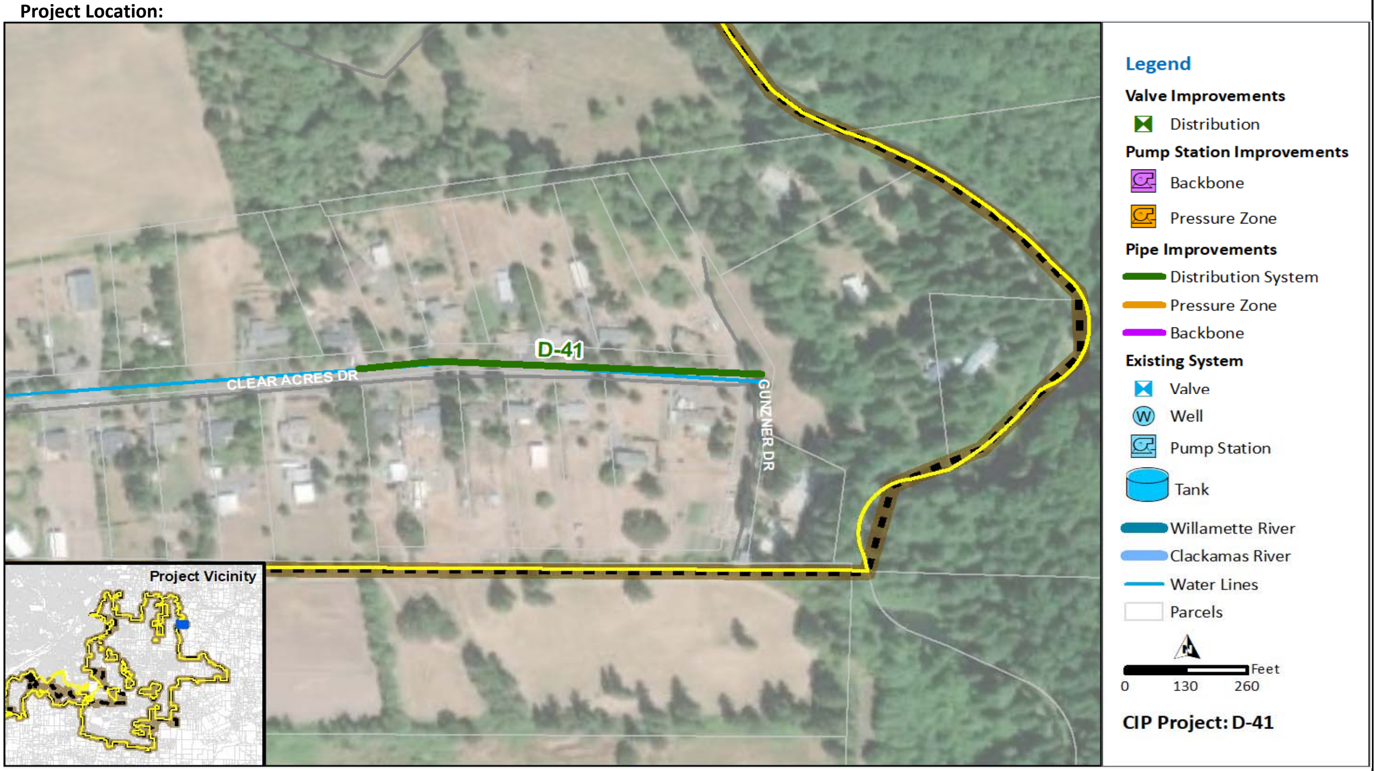
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 348,163
Total Project Cost	100%	$ 348,163

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 348,163
Total Project Cost			$ 348,163

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Go to CIP Summary Table

Project ID:	D-42
Project Name:	S Sandalwood Rd and S Brook Ct Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Holcomb

Project Description:

Replace existing 6" pipe with 8" pipe on S Sandwood Rd from S Lora Ct south to end of street and S Brook St from S Sandalwood Rd to end of street.
Purpose:
1. Project is required to provide fire flow
2. This pipeline has been flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	2,540	LF	$ 230	$ 584,200	$ 175,260.00	$ 146,050	$ 116,840.00	$ 1,022,350
Total Project Cost								$ 1,022,350

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 511,175
Improvement:	50%	$ 511,175
Total Project Cost	100%	$ 1,022,350

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 1,022,350
Total Project Cost			$ 1,022,350

Project Location:

Go to Maps Tab

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Water System Plan
Capital Improvement Program

Project ID: D-43
Project Name: S Wildflower Ln and S Pam Dr Pipe Upsize
Facility Type: Pipe
Pressure Zone: Holcomb

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe on S Pam Dr from S Wildflower Ln south to end of street and S Wildflower Ln from S Pan Dr to end of pipe.
Purpose: Project is required to provide fire flow

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,540	LF	$ 230	$ 354,200	$ 106,260.00	$ 88,550	$ 70,840.00	$ 619,850
Total Project Cost								$ 619,850

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 619,850
Total Project Cost	100%	$ 619,850

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 619,850
Total Project Cost			$ 619,850

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-44
Project Name:	S Neibur Rd Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Redland

Go to CIP Summary Table

Project Description:

Replace existing 4" pipe with 8" pipe on S Neibur Rd from S Redland Rd east to end of pipe.
Purpose: Project is required to provide fire flow

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	4,443	LF	$ 230	$ 1,021,890	$ 306,567.00	$ 255,473	$ 204,378.00	$ 1,788,308
Total Project Cost								$ 1,788,308

Go to Assumptions Tab

Cost Allocation:

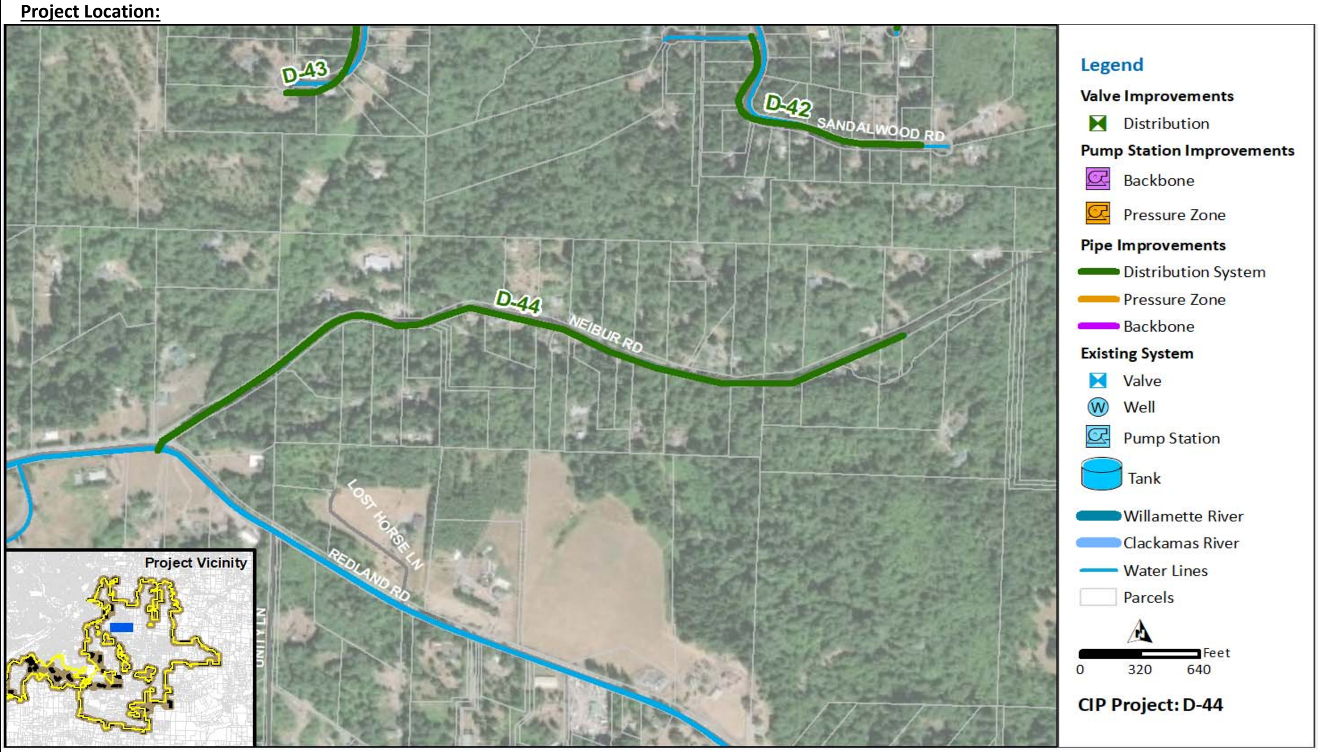
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 1,788,308
Total Project Cost	100%	$ 1,788,308

Project Completed?	

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 1,788,308
Total Project Cost			$ 1,788,308

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Go to CIP Summary Table

Project ID: D-45
Project Name: S Redland Rd New Pipe
Facility Type: Pipe
Pressure Zone: Redland

Project Description:
Install new 12" pipe parallel to existing 8" pipe on S Redland Rd from S Ferguson Rd to S Potter Rd.
Purpose:
1. This project is required to provide fire flows.
2. Approximately 4,400 ft of this pipeline was established as part of the seismic system.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
12" Pipe	4,418	LF	$ 260	$ 1,148,680	$ 344,604.00	$ 287,170	$ 229,736.00	$ 2,010,190
Total Project Cost								$ 2,010,190

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 2,010,190
Total Project Cost	100%	$ 2,010,190

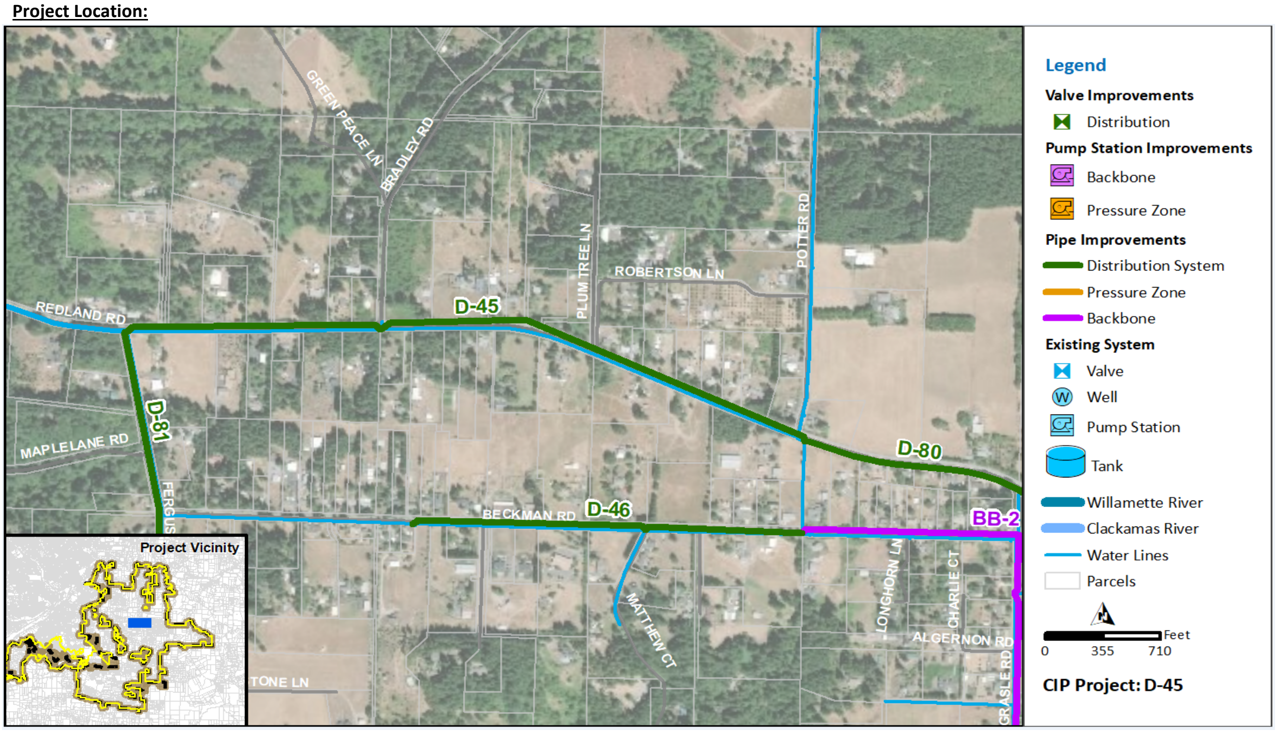
Project Completed?	No

Go to Assumptions Tab

Project Timing:

Project Element	Timing		Cost
12" Pipe	Long-term		$ 2,010,190
Total Project Cost			$ 2,010,190

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Go to CIP Summary Table

Project ID:	D-46
Project Name:	SE Beckman Rd New Pipe
Facility Type:	Pipe
Pressure Zone:	Redland

Project Description:
Replace existing 6" pipe with 8" pipe on SE Beckman Rd east and west of S Matthew Ct.
Purpose:
1. Project is required to provide fire flows
2. This pipeline has been flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
SE Beckman Rd - 8" Pipe	2,435	LF	$ 230	$ 560,050	$ 168,015.00	$ 140,013	$ 112,010.00	$ 980,088
Total Project Cost								$ 980,088

Go to Assumptions Tab

Cost Allocation:

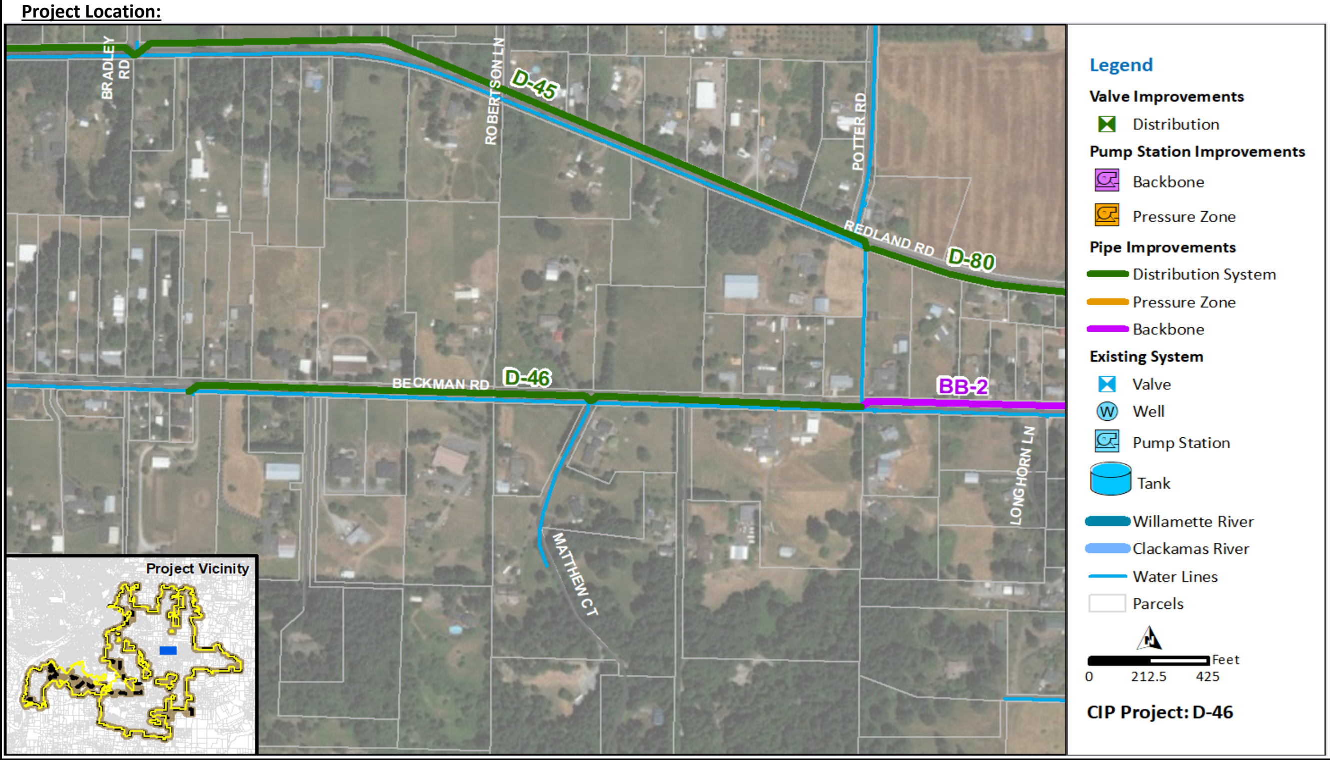
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 490,044
Improvement:	50%	$ 490,044
Total Project Cost	100%	$ 980,088

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
SE Beckman Rd - 8" Pipe	Long-term		$ 980,088
Total Project Cost			$ 980,088

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-47
Project Name:	S Burkstrom Rd Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Holcomb and Holcomb-Hunter Heights

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe on S Burkstrom Rd from S Forsythe Rd south to end of street.
Purpose:
1. Project is required to provide fire flow.
2. This pipeline has been flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	747	LF	$ 230	$ 171,810	$ 51,543.00	$ 42,953	$ 34,362.00	$ 300,668
Total Project Cost								$ 300,668

Go to Assumptions Tab

Cost Allocation:

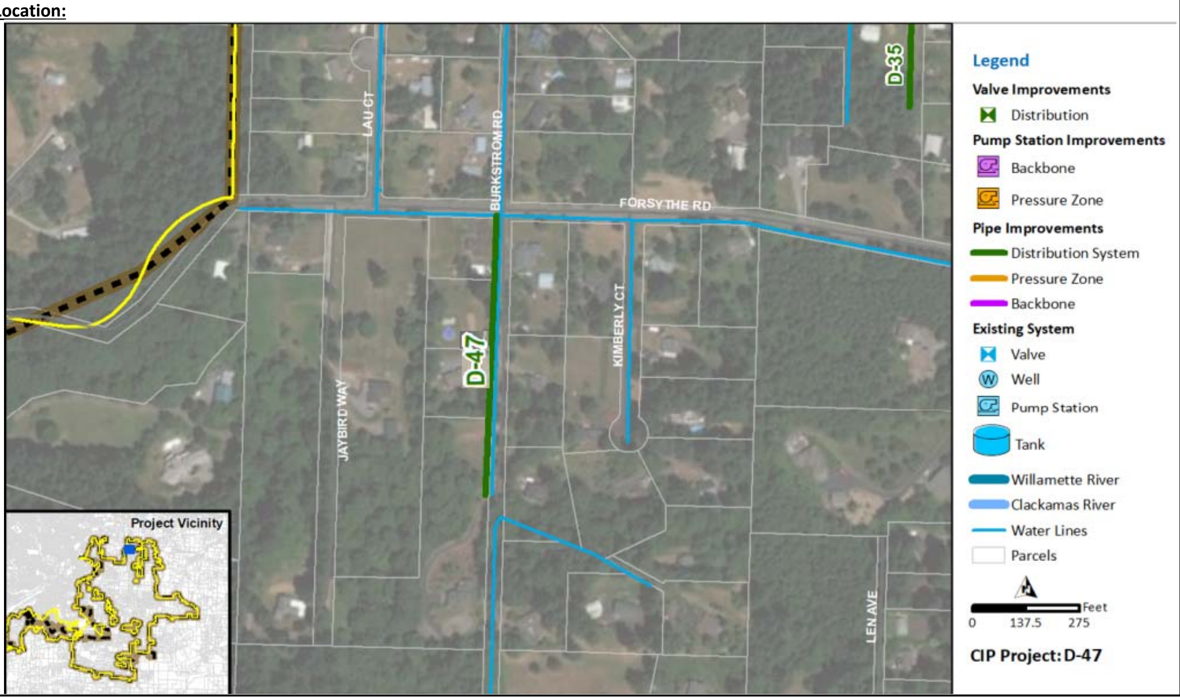
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 150,334
Improvement:	50%	$ 150,334
Total Project Cost	100%	$ 300,668

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 300,668
Total Project Cost			$ 300,668

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-48
Project Name:	S Canter Ln Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Redland

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe on S Canter Ln from S Redland Rd to S Nestle Ln.
Purpose:
1. Project is required to provide fire flow.
2. This pipeline has been flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,845	LF	$ 230	$ 424,350	$ 127,305.00	$ 106,088	$ 84,870.00	$ 742,613
Total Project Cost								$ 742,613

Go to Assumptions Tab

Cost Allocation:

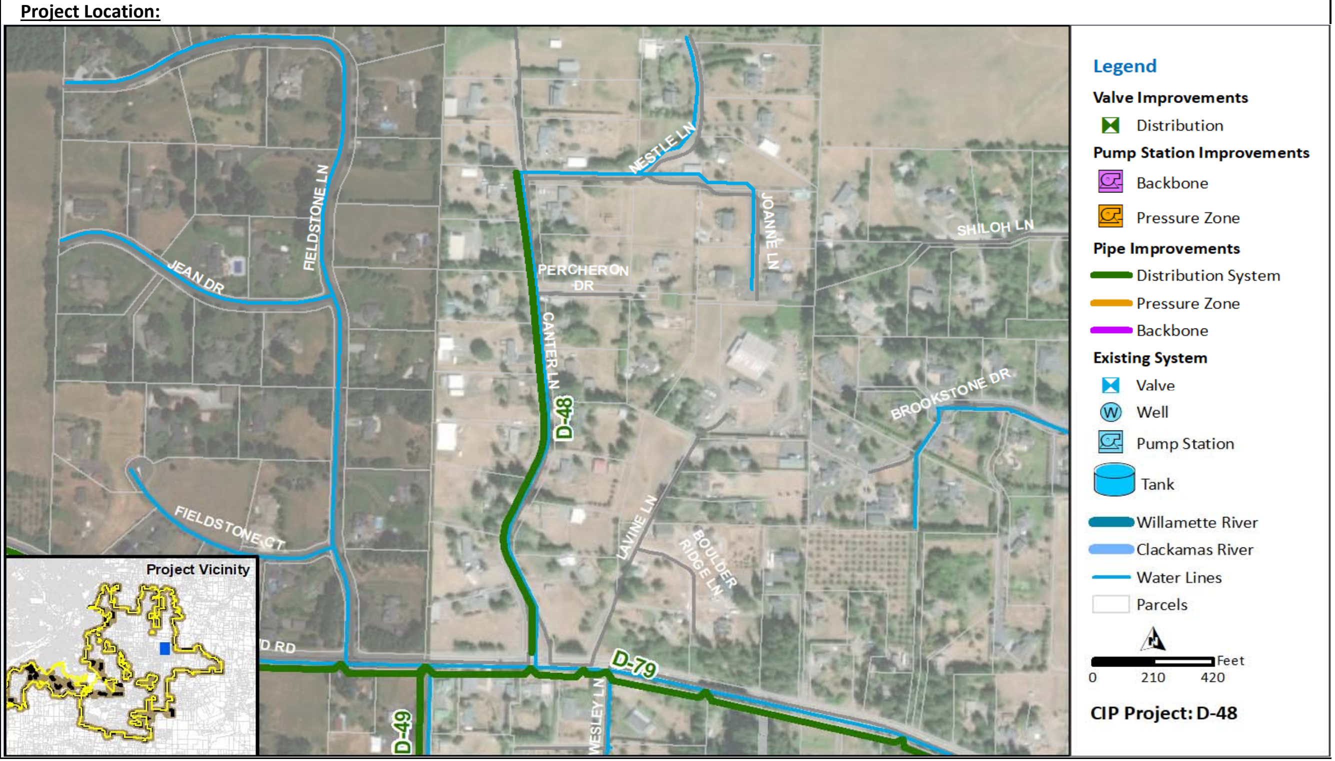
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 371,306
Improvement:	50%	$ 371,306
Total Project Cost	100%	$ 742,613

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 742,613
Total Project Cost			$ 742,613

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-49
Project Name: S Norman Rd, S Elida Rd/S Glisan Rd New Pipe
Facility Type: Pipe
Pressure Zone: Redland

Go to CIP Summary Table

Project Description:
Install new 8" pipe parallel to existing 4" pipe on S Norman Rd from S Redland Rd to S Glisan Rd.
Purpose: Project is required to provide fire flow.

Install new 8" pipe on S Elida Rd from S Redland Rd to S Glisan Rd and S Glisan Rd to S Cadle Rd
Purpose: Project is required to provide fire flows.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	2,926	LF	$ 230	$ 672,980	$ 201,894.00	$ 168,245	$ 134,596.00	$ 1,177,715
Total Project Cost								$ 1,177,715

Go to Assumptions Tab

Cost Allocation:

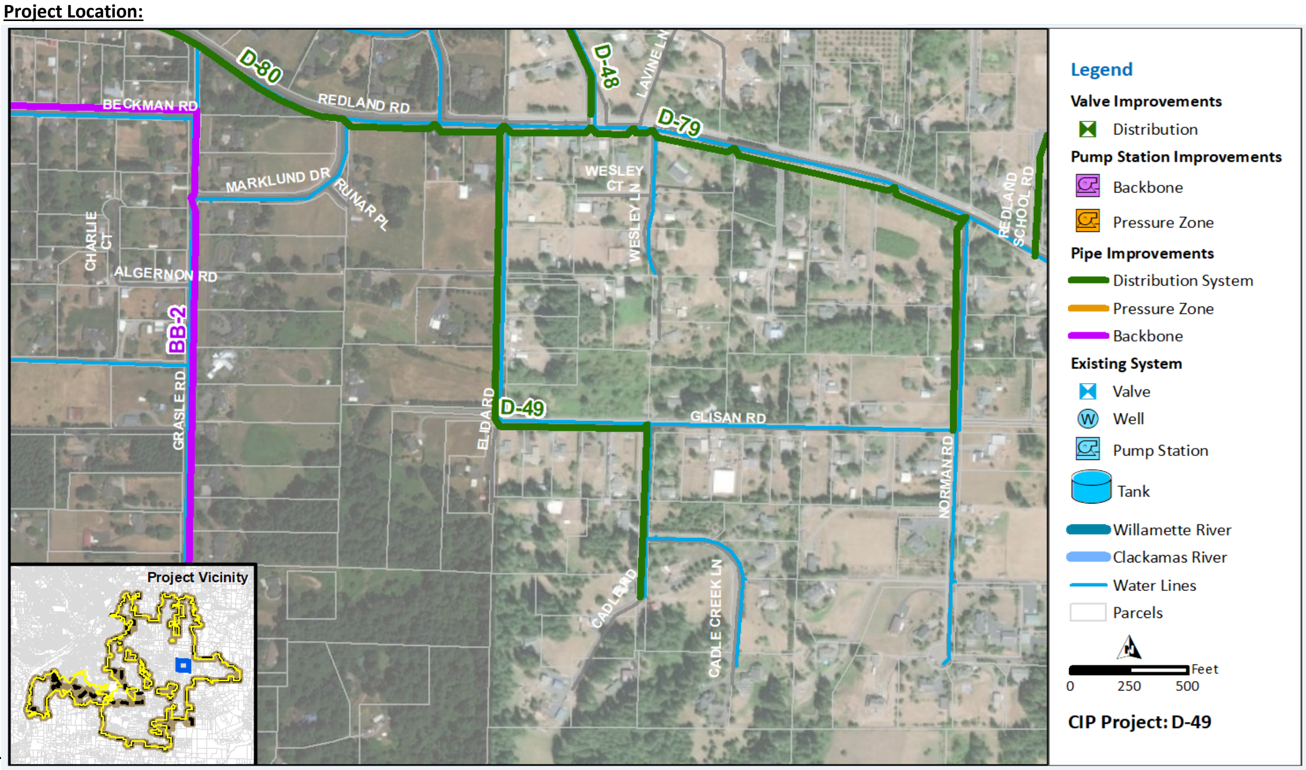
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 1,177,715
Total Project Cost	100%	$ 1,177,715

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 1,177,715
Total Project Cost			$ 1,177,715

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Go to CIP Summary Table

Project ID: D-50
Project Name: Fischers Mill Rd Upsize; S Hinkle Rd/S Kimball Rd New Pipe
Facility Type: Pipe
Pressure Zone: Redland

Project Description:

Replace existing 4" pipe with new 8" pipe Fischers Mill Rd from S Kimball Rd to end of street
Purpose: This project is required to provide fire flows

Replace existing 6" pipe with new 12" pipe Fischers Mill Rd from S Redland Rd to S Kimball Rd
Purpose: This project is required to provide fire flows

Install new 8" pipe on S Hinkle Rd/S Kimball Rd from S Redland Rd to S Fischers Mill Rd
Purpose: This project is required to provide fire flows

Upsize dead end pipes
Purpose: This project is required to provide fire flows

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Fischers Mill Rd - 12" Pipe	10,374	LF	$ 260	$ 2,697,240	$ 809,172	$ 674,310	$ 539,448.00	$ 4,720,170
Fischers Mill Rd - 8" Pipe	2,623	LF	$ 230	$ 603,290	$ 180,987	$ 150,823	$ 120,658	$ 1,055,758
S Hinkle Rd/S Kimball Rd - 8" P	8,050	LF	$ 230	$ 1,851,500	$ 555,450	$ 462,875	$ 370,300	$ 3,240,125
Upsize dead end pipe	5,696	LF	$ 230	$ 1,310,080	$ 393,024	$ 327,520	$ 262,016	$ 2,292,640
Total Project Cost								$ 11,308,693

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Cost Allocation:

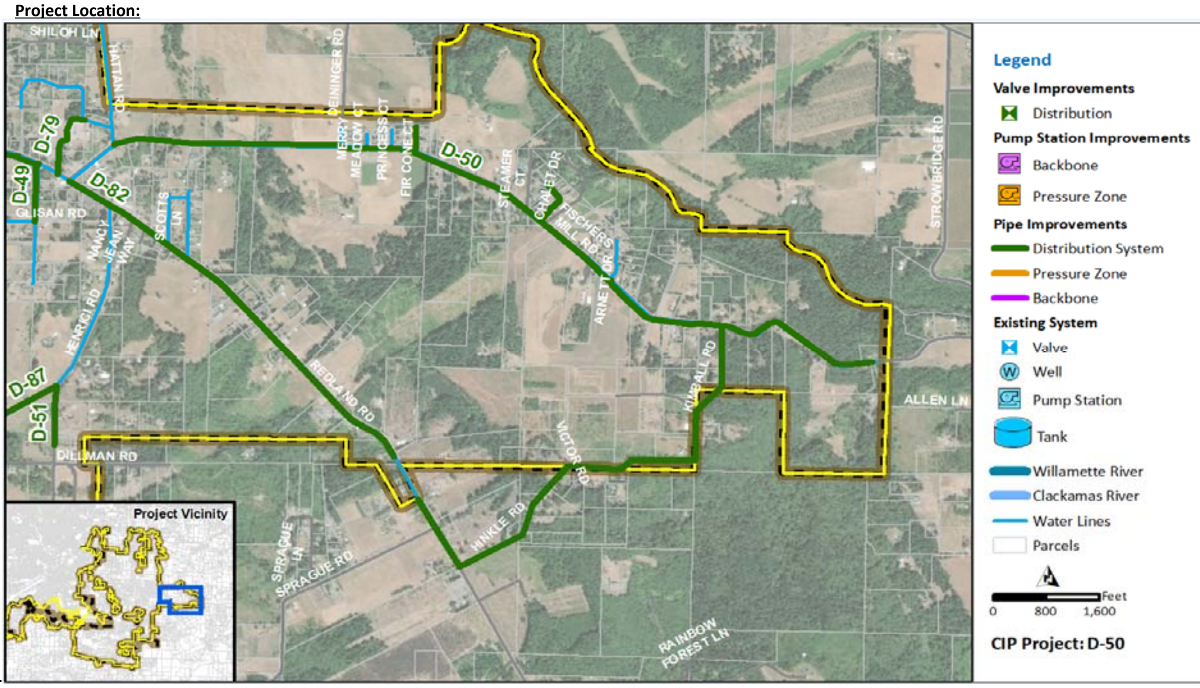
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 11,308,693
Total Project Cost	100%	$ 11,308,693

Project Timing:

Project Element	Timing		Cost
Fischers Mill Rd - 12" Pipe	Long-term		$ 4,720,170
Fischers Mill Rd - 8" Pipe	Long-term		$ 1,055,758
S Hinkle Rd/S Kimball Rd - 8" Pip	Long-term		$ 3,240,125
Upsize dead end pipe	Long-term		$ 2,292,640
Total Project Cost			$ 11,308,693

Project Completed?	No

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-51
Project Name:	S Dillman Rd Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Redland

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe on S Dillman Rd south from S Henrici Rd.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	968	LF	$ 230	$ 222,640	$ 66,792.00	$ 55,660	$ 44,528.00	$ 389,620
Total Project Cost								$ 389,620

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Cost Allocation:

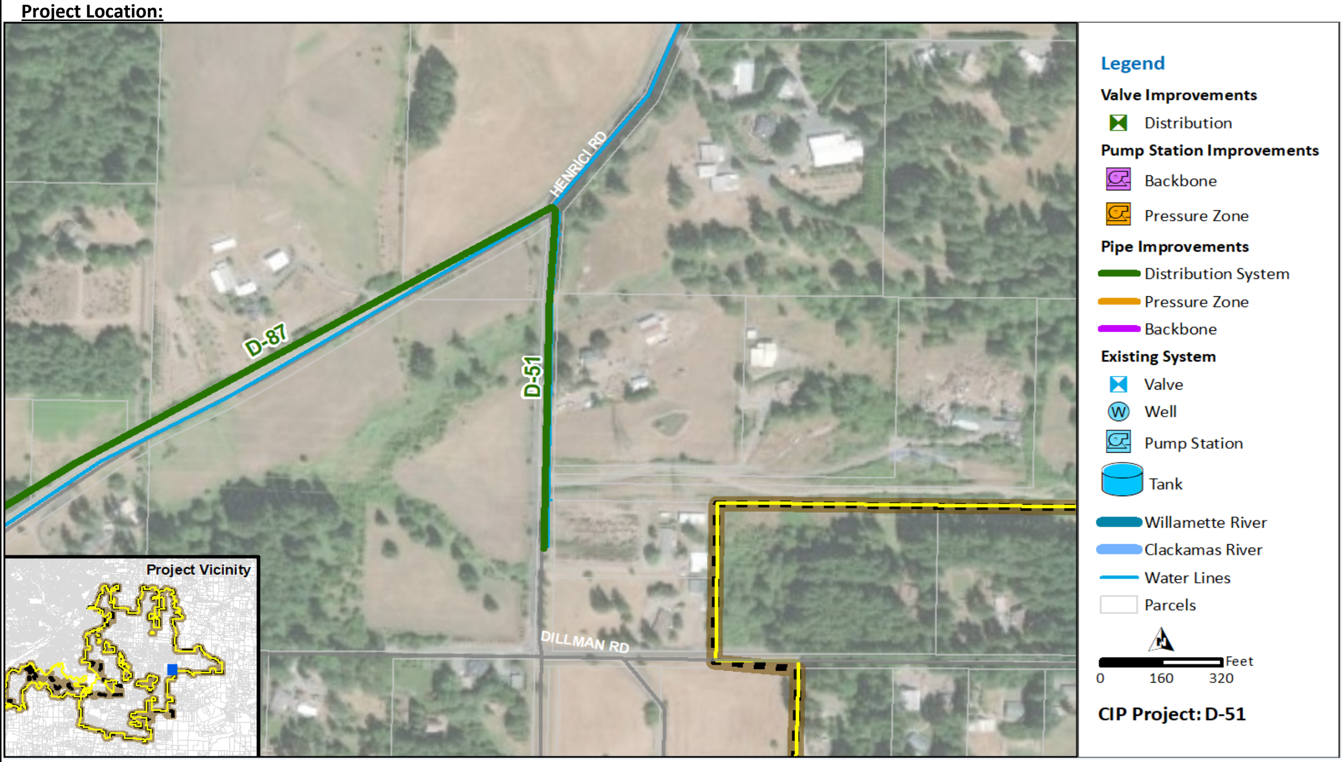
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 389,620
Total Project Cost	100%	$ 389,620

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 389,620
Total Project Cost			$ 389,620

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-52
Project Name:	S Grasle Rd south of Team Ct Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Redland

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	495	LF	$ 230	$ 113,850	$ 34,155.00	$ 28,463	$ 22,770.00	$ 199,238
Total Project Cost								$ 199,238

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Cost Allocation:

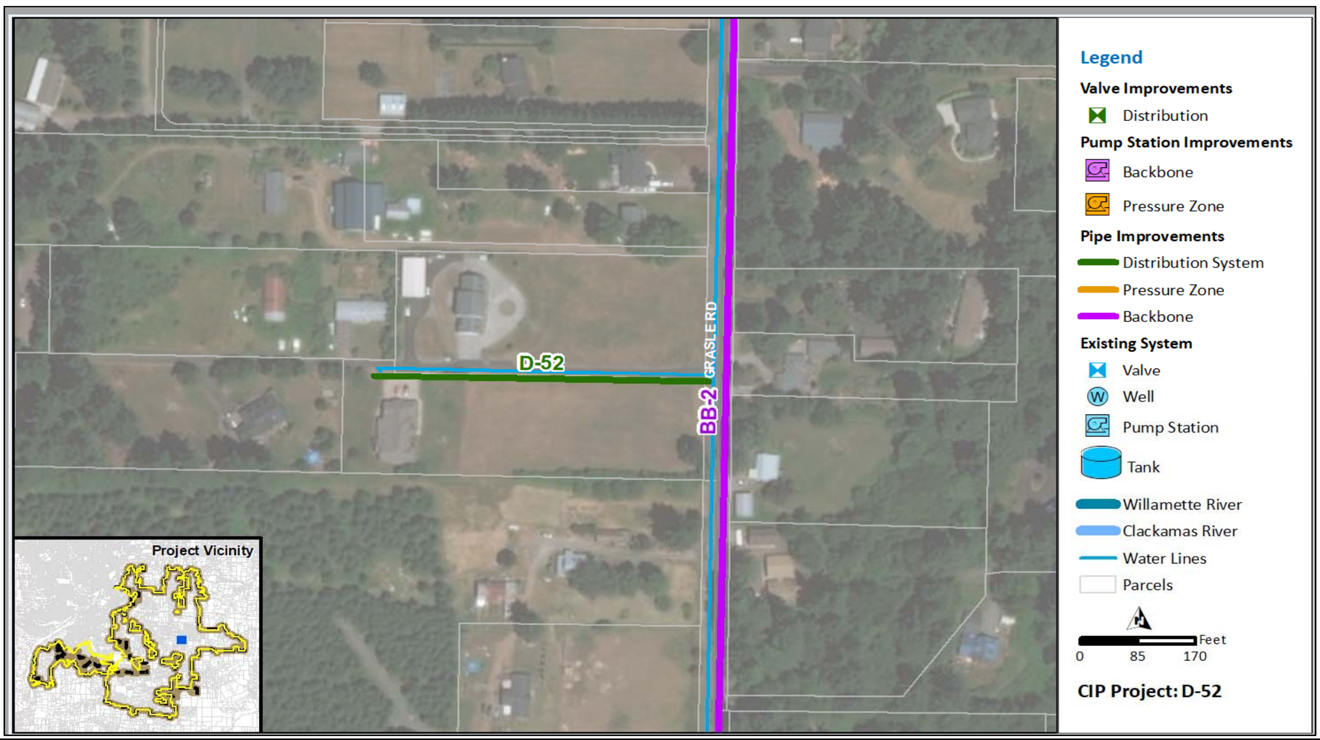
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 199,238
Total Project Cost	100%	$ 199,238

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 199,238
Total Project Cost			$ 199,238

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-53
Project Name: S North End Rd, S Terry Michael Dr New Pipe
Facility Type: Pipe
Pressure Zone: Redland

Go to CIP Summary Table

Project Description:
Replace existing 4" pipe with 8" pipe on S North End Rd from S Grasle Rd to S Terry Michael Dr
Purpose: Project is required to provide fire flows.

Replace existing 4" pipe with 8" pipe on S Terry Michael Dr from S North End Rd north.
Purpose: Project is required to provide fire flows.

Additional Purpose: Approximately 2,600 ft of this pipeline was established as part of the seismic system.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
S Terry Michael Dr - 8" Pipe	708	LF	$ 230	$ 162,840	$ 48,852.00	$ 40,710	$ 32,568.00	$ 284,970
S North Ed Rd - 8" Pipe	1,972	LF	$ 230	$ 453,560	$ 136,068	$ 113,390	$ 90,712	$ 793,730
Total Project Cost								$ 1,078,700

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 1,078,700
Total Project Cost	100%	$ 1,078,700

Project Completed?	No

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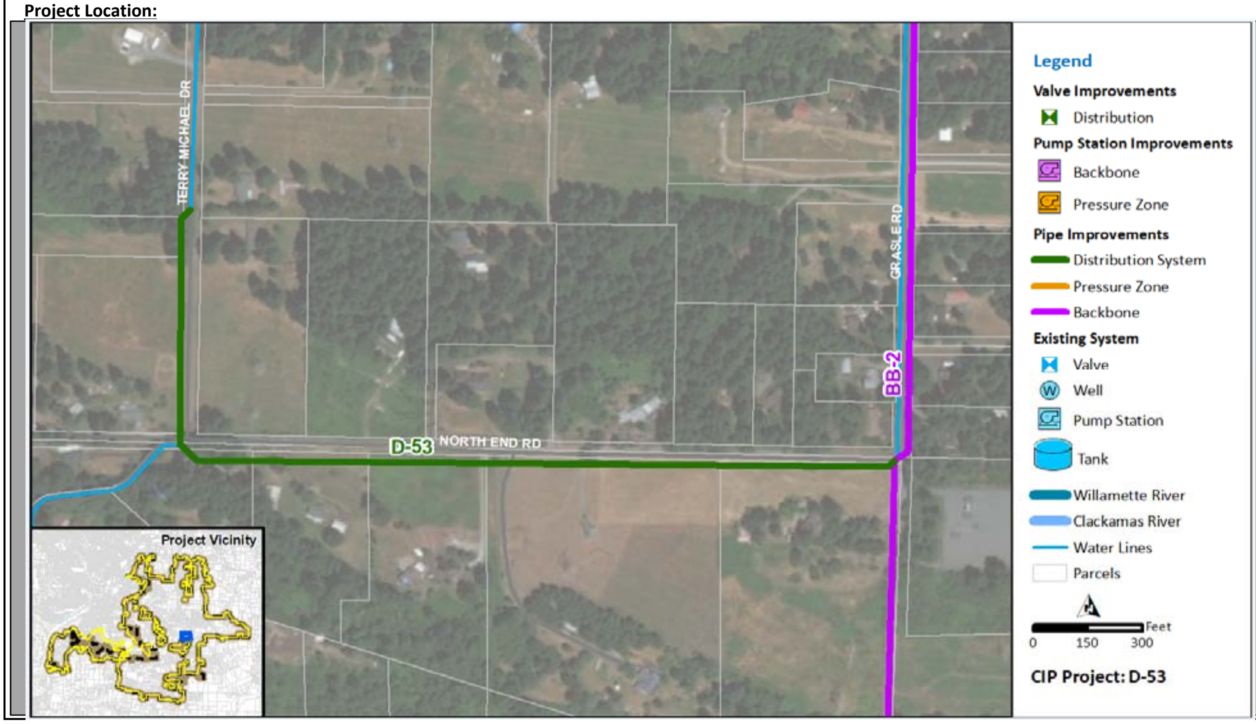
Project Timing:

Project Element	Timing		Cost
S Terry Michael Dr - 8" Pipe	Long-term		$ 284,970
S North Ed Rd - 8" Pipe	Long-term		$ 793,730
Total Project Cost			$ 1,078,700

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

carollo

Project ID: D-54
Project Name: S Thayer Rd, S Walker Rd, S Ferguson Rd Pipe Upsize
Facility Type: Pipe
Pressure Zone: Redland

Go to CIP Summary Table

Project Description:
Replace existing 4" and 6" pipe with 8" pipe on S Ferguson Rd from SE Beckman Rd continuing onto S Thayer Rd; S Walker Rd from S Ferguson Rd north, and S Coplet Ct from S Ferguson Rd to end of street.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	11,785	LF	$ 230	$ 2,710,550	$ 813,165	$ 677,638	$ 542,110.00	$ 4,743,463
Total Project Cost								$ 4,743,463

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Cost Allocation:

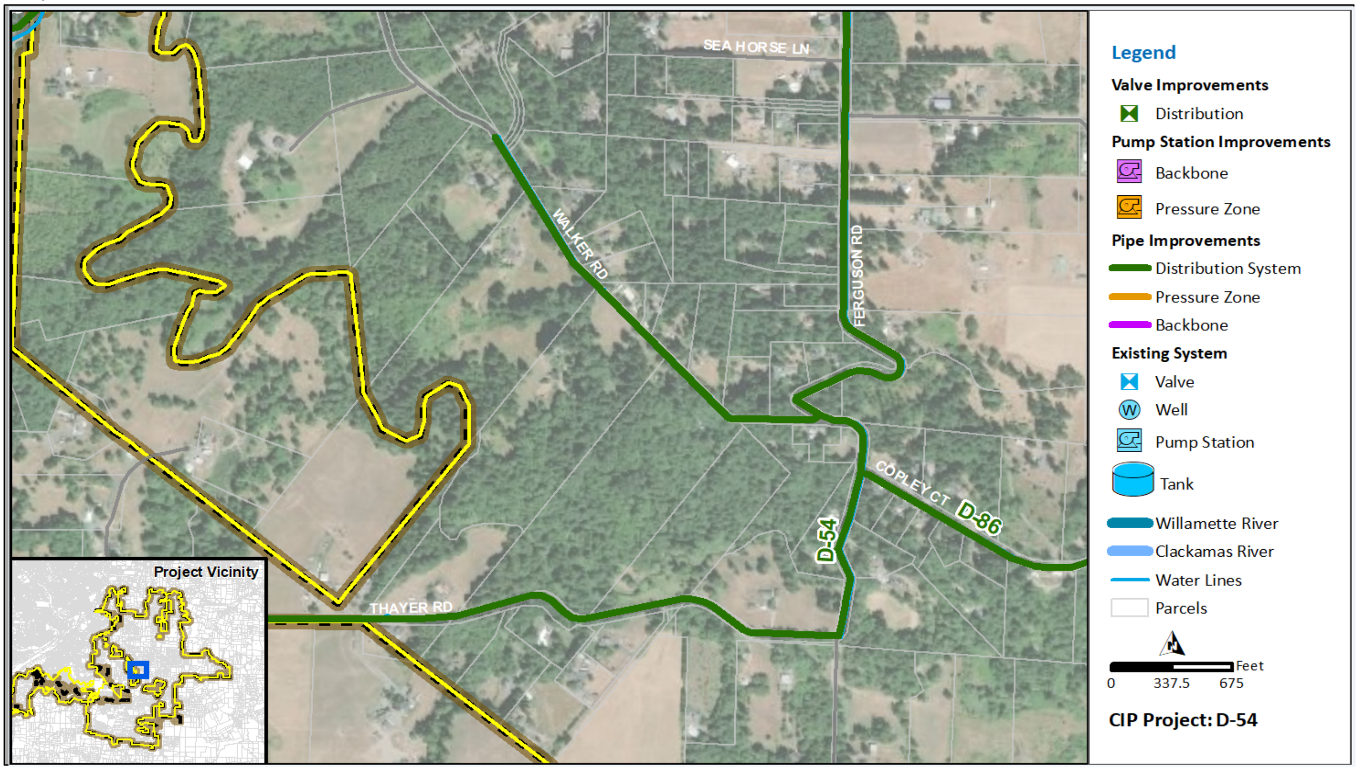
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 4,743,463
Total Project Cost	100%	$ 4,743,463

Project Completed?	

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 4,743,463
Total Project Cost			$ 4,743,463

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-55
Project Name:	S Maplelane Rd New Pipe, New PRV Station
Facility Type:	Pipe, Pressure Zone
Pressure Zone:	Henrici and Redland

Go to CIP Summary Table

Project Description:
Install new pipe on S Maplelane Rd to connect existing pipes from S Walker Rd to S Waldow Rd. Portions of the pipe will be installed parallel to existing pipe, and portions of the pipe will include a new river crossing. Approx 2,100 ft of 8" pipe will be parallel to existing 4" pipe. The 6" pipe will be parallel to existing 6" pipe.

Install a new PRV station between the Redland and Henrici pressure zone.

Purpose: The project is required to address low pressures in the vicinity and to convey water from the Redland zone to the Henrici zone via a PRV as a supplement to the proposed PRV station from the Redland to the Henrici Zone.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
S Maplelane Rd - 6" Pipe	3,580	LF	$ 200	$ 716,000	$ 214,800	$ 179,000	$ 143,200	$ 1,253,000
S Maplelane Rd - 8" Pipe	2,756	LF	$ 230	$ 633,880	$ 190,164	$ 158,470	$ 126,776	$ 1,109,290
S Maplelane Rd - PRV Station	1	LS	$ 200,000	$ 200,000	$ 60,000	$ 50,000	$ 40,000	$ 350,000
S Maplelane Rd - River Crossing (8" Pipe)	150	LF	$ 1,143	$ 171,505	$ 51,452	$ 42,876	$ 34,301	$ 300,135
Total Project Cost								$ 2,712,290

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Cost Allocation:

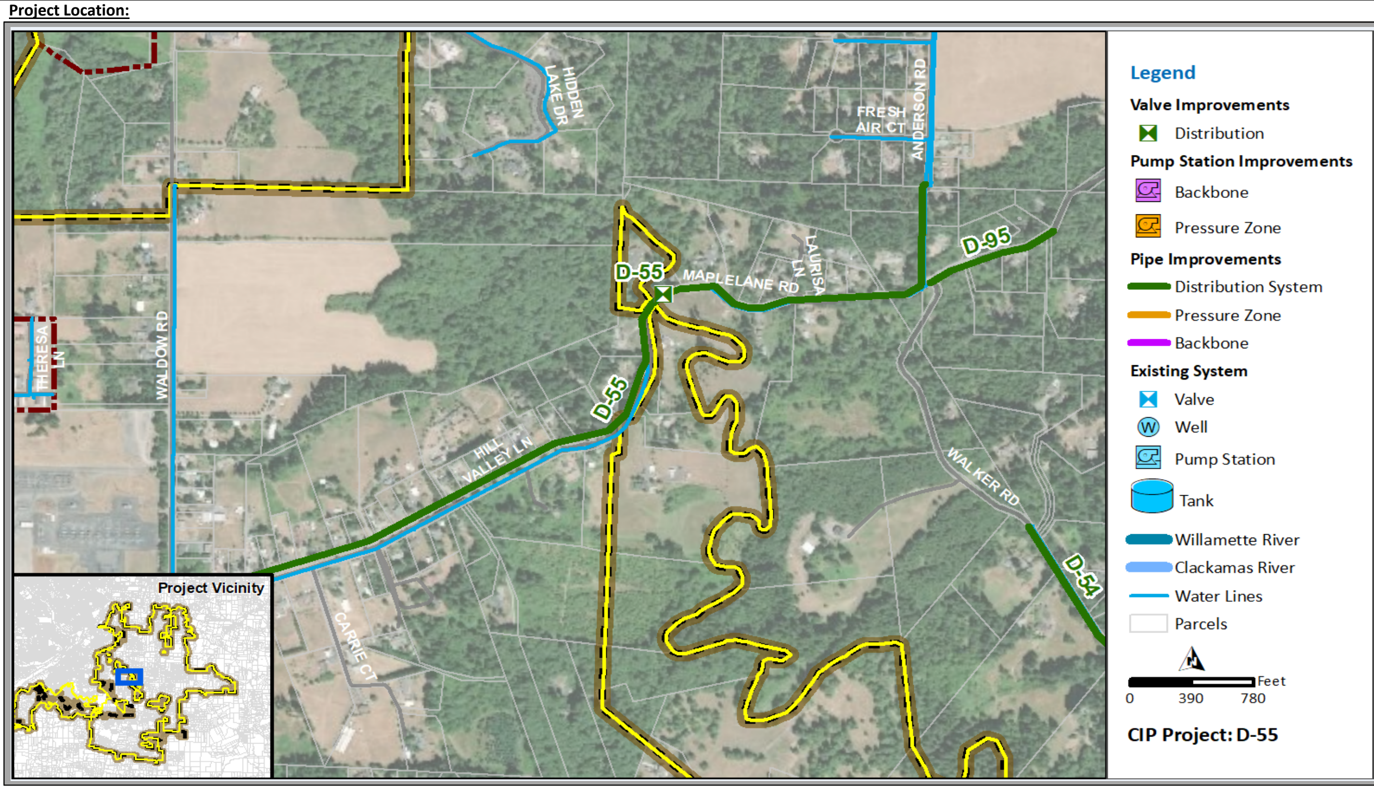
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 2,712,290
Total Project Cost	100%	$ 2,712,290

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
S Maplelane Rd - 6" Pipe	2022		$ 1,253,000
S Maplelane Rd - 8" Pipe	2022		$ 1,109,290
S Maplelane Rd - PRV Station	2023		$ 350,000
S Maplelane Rd - River Crossin	2023		$ 300,135
Total Project Cost			$ 3,012,425

Project Location:



Project ID:	D-56
Project Name:	S Maple Lane Road
Facility Type:	Pipe
Pressure Zone:	Redland

Go to CIP Summary Table

Project Description:

Replace existing 4" and 6" pipe with 8" pipe on S Maple Lane Road.
Purpose:
1. Upsize Pipe.
2. This pipeline has been flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	862	LF	$ 230	$ 198,260	$ 59,478.00	$ 49,565	$ 39,652.00	$ 346,955
Total Project Cost								$ 346,955

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Cost Allocation:

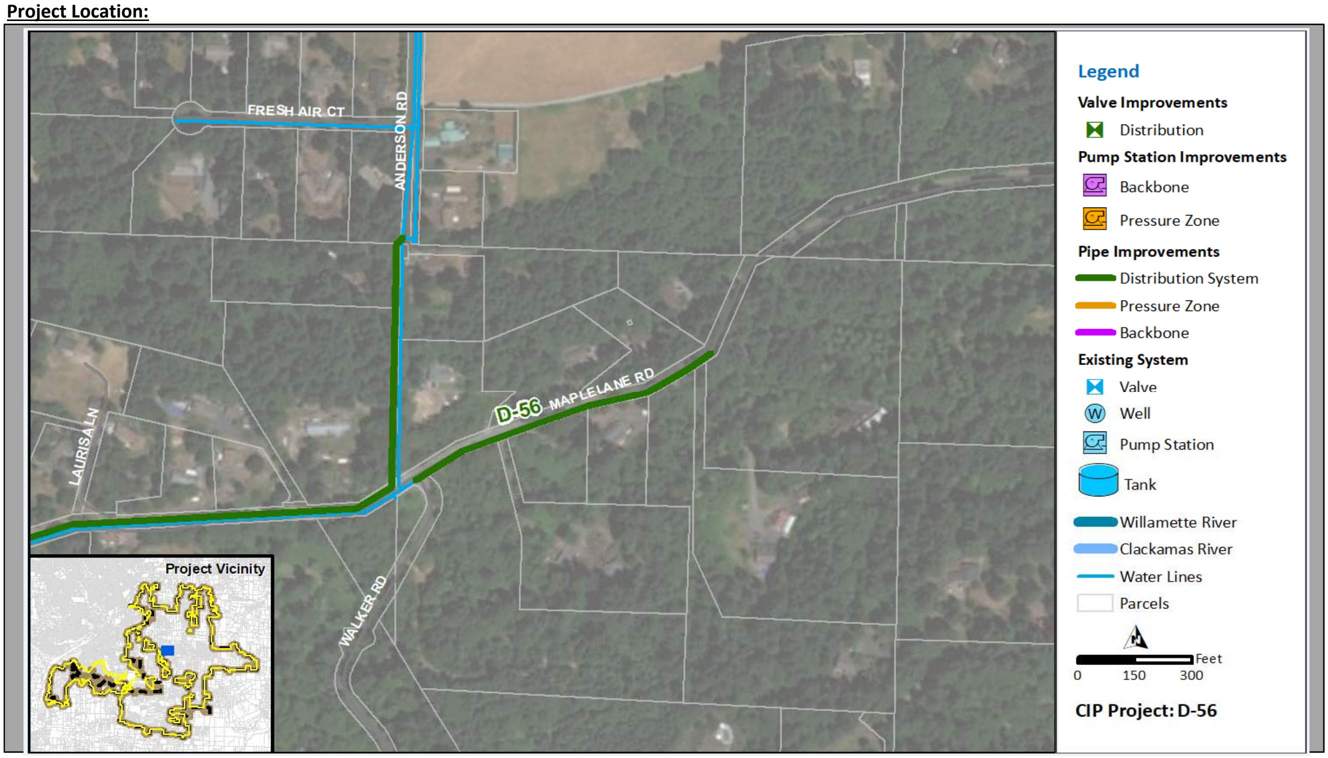
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 173,478
Improvement:	50%	$ 173,478
Total Project Cost	100%	$ 346,955

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 346,955
Total Project Cost			$ 346,955

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-57
Project Name:	S Loder Rd, Thimble Creek Dr Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Henrici

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe on S Loder Rd, S Thimble Creek Dr, and S Merry Lane Dr.
Purpose:
1. Project is required to provide fire flow.
2. This pipeline will reach its remaining useful life by the year 2019.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
12" Pipe	3,428	LF	$ 230	$ 788,440	$ 236,532	$ 197,110	$ 157,688.00	$ 1,379,770
Total Project Cost								$ 1,379,770

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Cost Allocation:

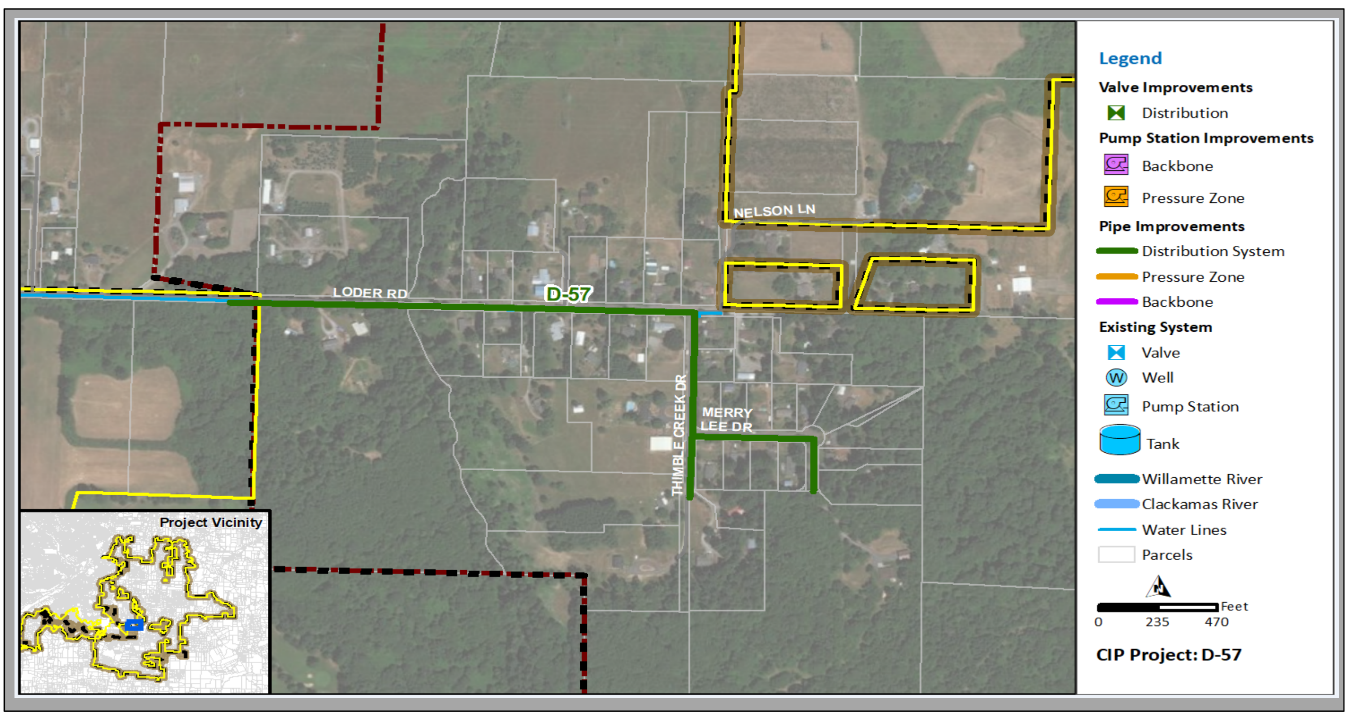
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 689,885
Improvement:	50%	$ 689,885
Total Project Cost	100%	$ 1,379,770

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
12" Pipe	2025		$ 1,379,770
Total Project Cost			$ 1,379,770

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-58
Project Name: S Ferguson Rd, S Heidi St Pipe Upsize
Facility Type: Pipe
Pressure Zone: Beaver Creek

Go to CIP Summary Table

Project Description:
Replace existing 4" and 6" pipe with 8" pipe on S Ferguson Rd from S Moore Rd to S Heidi St; S Heidi St to S Annette Dr, S Annette Dr, and S Rachel Ct.
Purpose:
1. Project is required to provide fire flow.
2. This pipeline will reach its remaining useful life by the year 2019.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	3,200	LF	$ 230	$ 736,000	$ 220,800	$ 184,000	$ 147,200.00	$ 1,288,000
Total Project Cost								$ 1,288,000

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Cost Allocation:

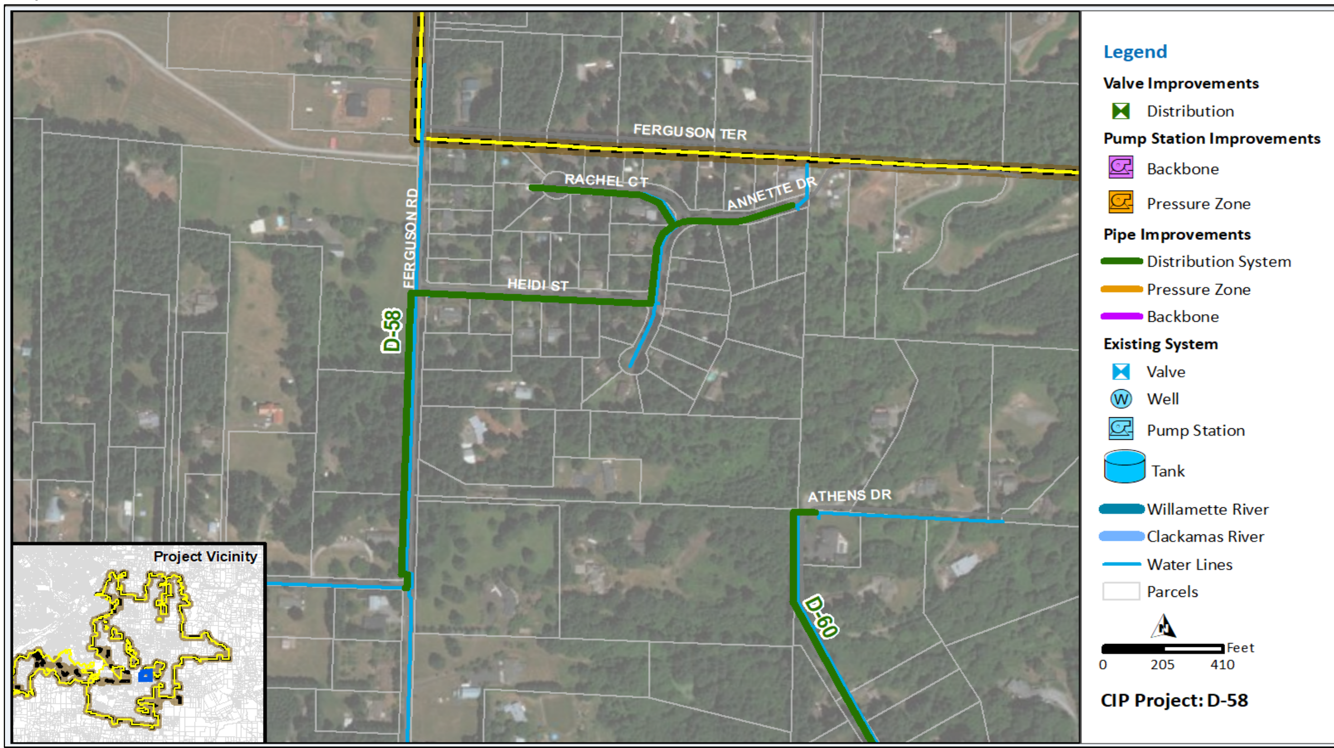
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 644,000
Improvement:	50%	$ 644,000
Total Project Cost	100%	$ 1,288,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	2026		$ 644,000
8" Pipe	2027		$ 644,000
Total Project Cost			$ 1,288,000

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-59
Project Name:	S Creek Rd Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Replace existing 4" pipe with 8" pipe on S Creek Rd from S Henrici Rd north.

Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	2,315	LF	$ 230	$ 532,450	$ 159,735	$ 133,113	$ 106,490.00	$ 931,788
Total Project Cost								$ 931,788

Go to Assumptions Tab

Cost Allocation:

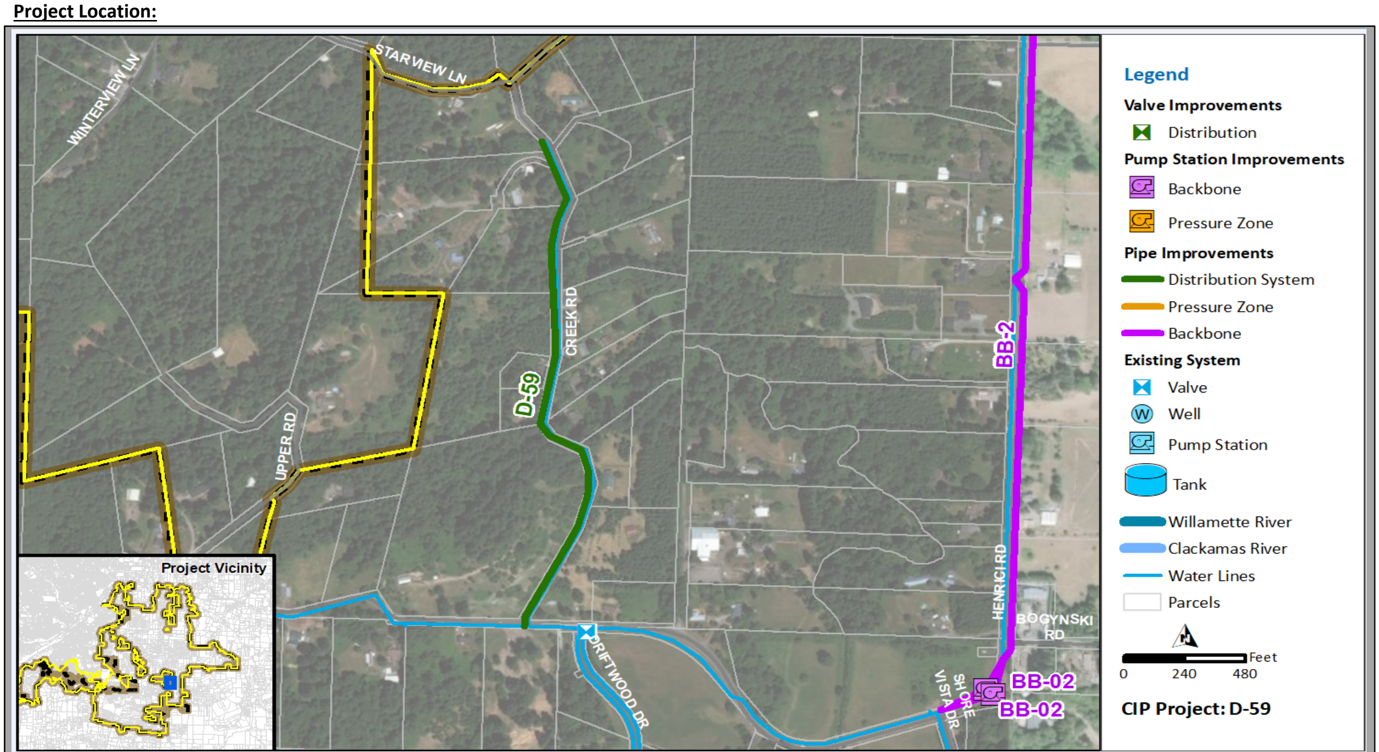
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 931,788
Total Project Cost	100%	$ 931,788

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 931,788
Total Project Cost			$ 931,788

Project Location:



Go to CIP Summary Table

Project ID:	D-60
Project Name:	S Athens Rd, S Olympus Rd Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Project Description:

Replace existing 4" and 6" pipe with 8" pipe on S Athens Rd from S Henrici Rd to end of street, and S Olympus Rd from S Athens Rd to end of street.

Purpose:

1. Project is required to provide fire flow.
2. This pipeline will reach its remaining useful life by the year 2019.
3. This pipeline has been flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	2,996	LF	$ 230	$ 689,080	$ 206,724	$ 172,270	$ 137,816.00	$ 1,205,890
Total Project Cost								$ 1,205,890

Go to Assumptions Tab

Cost Allocation:

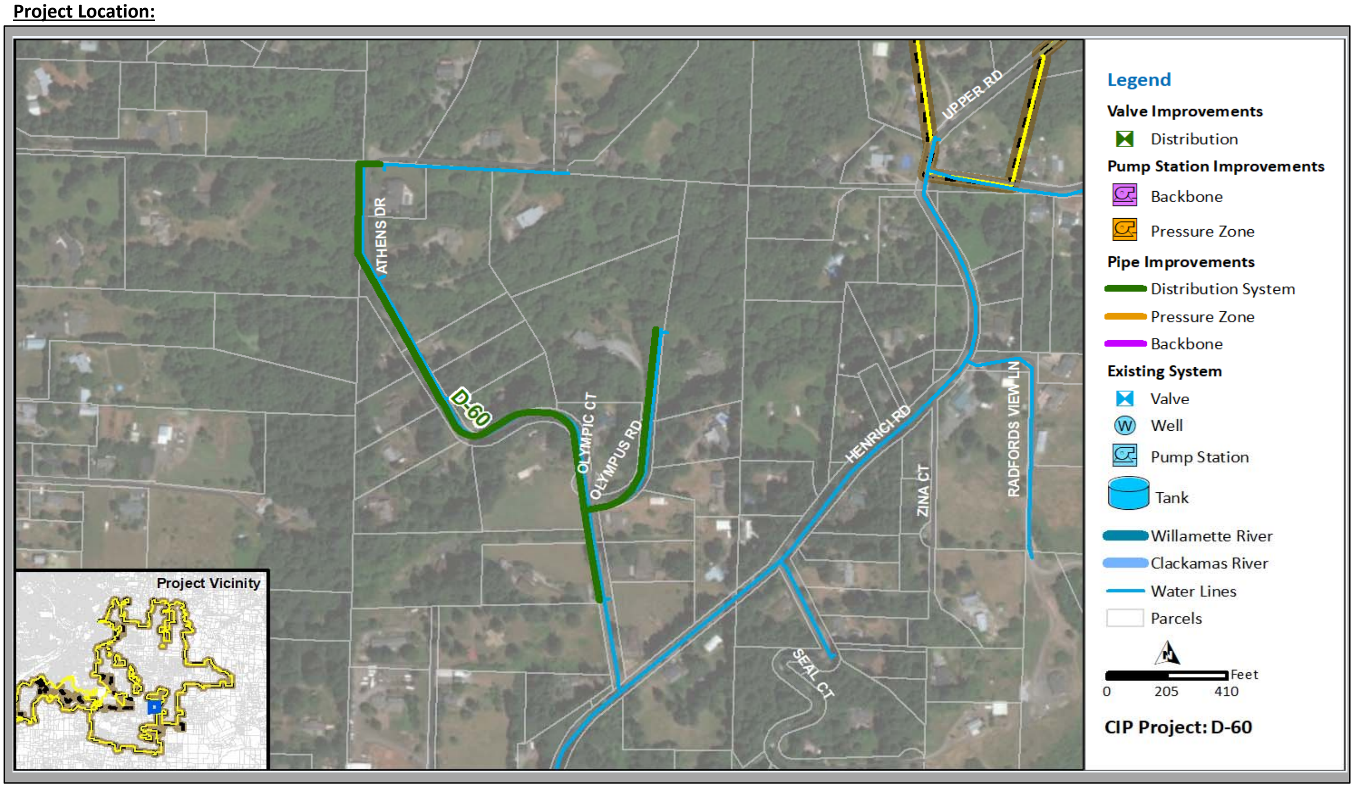
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 602,945
Improvement:	50%	$ 602,945
Total Project Cost	100%	$ 1,205,890

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	2024		$ 1,205,890
Total Project Cost			$ 1,205,890

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-61
Project Name:	Beavercreek Loop Connection
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Create a loop by installing new 12" pipe along S Mountain Meadow Rd from S Sunrise Ln to S Monpano Overlook Dr
Purpose: This project is required to fix the low pressure area in Beavercreek Pressure Zone

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
12" Pipe	2,271	LF	$ 260	$ 590,460	$ 177,138.00	$ 147,615	$ 118,092.00	$ 1,033,305
Total Project Cost								$ 1,033,305

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Cost Allocation:

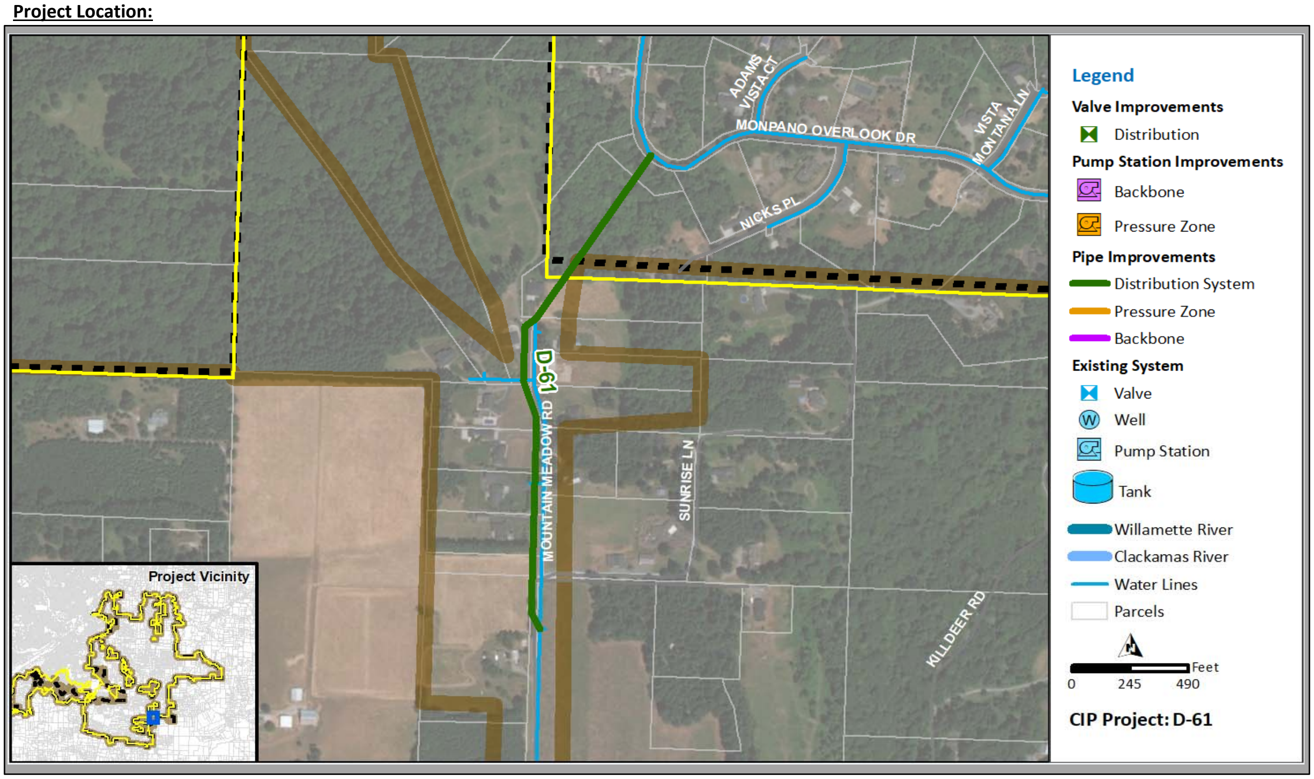
Project Type	Percent	Cost
Capacity:	100%	$ 1,033,305
Repair & Replacement:	0%	$ -
Improvement:	0%	$ -
Total Project Cost	100%	$ 1,033,305

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
12" Pipe	2026		$ 1,033,305
Total Project Cost			$ 1,033,305

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

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Project ID:	D-62
Project Name:	Henrici Rd New Pipe; Henrici Tank PRV Station
Facility Type:	Pipe, PRV
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Install 12" pipe parallel to existing 6" pipe on Henrici Rd from Beavercreek Rd to S Ferguson Rd; Install new PRV station at Henrici Reservoir with new 12" pipe. Purpose: The project is required to address low pressures in the vicinity.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Henrici PRV Station	1	LS	$ 200,000	$ 200,000	$ 60,000	$ 50,000	$ 40,000	$ 350,000
Henrici Rd - 12" pipe	4,957	LF	$ 260	$ 1,288,820	$ 386,646	$ 322,205	$ 257,764	$ 2,255,435
Total Project Cost								$ 2,605,435

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Cost Allocation:

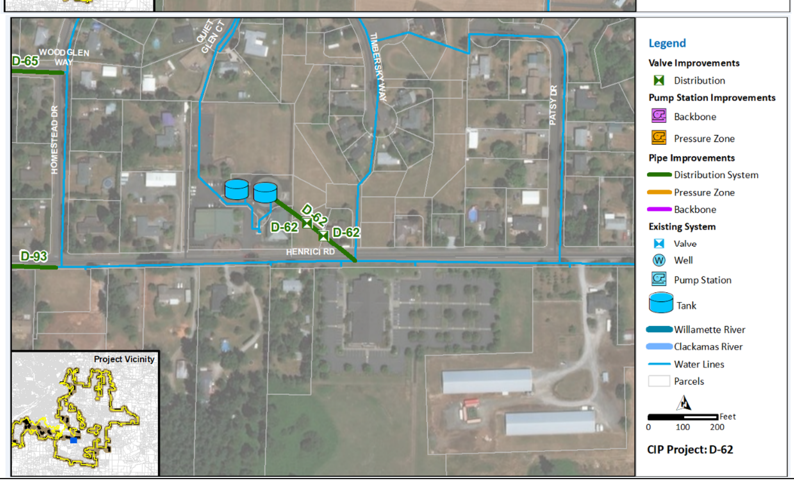
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 2,605,435
Total Project Cost	100%	$ 2,605,435

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
Henrici PRV Station	2022		$ 350,000
Henrici Rd - 12" pipe	2022		$ 2,255,435
Total Project Cost			$ 2,605,435

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-63
Project Name:	Danny Ln Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe on S Danny Ct from S Henrici Rd north to end of pipe.
Purpose:
1. Project is required to provide fire flow.
2. This pipeline will reach its remaining useful life by the year 2019.
3. This pipeline has been flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,270	LF	$ 230	$ 292,100	$ 87,630	$ 73,025	$ 58,420.00	$ 511,175
Total Project Cost								$ 511,175

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Cost Allocation:

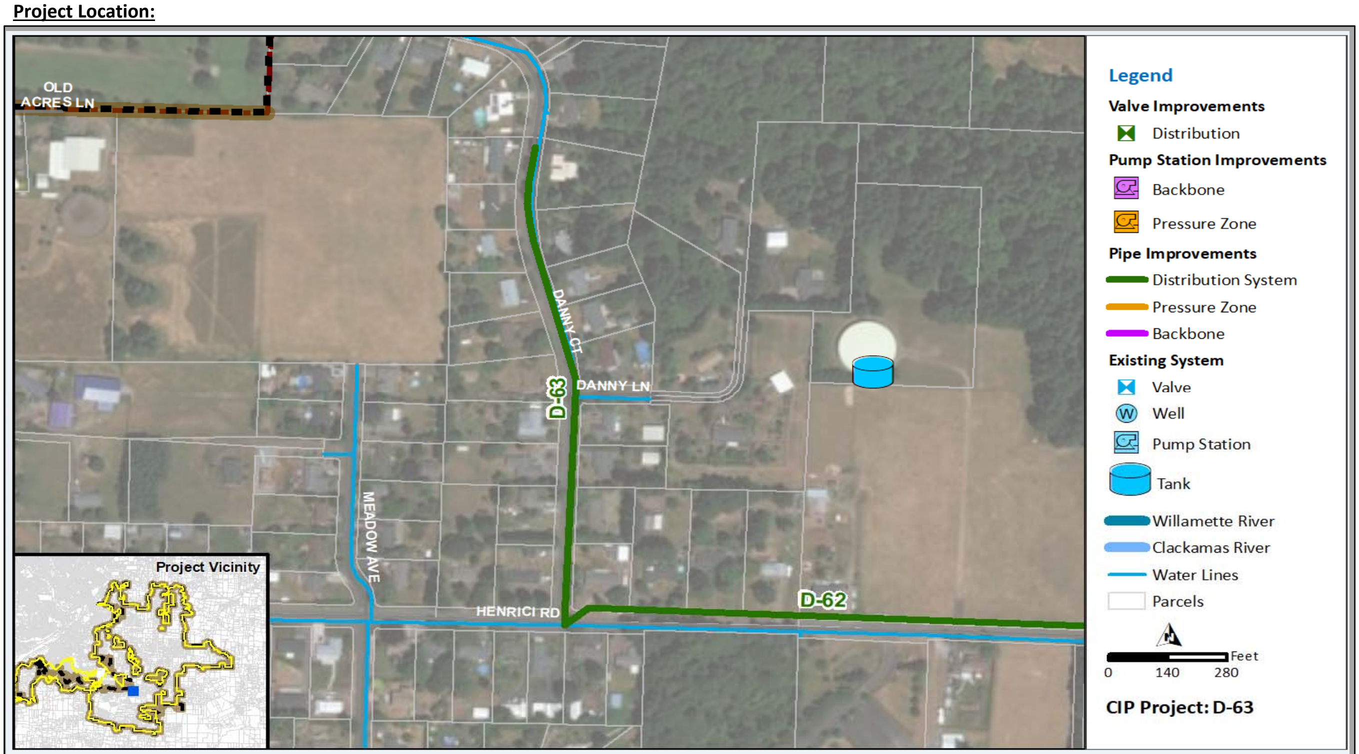
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 255,588
Improvement:	50%	$ 255,588
Total Project Cost	100%	$ 511,175

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	2019		$ 511,175
Total Project Cost			$ 511,175

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-64
Project Name:	S Saddle Ln Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe on S Saddle Ln from S Old Acres Ln south to end of street.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	976	LF	$ 230	$ 224,480	$ 67,344	$ 56,120	$ 44,896.00	$ 392,840
Total Project Cost								$ 392,840

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 392,840
Total Project Cost	100%	$ 392,840

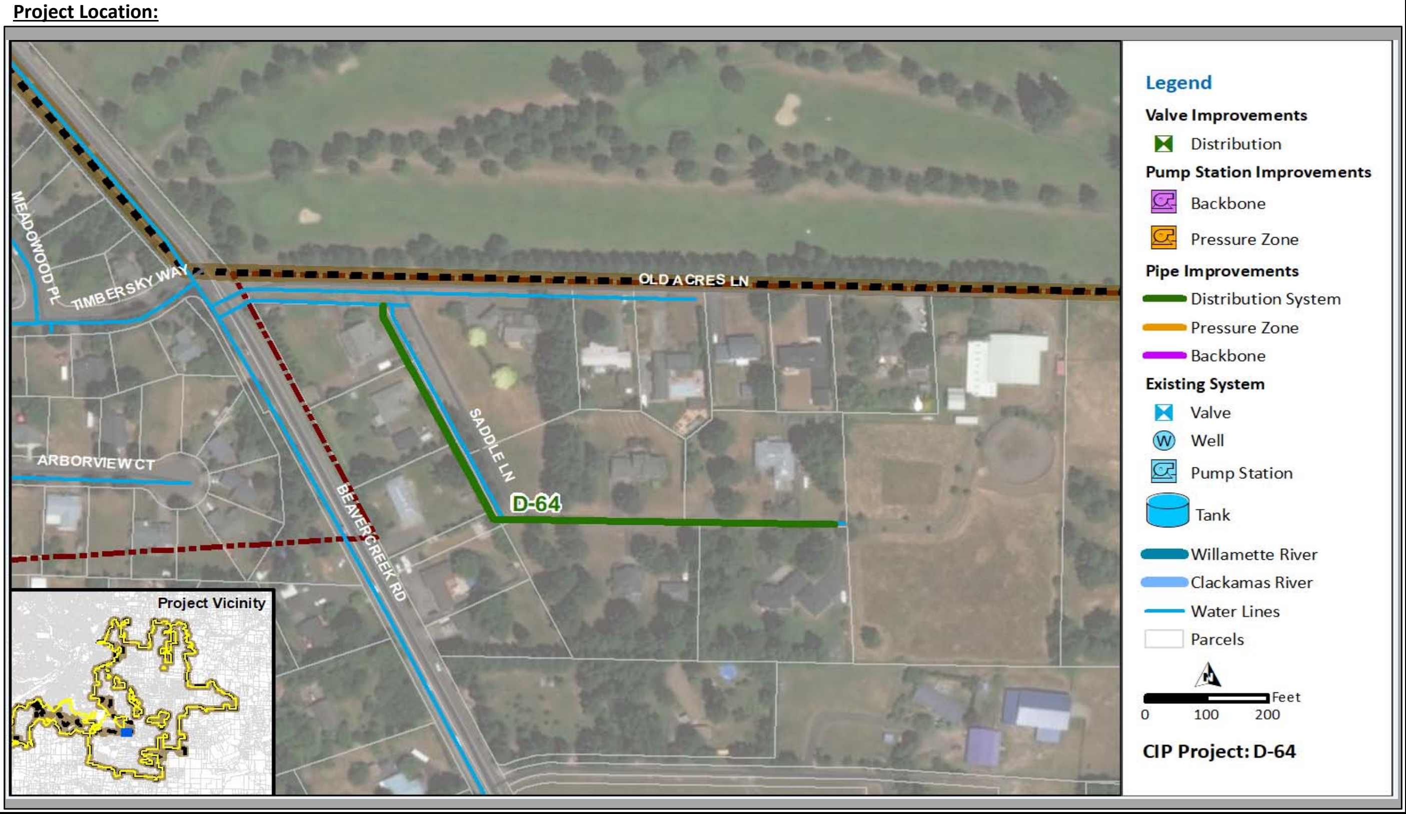
Project Completed?	No

Go to Assumptions Tab

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 392,840
Total Project Cost			$ 392,840

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-65
Project Name:	Woodglen Way, Crystal Ct Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe on S Woodglen Way from S Homestead Dr to S Crystal Ct and S Crystal Ct from S Woodglen Way east to end of street. Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency	Engineer/ Legal/Admin	Project Contingency	Total Cost
					30%	25%	20%	
8" Pipe	1,331	LF	$ 230	$ 306,130	$ 91,839	$ 76,533	$ 61,226.00	$ 535,728
Total Project Cost								$ 535,728

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 535,728
Total Project Cost	100%	$ 535,728

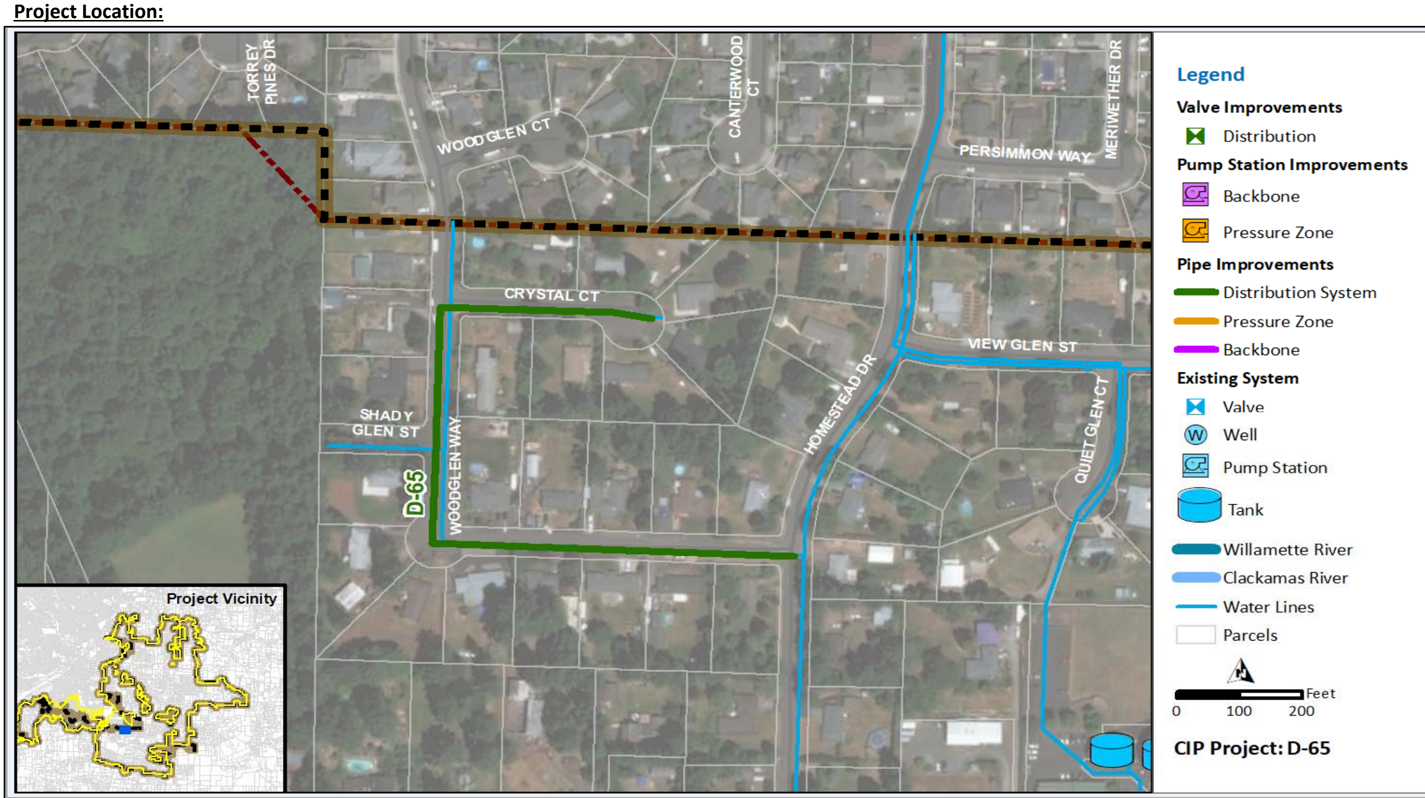
Project Completed?	No

Go to Assumptions Tab

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 535,728
Total Project Cost			$ 535,728

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-66
Project Name:	Beavercreek - Henrici Rd
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Replace existing 8" pipe with new 12" pipe on Henrici Rd from Cascade Hwy S to S Reeder Rd.
Purpose: This project is required to provide fire flows.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
12" Pipe	2,107	LF	$ 260	$ 547,820	$ 164,346.00	$ 136,955	$ 109,564.00	$ 958,685
Total Project Cost								$ 958,685

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 958,685
Total Project Cost	100%	$ 958,685

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
12" Pipe	Long-term		$ 958,685
Total Project Cost			$ 958,685

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-67
Project Name: S Quail Crest Ln Pipe Upsize
Facility Type: Pipe
Pressure Zone: Beaver Creek

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe on S Quail Crest Ln to end of pipe.
Purpose:
1. Project is required to provide fire flow.
2. This pipeline will reach its remaining useful life by the year 2020.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	854	LF	$ 230	$ 196,420	$ 58,926	$ 49,105	$ 39,284.00	$ 343,735
Total Project Cost								$ 343,735

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Cost Allocation:

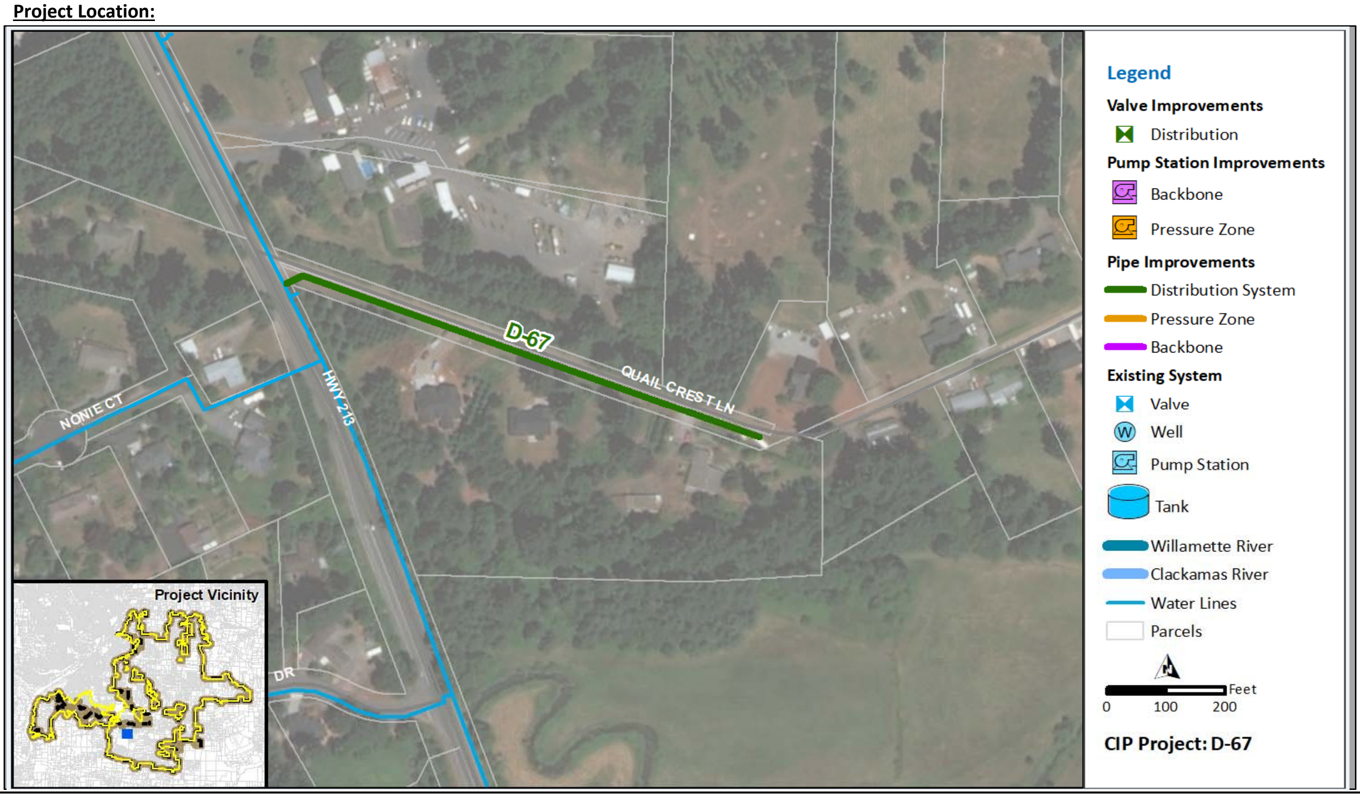
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 171,868
Improvement:	50%	$ 171,868
Total Project Cost	100%	$ 343,735

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	2026		$ 343,735
Total Project Cost			$ 343,735

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-68
Project Name:	S Mossy Rock Ct, S Greentree Dr Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe on S Mossy Rock Ct from S Green Tree Dr north to end of street and on S Greentree Dr from S Mossy Rock Ct to S Casca Berry Ct.

Purpose:

1. Project is required to provide fire flow.
2. This pipeline was flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,680	LF	$ 230	$ 386,400	$ 115,920	$ 96,600	$ 77,280.00	$ 676,200
Total Project Cost								$ 676,200

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Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 338,100
Improvement:	50%	$ 338,100
Total Project Cost	100%	$ 676,200

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 676,200
Total Project Cost			$ 676,200

Project Location:

Project ID:	D-69
Project Name:	S Clear View Ct Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe on S Clear View Ct from Leland Rd north to end of street.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	870	LF	$ 230	$ 200,100	$ 60,030	$ 50,025	$ 40,020.00	$ 350,175
Total Project Cost								$ 350,175

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Cost Allocation:

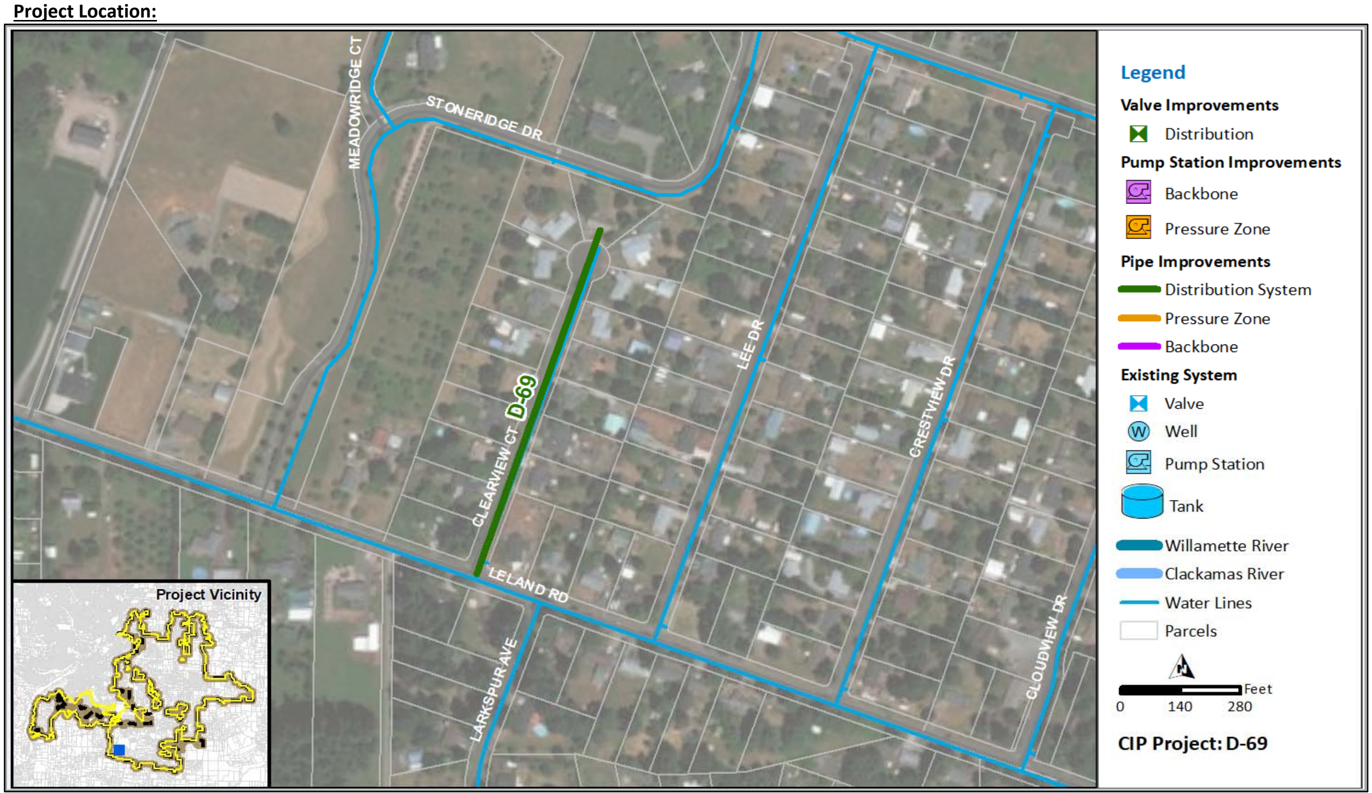
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 350,175
Total Project Cost	100%	$ 350,175

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 350,175
Total Project Cost			$ 350,175

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-70
Project Name: S Farm Pond Ct Pipe Upsize
Facility Type: Pipe
Pressure Zone: Beaver Creek

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe on S Farm Pond Ct from S Foothills Ave to end of street.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	819	LF	$ 230	$ 188,370	$ 56,511	$ 47,093	$ 37,674.00	$ 329,648
Total Project Cost								$ 329,648

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 329,648
Total Project Cost	100%	$ 329,648

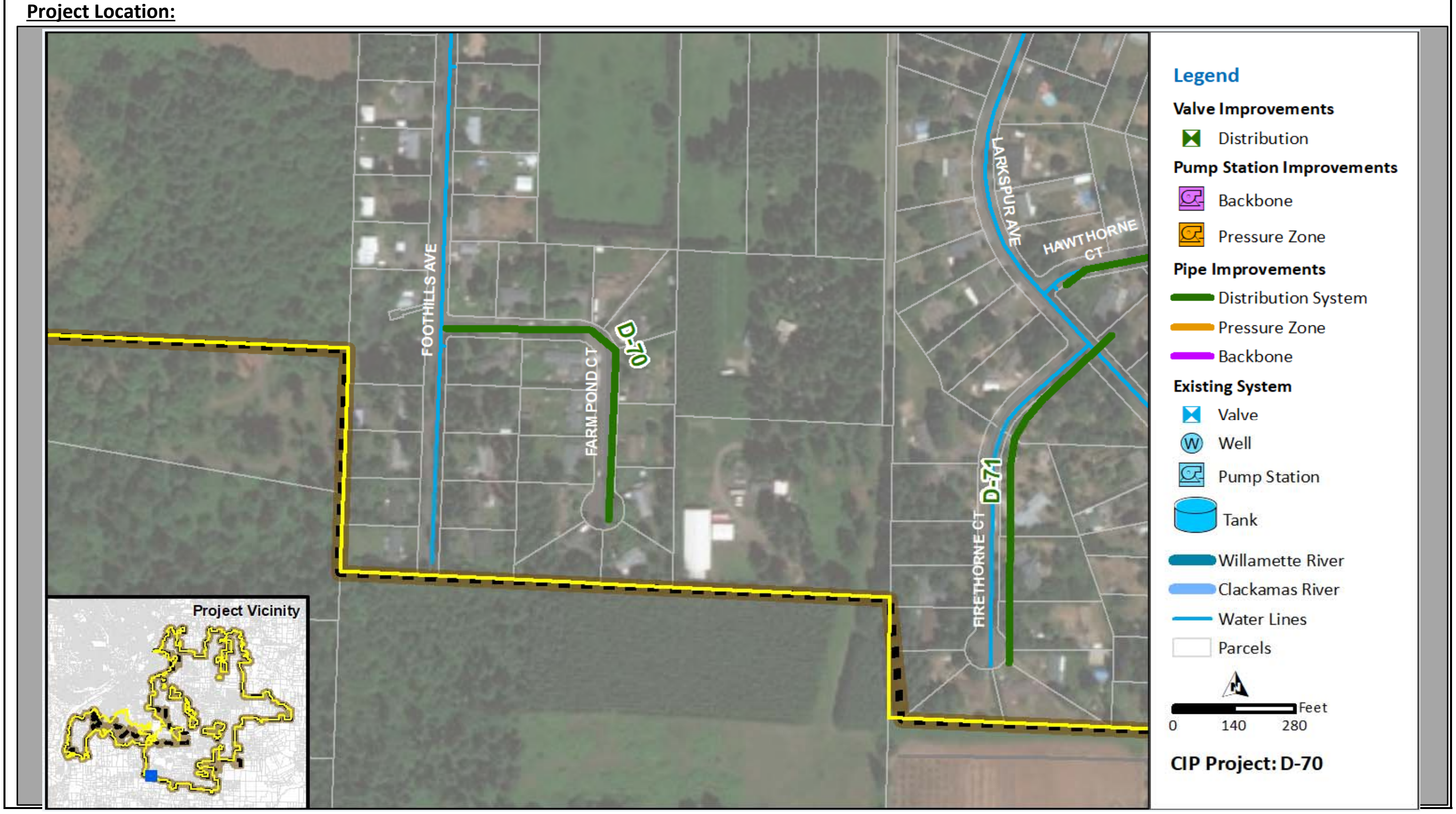
Project Completed?	No

Go to Assumptions Tab

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 329,648
Total Project Cost			$ 329,648

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-71
Project Name:	S Hawthorne Ct, S Firethorne Ct Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe on S Hawthorne Ct from S Larkspur Ave to end of street and S Firethorne Ct from S Larkspur Ave to end of street.
Purpose:
1. Project is required to provide fire flow.
2. This pipeline was flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency	Engineer/ Legal/Admin	Project Contingency	Total Cost
					30%	25%	20%	
8" Pipe	1,934	LF	$ 230	$ 444,820	$ 133,446	$ 111,205	$ 88,964.00	$ 778,435
Total Project Cost								$ 778,435

Go to Assumptions Tab

Cost Allocation:

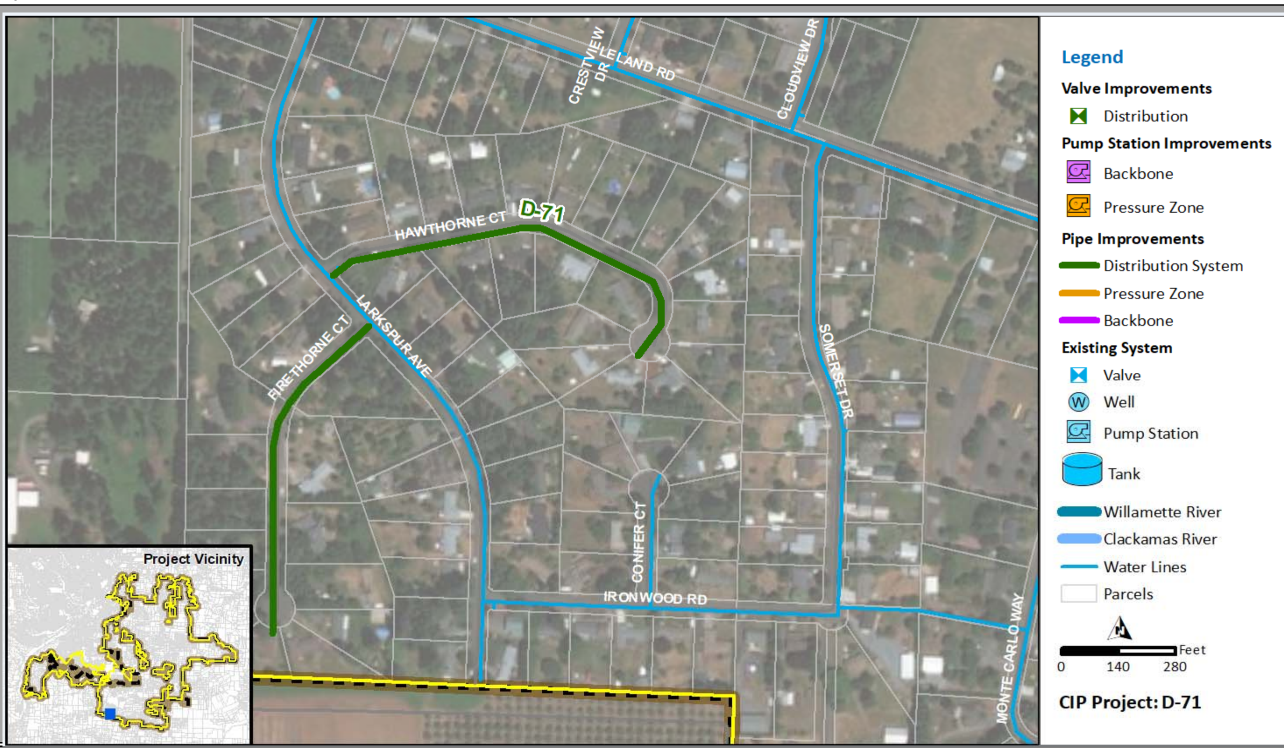
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 389,218
Improvement:	50%	$ 389,218
Total Project Cost	100%	$ 778,435

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 778,435
Total Project Cost			$ 778,435

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-72
Project Name: S Lammer Rd Pipe Upsize
Facility Type: Pipe
Pressure Zone: Beaver Creek

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe on S Lammer Rd from S Beavercreek Rd west to end of street.
Purpose:
1. Project is required to provide fire flow.
2. This pipeline will reach its remaining useful life by the year 2019.
3. This pipeline was flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	2,201	LF	$ 230	$ 506,230	$ 151,869	$ 126,558	$ 101,246.00	$ 885,903
Total Project Cost								$ 885,903

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 442,951
Improvement:	50%	$ 442,951
Total Project Cost	100%	$ 885,903

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	2027		$ 885,903
Total Project Cost			$ 885,903

Project Location:

Clackamas River Water
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Capital Improvement Program

Project ID:	D-73
Project Name:	S Levi Ct, S Levi Rd Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe on S Levi Rd from S Ivel Rd to end of pipe and S Levi Ct from S Levi Rd to end of pipe.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	2,112	LF	$ 230	$ 485,760	$ 145,728	$ 121,440	$ 97,152.00	$ 850,080
Total Project Cost								$ 850,080

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Cost Allocation:

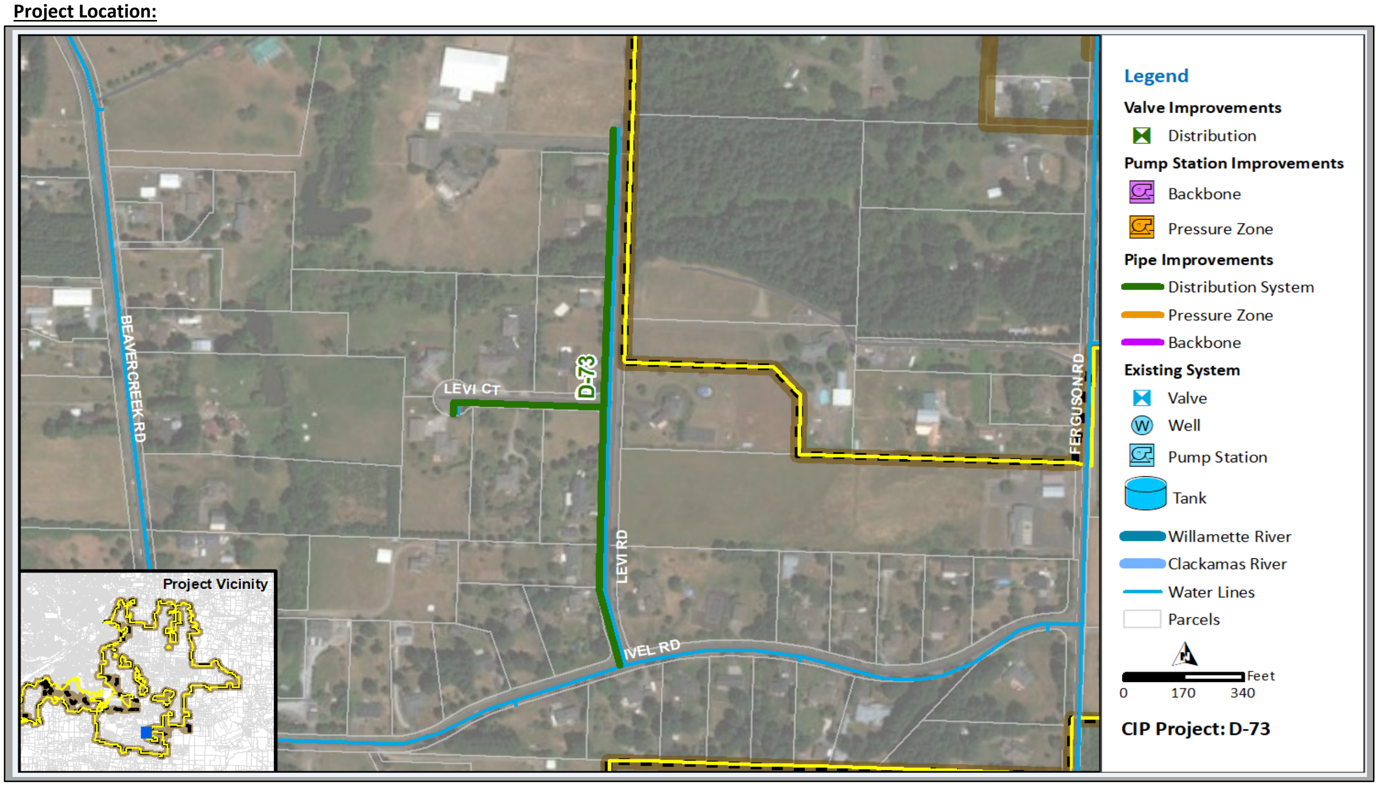
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 850,080
Total Project Cost	100%	$ 850,080

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 850,080
Total Project Cost			$ 850,080

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-74
Project Name:	S Leland Rd, S Beavercreek Rd Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Replace existing 8" pipe with new 12" pipe on S Leland Rd from S Leslie Ave to S Kamrath Rd.
Purpose: This project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency	Engineer/ Legal/Admin	Project Contingency	Total Cost
					30%	25%	20%	
S Leland Rd - 12" Pipe	4,871	LF	$ 260	$ 1,266,460	$ 379,938.00	$ 316,615	$ 253,292.00	$ 2,216,305
Total Project Cost								$ 2,216,305

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 2,216,305
Total Project Cost	100%	$ 2,216,305

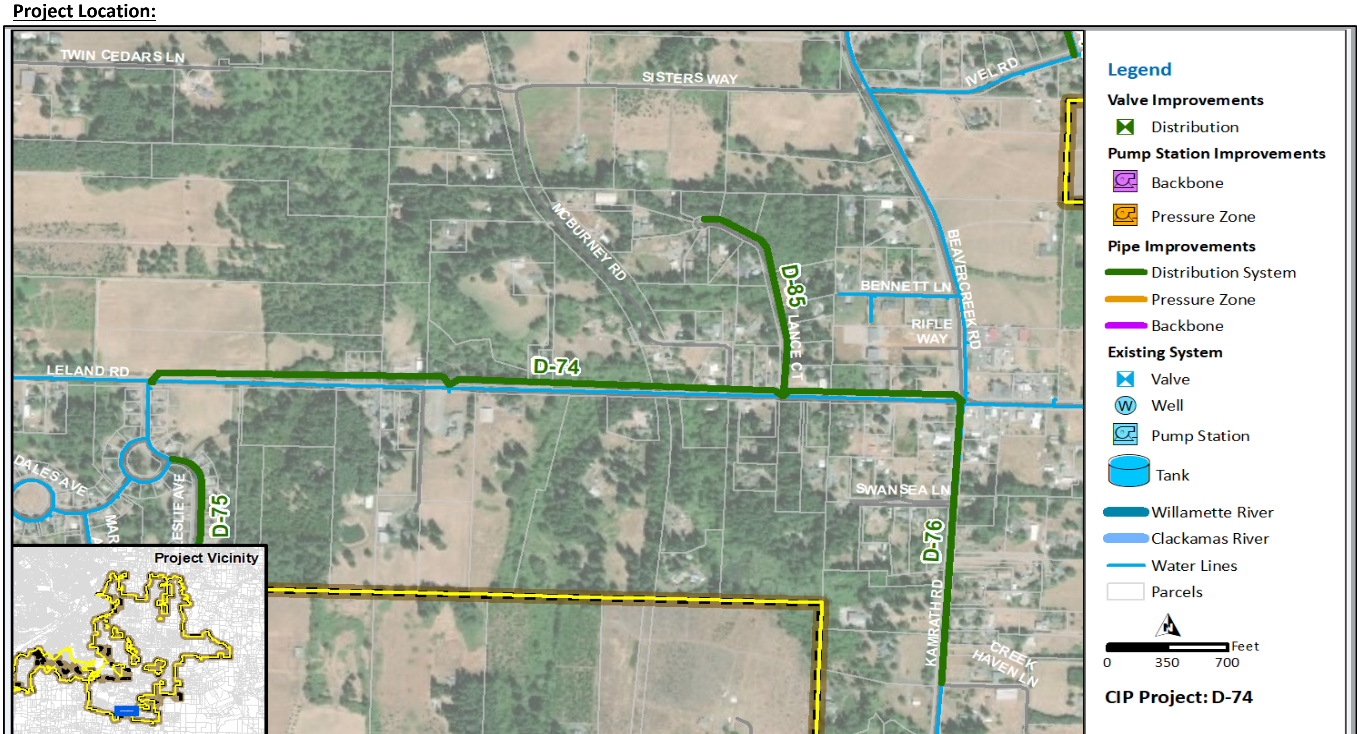
Project Completed?	No

Go to Assumptions Tab

Project Timing:

Project Element	Timing		Cost
S Leland Rd - 12" Pipe	Long-term		$ 2,216,305
Total Project Cost			$ 2,216,305

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-75
Project Name:	S Leslie Ave Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe on S Leslie Ave from S Dales Ave south to end of street.

Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	950	LF	$ 230	$ 218,500	$ 65,550	$ 54,625	$ 43,700.00	$ 382,375
Total Project Cost								$ 382,375

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Cost Allocation:

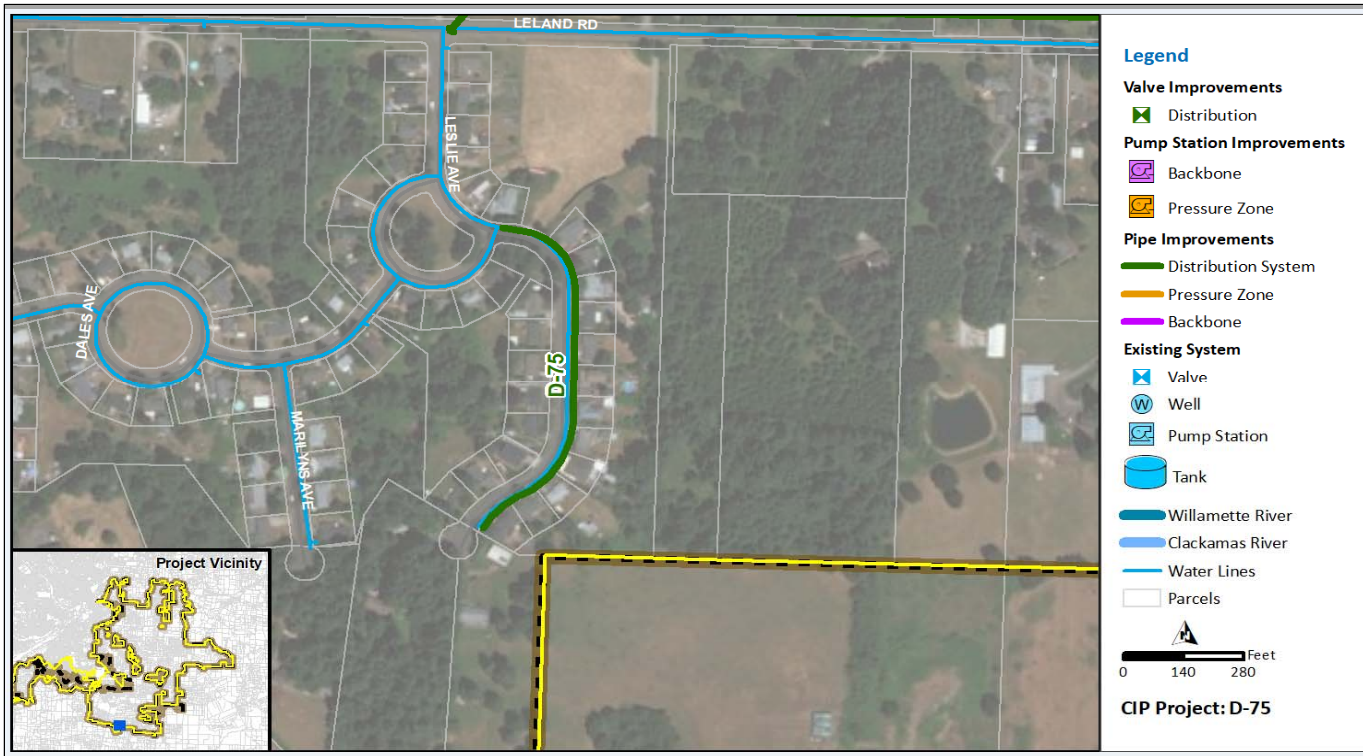
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 382,375
Total Project Cost	100%	$ 382,375

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 382,375
Total Project Cost			$ 382,375

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-76
Project Name:	S Kamrath Rd Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe on S Kamrath Rd from S Beavercreek Rd to S Creek Haven Ln.
Purpose: Project is required to provide fire flow

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,825	LF	$ 230	$ 419,750	$ 125,925	$ 104,938	$ 83,950.00	$ 734,563
Total Project Cost								$ 734,563

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Cost Allocation:

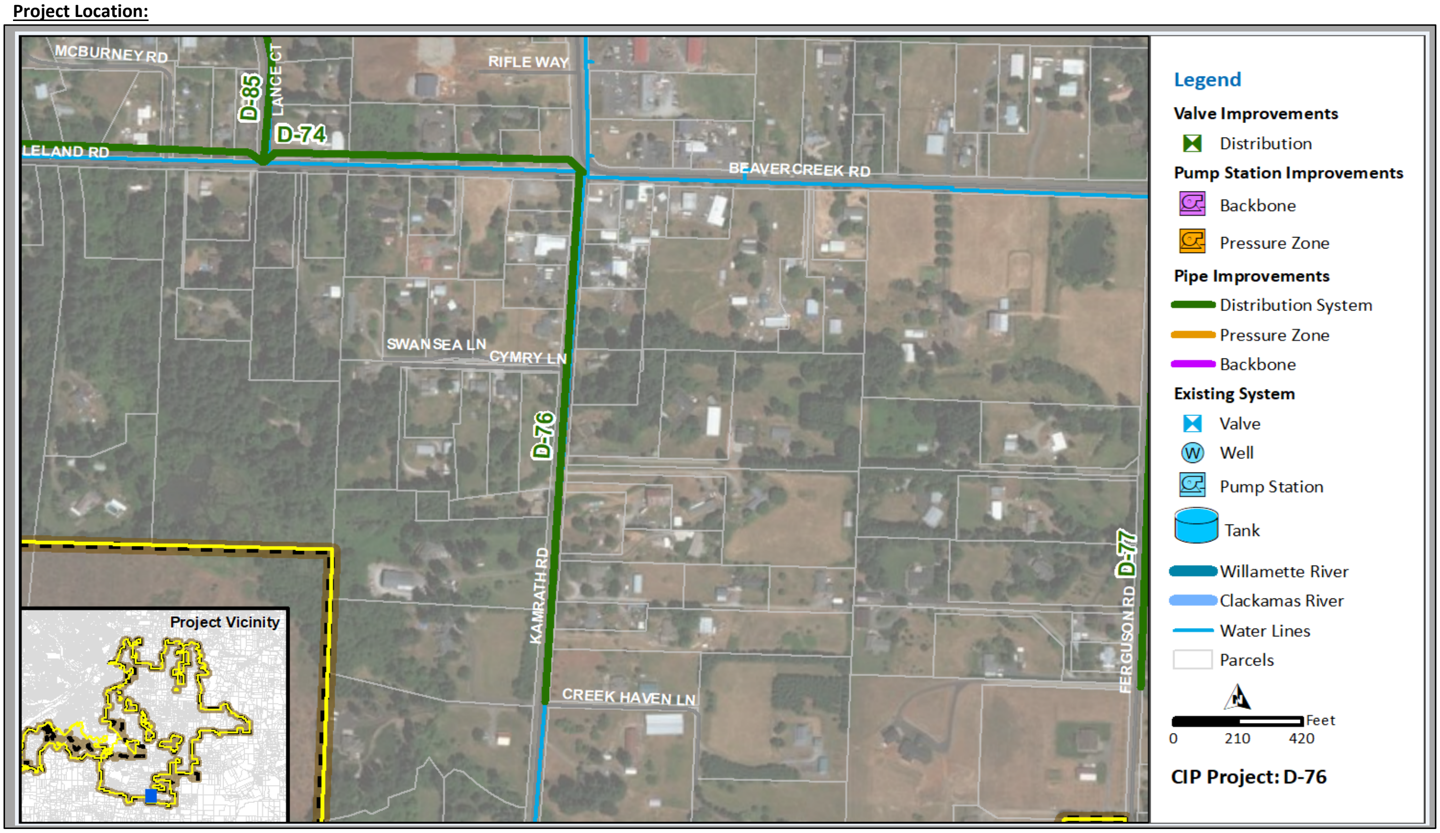
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 734,563
Total Project Cost	100%	$ 734,563

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 734,563
Total Project Cost			$ 734,563

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-77
Project Name:	S Ferguson Rd Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe on S Ferguson Rd from S Beavercreek Rd to S Williams Rd.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,690	LF	$ 230	$ 388,700	$ 116,610	$ 97,175	$ 77,740.00	$ 680,225
Total Project Cost								$ 680,225

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Cost Allocation:

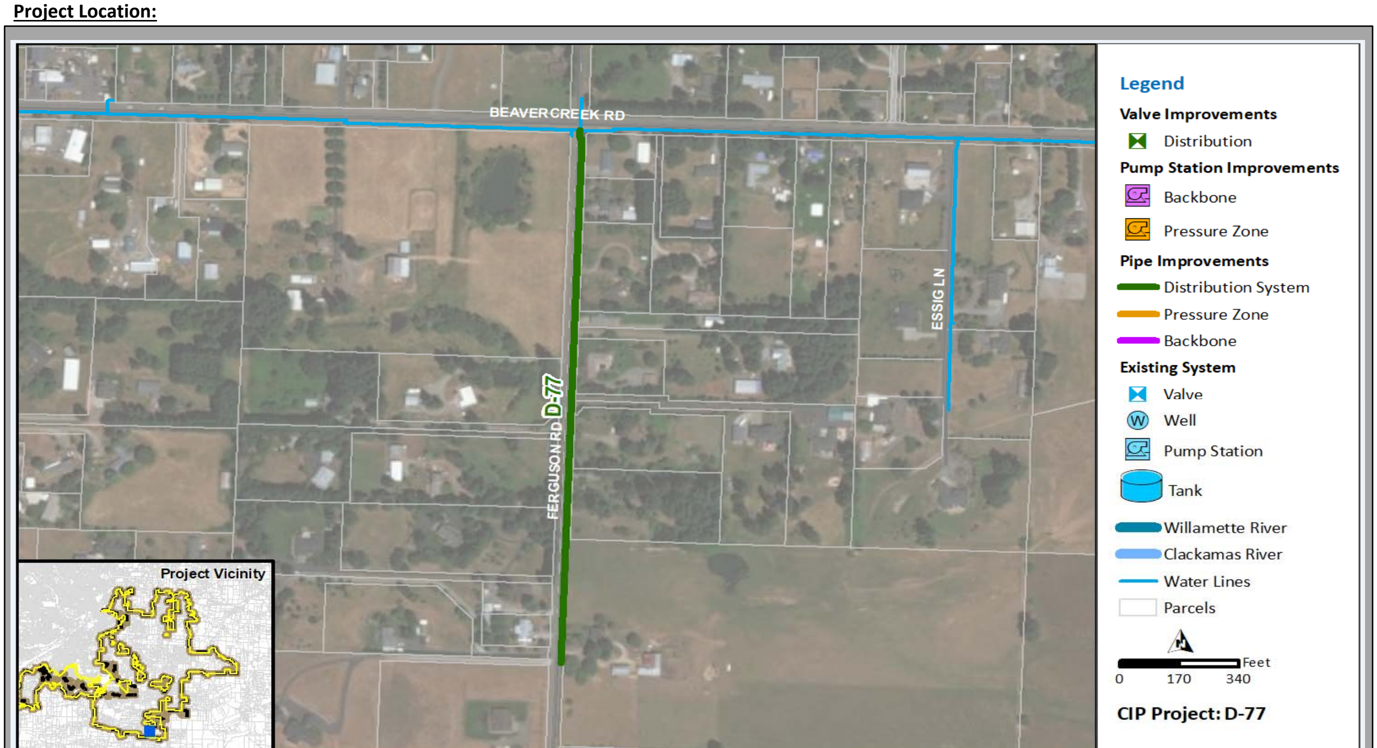
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 680,225
Total Project Cost	100%	$ 680,225

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 680,225
Total Project Cost			$ 680,225

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Go to CIP Summary Table

Project ID:	D-78
Project Name:	Henrici Rd
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Project Description:
Replace existing 8" pipe with 8" pipe on Henrici Road (HWY 213 east to RR Right-of-Way).
Purpose: Replace Pipe

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,293	LF	$ 230	$ 297,390	$ 89,217.00	$ 74,348	$ 59,478.00	$ 520,433
Total Project Cost								$ 520,433

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 520,433
Total Project Cost	100%	$ 520,433

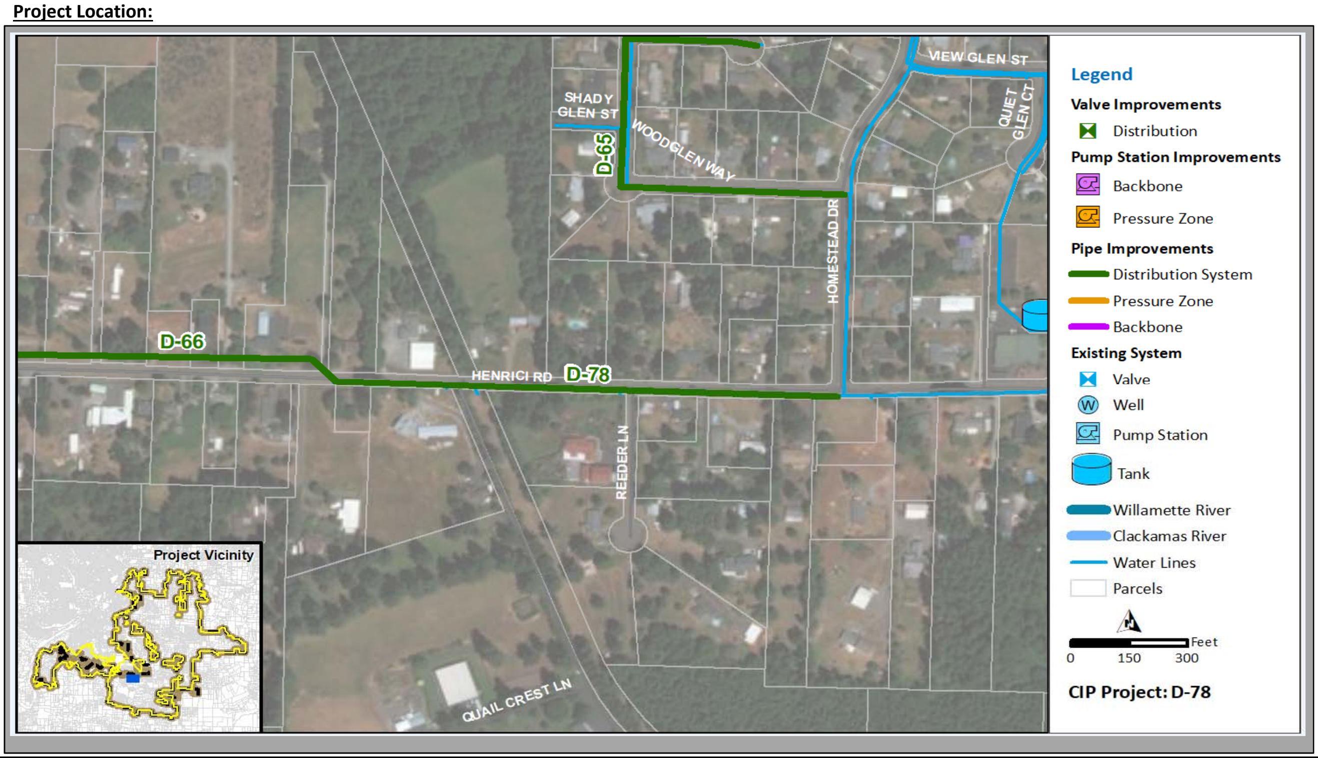
Project Completed?	No

Go to Assumptions Tab

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-Term		$ 520,433
Total Project Cost			$ 520,433

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-79
Project Name:	S Redland School Rd, S Redland Rd New Pipe
Facility Type:	Pipe
Pressure Zone:	Redland

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Project Description:

Install new 8" pipe on S Redland School Rd from S Redland Rd to Redland Elementary
Purpose: Project is required to provide fire flow to Redland elementary school.

Install new 12" pipe, parallel to existing 8" pipe, on S Redland Rd from S Norman Rd to S Marklund .
Purpose: Project is required to provide fire flow to Redland elementary school.

Additional Purpose: Approximately 2,900 ft of this pipeline was established as part of the seismic system.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
12" Pipe on S Redland Rd	2,903	LF	$ 260	$ 754,780	$ 226,434.00	$ 188,695	$ 150,956.00	$ 1,320,865
8" Pipe on S Redland School R	1,196	LF	$ 230	$ 275,080	$ 82,524	$ 68,770	$ 55,016	$ 481,390
Total Project Cost								$ 1,802,255

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Cost Allocation:

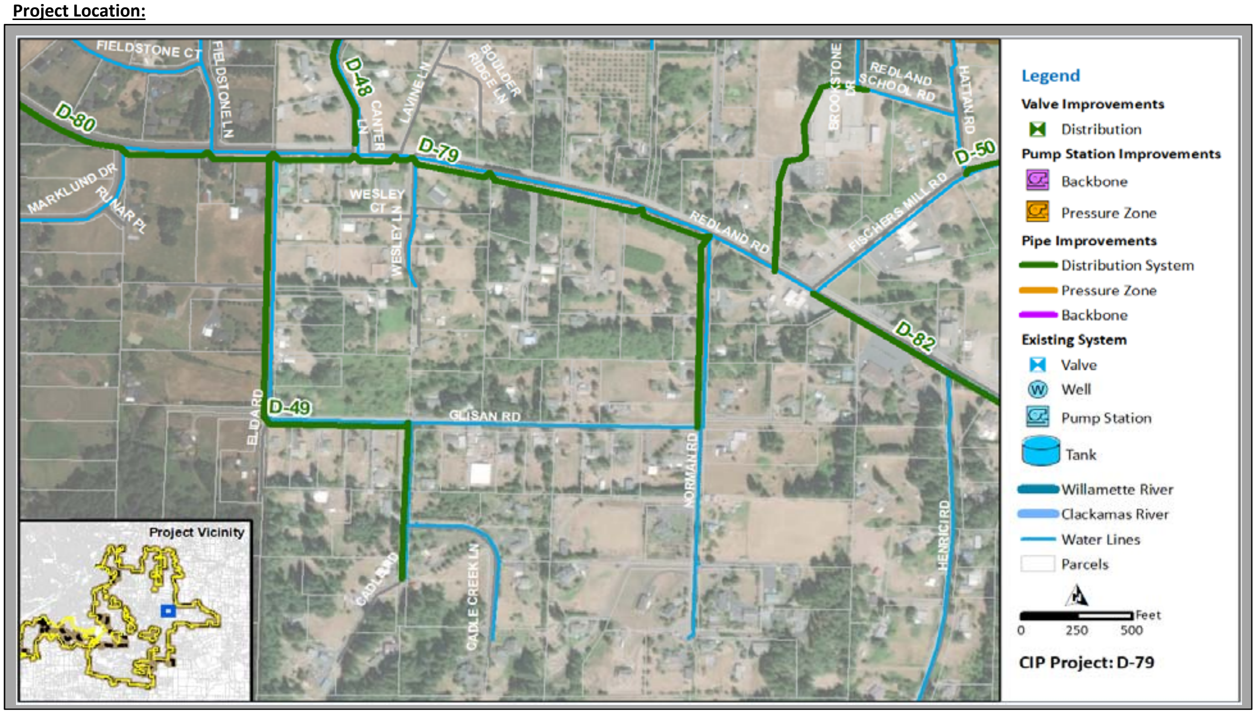
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 1,802,255
Total Project Cost	100%	$ 1,802,255

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
12" Pipe on S Redland Rd	2019		$ 1,320,865
8" Pipe on S Redland School R	2019		$ 481,390
Total Project Cost			$ 1,802,255

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Go to CIP Summary Table

Project ID:	D-80
Project Name:	Redland Road
Facility Type:	Pipe
Pressure Zone:	Redland

Project Description:

Redland Road (Potter Road to Fieldson Road) replace current 8" pipe with new 8" pipe.
Purpose:
1. Replace Pipe
2. Approximately 2,500 ft of this pipeline was established as part of the seismic system.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	2,063	LF	$ 230	$ 474,490	$ 142,347	$ 118,623	$ 94,898	$ 830,358
Total Project Cost								$ 830,358

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Cost Allocation:

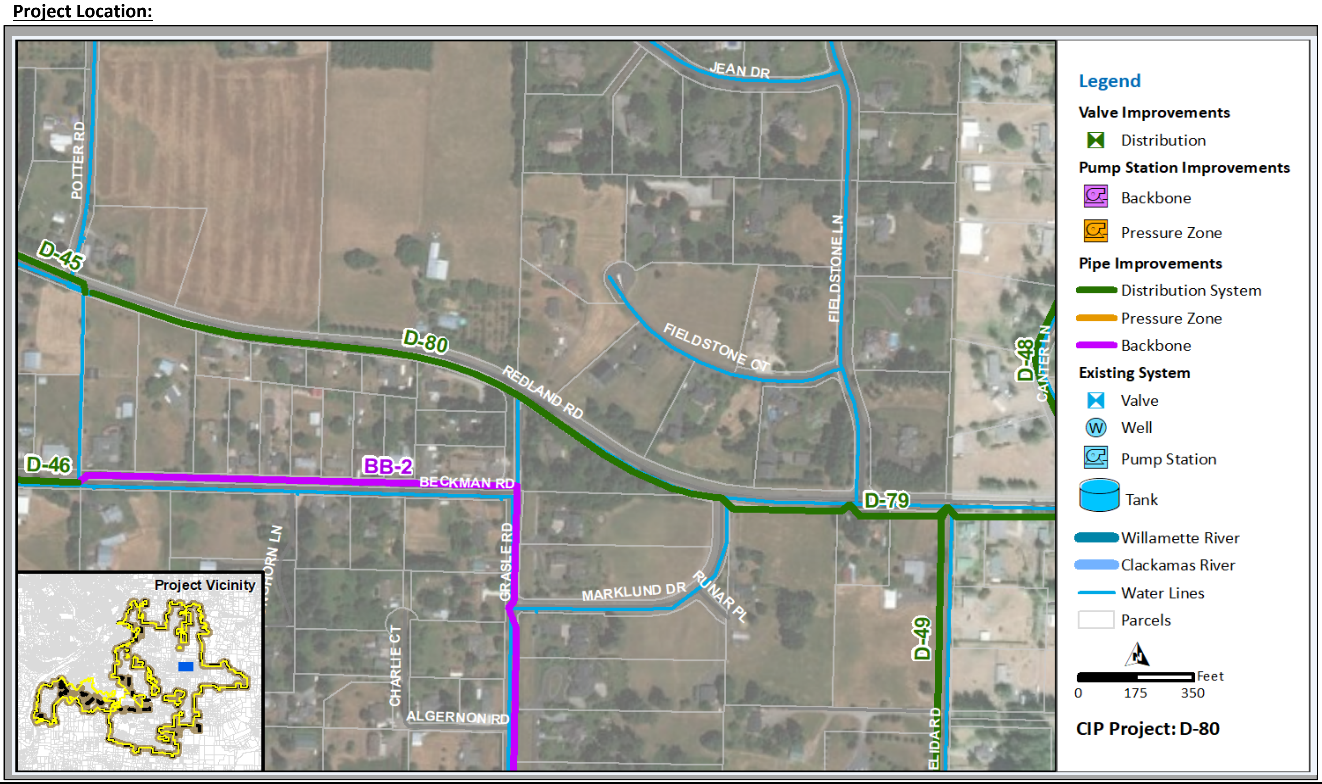
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 830,358
Total Project Cost	100%	$ 830,358

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 830,358
Total Project Cost			$ 830,358

Project Completed?	No

Project Location:



Go to CIP Summary Table

Project ID:	D-81
Project Name:	Ferguson Road (1)
Facility Type:	Pipe
Pressure Zone:	Redland

Project Description:

Ferguson Road (Redland Road to Beckman). Replace 6" Pipe with 8" pipe.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	2,500	LF	$ 230	$ 575,000	$ 172,500	$ 143,750	$ 115,000	$ 1,006,250
Total Project Cost								$ 1,006,250

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Cost Allocation:

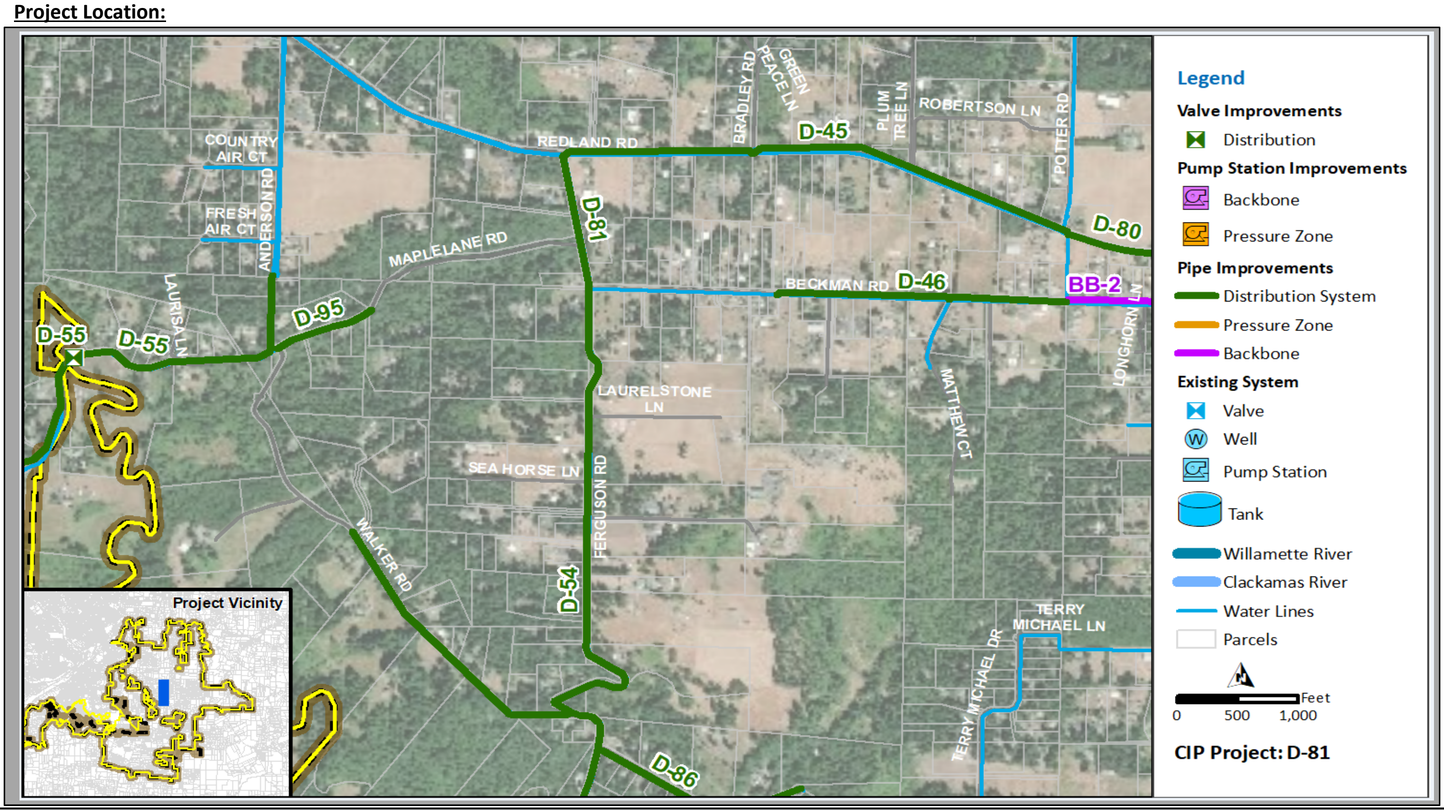
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 1,006,250
Total Project Cost	100%	$ 1,006,250

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-Term		$ 1,006,250
Total Project Cost			$ 1,006,250

Project Completed?	No

Project Location:



carollo

Project ID:	D-82
Project Name:	Redland Road
Facility Type:	Pipe
Pressure Zone:	Redland

Go to CIP Summary Table

Project Description:
Redland Road. Replace 6" Pipe with 8" pipe.
Purpose:
1. Upsize Pipe.
2. Approximately 540 ft of this pipeline was established as part of the seismic system.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,821	LF	$ 230	$ 418,830	$ 125,649	$ 104,708	$ 83,766	$ 732,953
Total Project Cost								$ 732,953

Go to Assumptions Tab

Cost Allocation:

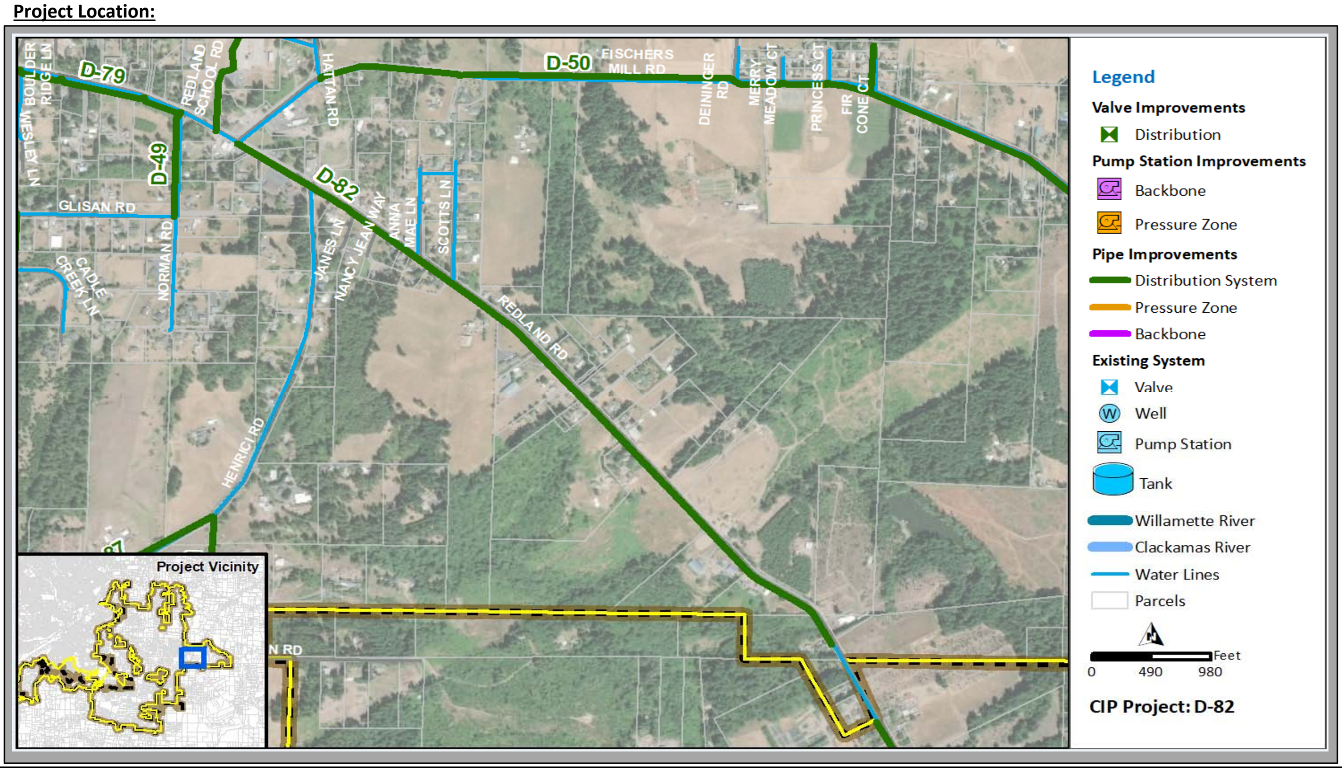
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 732,953
Total Project Cost	100%	$ 732,953

Project Completed? No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 732,953
Total Project Cost			$ 732,953

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-83
Project Name:	S Jason Dr Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe on S Jason Dr from S Henrici Rd north to first hydrant at 20252 S. Jason Dr.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,041	LF	$ 230	$ 239,430	$ 71,829	$ 59,858	$ 47,886.00	$ 419,003
Total Project Cost								$ 419,003

Go to Assumptions Tab

Cost Allocation:

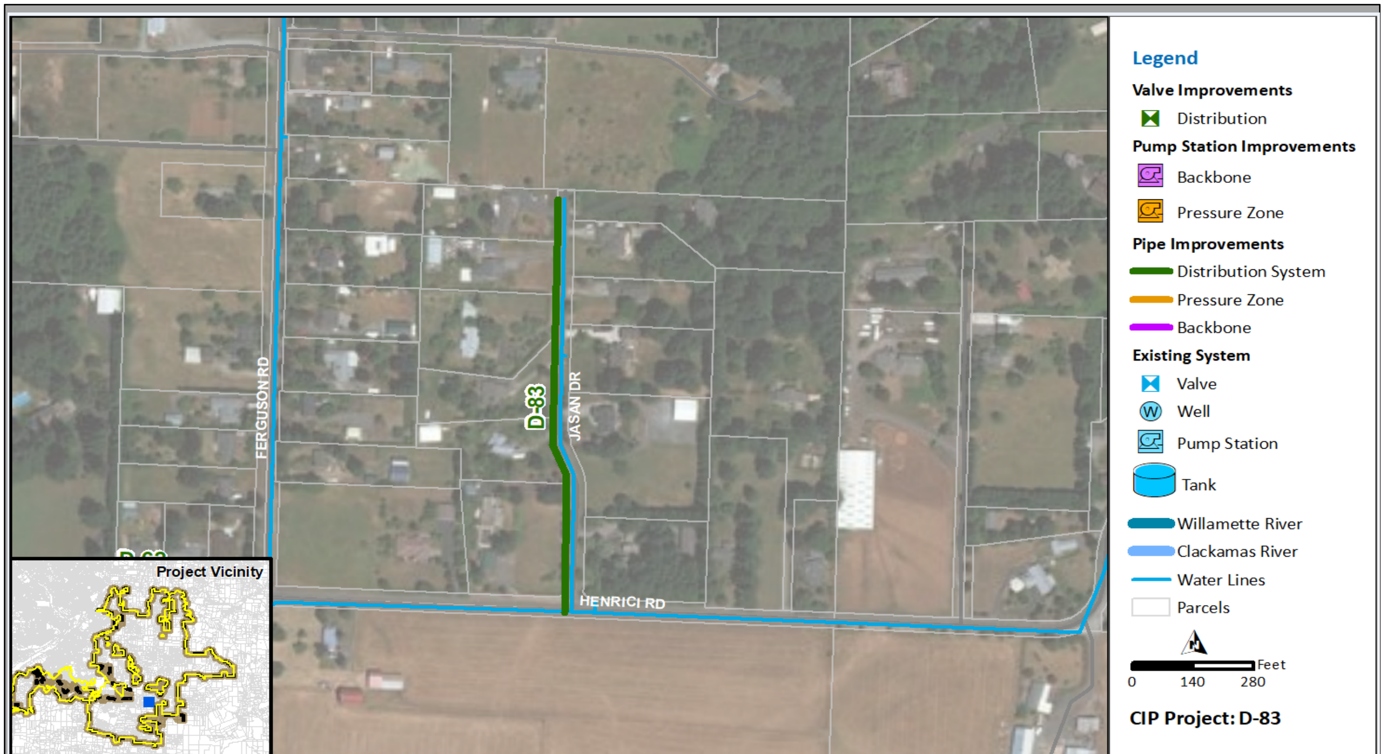
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 419,003
Total Project Cost	100%	$ 419,003

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 419,003
Total Project Cost			$ 419,003

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-84
Project Name:	S Dans Ct Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe on S Dans Ct from S Dales Ave south to end of street.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,656	LF	$ 230	$ 380,880	$ 114,264	$ 95,220	$ 76,176.00	$ 666,540
Total Project Cost								$ 666,540

Go to Assumptions Tab

Cost Allocation:

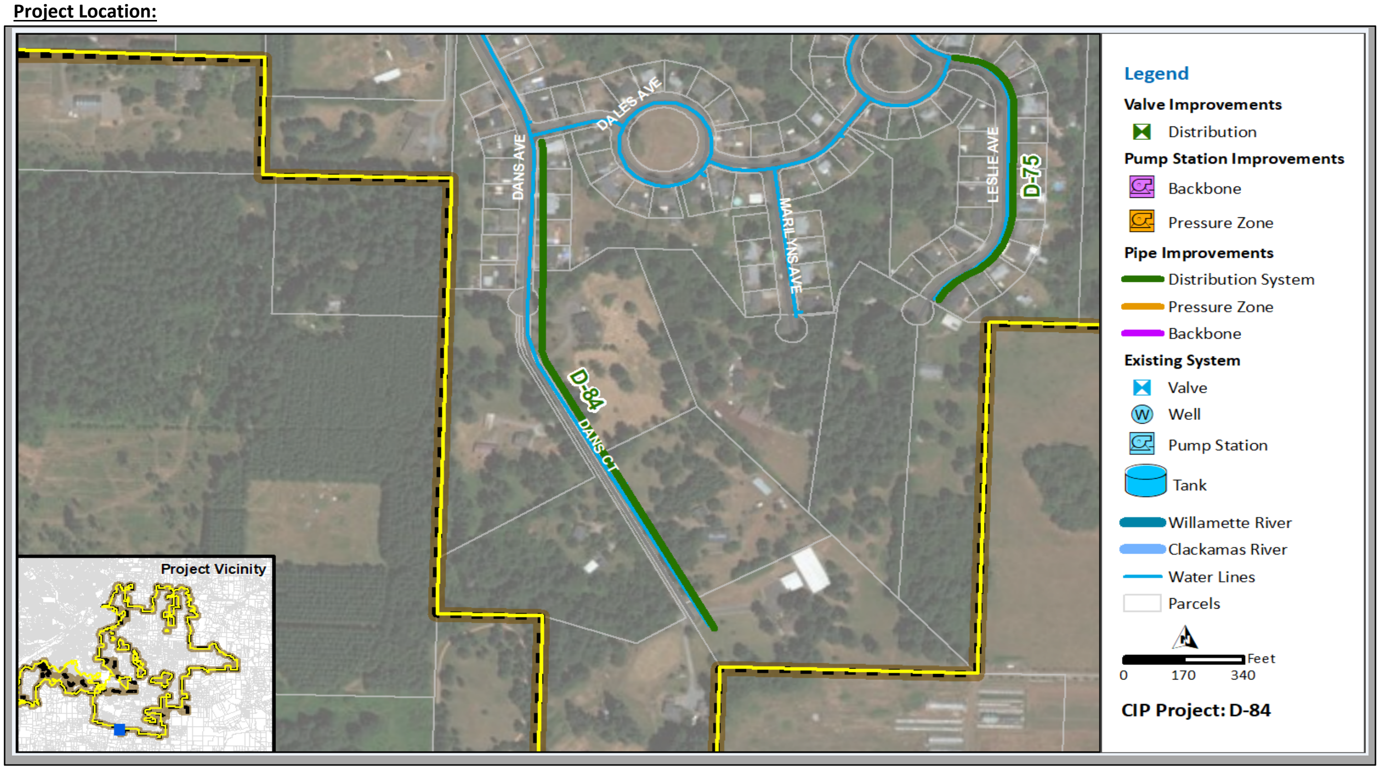
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 666,540
Total Project Cost	100%	$ 666,540

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 666,540
Total Project Cost			$ 666,540

Project Location:



Project ID:	D-85
Project Name:	S Lance Ct Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Beaver Creek

Go to CIP Summary Table

Project Description:

Replace existing 6" pipe with 8" pipe on S Lance Ct from S Leland Rd north to end of street.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,401	LF	$ 230	$ 322,230	$ 96,669	$ 80,558	$ 64,446.00	$ 563,903

Total Project Cost	$ 563,903

Notes on Cost Estimation:

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Cost Allocation:

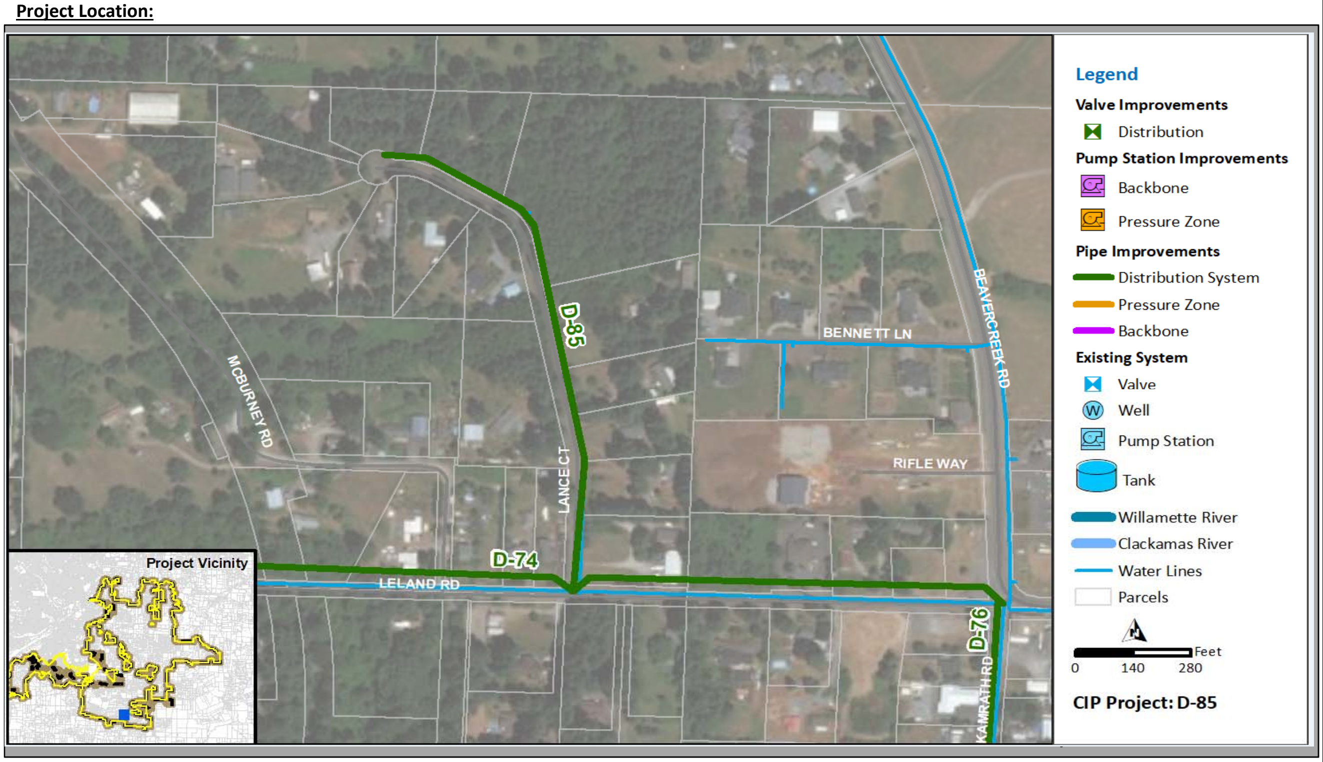
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 563,903
Total Project Cost	100%	$ 563,903

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 563,903
Total Project Cost			$ 563,903

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-86
Project Name: S Copley Ct Pipe Upsize
Facility Type: Pipe
Pressure Zone: Redland

Go to CIP Summary Table

Project Description:
Replace existing 6" pipe with 8" pipe on S Copley Ct from S Ferguson Rd east to end of pipe.
Purpose: Project is required to provide fire flow.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,871	LF	$ 230	$ 430,330	$ 129,099	$ 107,583	$ 86,066.00	$ 753,078
Total Project Cost								$ 753,078

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Cost Allocation:

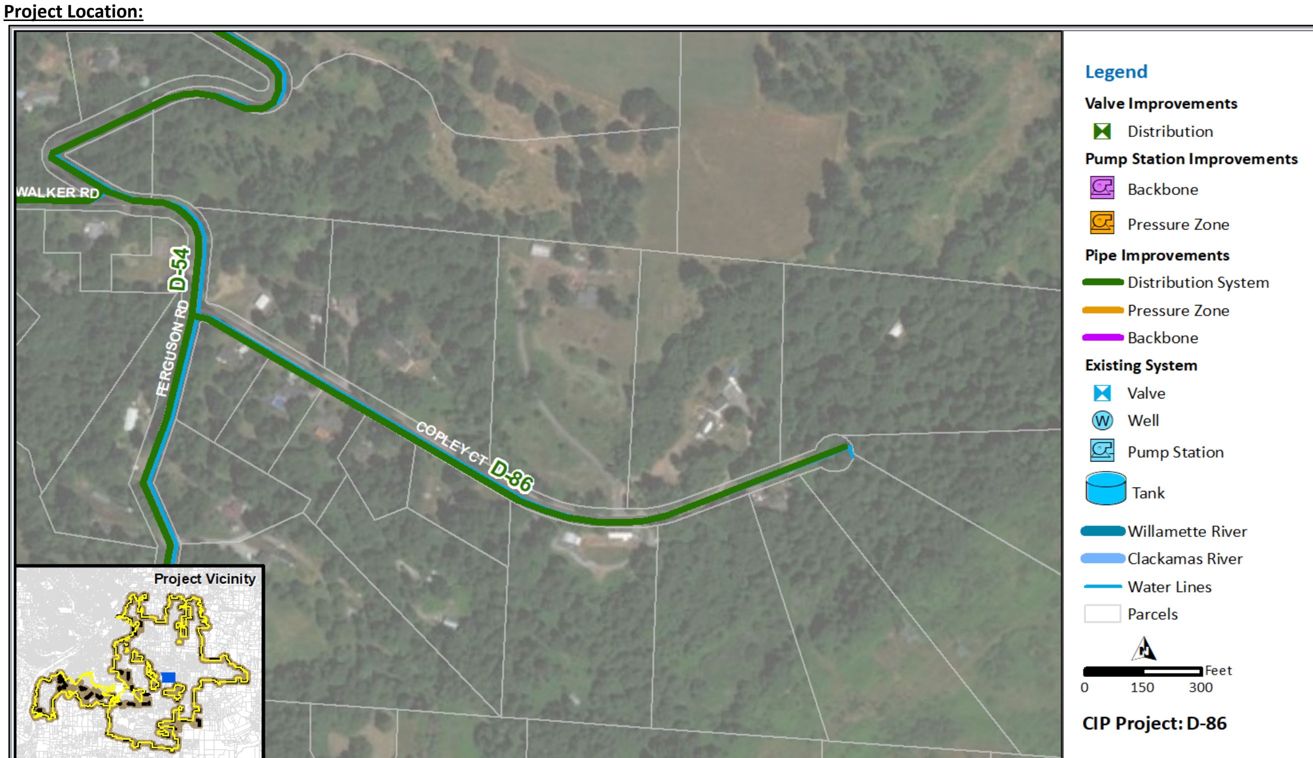
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 753,078
Total Project Cost	100%	$ 753,078

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 753,078
Total Project Cost			$ 753,078

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-87
Project Name:	S Henrici Rd (between Redland Rd and S Bogynski Rd) Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Redland

Go to CIP Summary Table

Project Description:

Replace existing 4" pipe with 8" pipe on S Henrici Rd from intersection with Backbone Phase 2 pipe north to S Dillman Rd.
Purpose:
1. Project is required to provide fire flow
2. Approximately 900 ft of this pipeline was established as part of the seismic system.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	4,256	LF	$ 230	$ 978,880	$ 293,664	$ 244,720	$ 195,776	$ 1,713,040
Total Project Cost								$ 1,713,040

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Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 1,713,040
Total Project Cost	100%	$ 1,713,040
Project Completed?	No	

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 1,713,040
Total Project Cost			$ 1,713,040

Project Location: