ORDINANCE NO. 21-1001

AN ORDINANCE OF THE CITY OF OREGON CITY ADOPTING REVISIONS TO THE WATER MASTER PLAN AS AN ANCILLARY DOCUMENT TO THE COMPREHENSIVE PLAN

WHEREAS, the City provides quality, reliable water to its customers through its water distribution system; and

WHEREAS, the City plans water system improvements as necessary to serve its customers, now and in the future through the development of its Water Master Plan; and

WHEREAS, the City adopted its current Water Master Plan in 2012, providing a 20-year plan for system improvements; and

WHEREAS, the City identified operational challenges not reflected in the current master plan and updated its hydraulic model and system analysis, resulting in an updated list of capital projects; and

WHEREAS, the City seeks to amend its Water Master Plan, to reflect the updates; and

WHEREAS, since that time, the City has been working hard to complete projects identified in the 2012 Plan; and

WHEREAS, with the Amendment to the Water Master Plan, the City will have an updated plan to better operate, maintain, and improve our system over the next 20 years to provide customers with quality and reliable water.

NOW, THEREFORE, OREGON CITY ORDAINS AS FOLLOWS:

Section 1. For the reasons set forth in the Legislative Staff Report findings for file GLUA-19-0-00016 (LEG 19-00002) – Amendments to the Water Master Plan, the City Commission hereby amends the City of Oregon City Comprehensive Plan by adopting the revisions to the 2012 Water Master Plan, attached to this Ordinance as Exhibit A 2012 Water Master Plan Amendment, as an ancillary document.

Section 2. This Ordinance shall take effect 30 days from the date of adoption.

Read for the first time at a regular meeting of the City Commission held on the 20th day of January, and the City Commission finally enacted the foregoing Ordinance this 3rd day of February 2021.

ROCKY SMITH, JR.
Commission President

Attested to this 3rd day of February 2021:

Kattie Riggs, City Recorder

Approved as to legal sufficiency:

City Attorney

Attachments:
Exhibit A – Amendments to the 2012 Water Master Plan

City of Oregon City

2012 Water Distribution System Master Plan Amendment

Revised 1-20-2021

murraysmith

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Introduction

In 2012, the City of Oregon City (City) adopted the *Water Distribution System Master Plan* (2012 WDSMP) prepared by West Yost Associates, an ancillary document to the City's Comprehensive Plan and the Public Facilities Plan for the City's water distribution system as required by Oregon Administrative Rule (OAR) Chapter 660, Division 11, Public Facilities Planning. The 2012 WDSMP includes the Capital Improvement Program (CIP) which consists of a list of prioritized water distribution system projects and estimated costs were based on 2009 dollars. The CIP is a blueprint for forecasting capital expenditures and is one of the most important means of meeting the City's obligation towards community development and financial public facilities planning.

This document is an amendment to the 2012 WDSMP, developed primarily to provide an updated CIP in current dollars for implementation over a 20-year time frame, through 2040. In order to prepare a comprehensive update, elements of the 2012 WDSMP were either retained as the basis for updated analysis, revised and updated to current conditions, or replaced in their entirety. A summary of the relationship between the original Chapters of the 2012 WDSMP and this Amendment is presented below:

2012 WDSMP Chapter	2020 Amendment
1. Introduction	Documents updates presented herein as a supplement to Chapter 1
2. Existing Water Distribution System	Retained as is, limited system modifications have occurred
3. Water Demand Analysis	Replaces this Chapter with current and forecasted demands through the year 2040
4. Water Distribution System Service Standards	Amends specific criteria for service pressures, fire flows, pump stations and storage
5. Hydraulic Model Update	Replaces this Chapter with comprehensive model update and calibration
6. Existing Water Distribution System Evaluation	Replaces this Chapter with updated analysis and findings
7. Future Water Distribution System Evaluation	Replaces this Chapter with updated analysis and findings
8. Recommended Capital Improvement Program	Replaces this Chapter with updated CIP based on new existing and future system evaluation
9. Water Distribution System Financing Plan	Proposed method of funding is not changed, however project list is replaced by the project list in the Amendment

This 2012 WDSMP Amendment has been developed in accordance with Oregon Administrative Rule (OAR) 660-011 which requires that "a city or county shall develop and adopt a public facility plan for areas within an urban growth boundary containing a population greater than 2,500

persons. The purpose of the plan is to help assure that urban development in such urban growth boundaries is guided and supported by types and levels of urban facilities and services appropriate for the needs and requirements of the urban areas to be serviced, and that those facilities and services are provided in a timely, orderly and efficient arrangement…"

Water Distribution Model

A steady-state hydraulic network model was used to evaluate the performance of the distribution system under existing and future demand conditions to identify deficiencies and evaluate adequacy of improvements. The model uses the Innovyze InfoWater software, and the EPANet hydraulic engine, to simulate system pressures and demands throughout the distribution system. The model was most recently updated and calibrated in 2017, as documented in the *Water Distribution Model Calibration Technical Memorandum (*Murraysmith, 2017, Appendix A).

System Supply and Demands

The South Fork Water Board (SFWB) supplies treated water to the City of Oregon City, the Clackamas River Water District (CRW), and the City of West Linn. Until recently, SFWB was the localized sole supply for all three providers. However, West Linn upgraded their connection with Lake Oswego-Tigard to access emergency supply from the Lake Oswego-Tigard Water Treatment Plant, completed in 2017. Additionally, CRW is extending supply from their own treatment through an on-going "Backbone" Project. The diversified supply will decrease the total demand on the SFWB system but will primarily not affect projected demands on the City system, or water wheeled through the City system. Therefore, for this analysis, it was assumed that SFWB would continue to supply all three providers without hydraulic deficiencies.

Currently, the City, West Linn, and CRW share supply via the SFWB 30-inch transmission line and the SFWB Division Street Pump Station, or the SFWB 42-inch transmission line and the City Hunter Avenue Pump Station. The supply system is shown in Figure 1 and described in the bullets below. Included in Appendix B is a hydraulic profile of the complete system. A looped connection between the SFWB 30-inch and 42-inch transmission lines was completed in December 2018 and is not reflected in either the figure or the descriptions. This project serves to bypass a leaking portion of the SFWB 30-inch transmission line near the SFWB Water Treatment Plant (WTP) and does not significantly affect system supply. The planning and modeling for this project are documented in the *Emergency Water Supply Analysis Technical Memorandum* (Murraysmith 2019) included in Appendix C.

- West Linn supply is located downstream of the SFWB Division Street Pump Station, directly off SFWB transmission lines, at Master Meter 3 (MM03). West Linn owns and operates their supply line between MM03 and the West Linn Bolton Reservoir. System demands for West Linn are modeled at the Bolton Reservoir.

- CRW demands are supplied via a master meter directly off SFWB infrastructure (MM02), wheeled through City infrastructure to master meters (MM08, MM09, MM11, MM12,

MM13), and directly off City infrastructure, without an intervening master meter. CRW customers supplied without intervening master meters are considered regular City customers, for the purposes of modeling system demands. CRW customers supplied through City infrastructure and via master meters are included as modeled demands at the meter location. Similarly, CRW customers supplied directly off the SFWB line are represented as a single demand at the location of the master meter.

- The City service area includes all areas within the City's Urban Growth Boundary (UGB) as shown in Figure 1 including 10 pressure zones. The City is supplied through both the SFWB 30-inch transmission line via the SFWB Division Street Pump Station, and through the SFWB 42-inch transmission lines via the Hunter Avenue Pump Station. Currently, CRW serves some areas within the City's UGB, including the Barlow Crest area and portions of the South End. These areas have been discussed in detail between the City and CRW in the *Joint Engineering Study Technical Memorandum* (Murraysmith 2018, Appendix D).

Demand Definition

The following demand conditions were used to evaluate system capacity.

- Average daily demand (ADD) is the total annual water volume used system-wide divided by 365 days per year.
- Maximum day demand (MDD) is the largest 24-hour water volume for a given year. In western Oregon, MDD usually occurs each year between July 1st and September 30th, referred to as the peak season.
- Peak hour demand (PHD) is estimated as the largest hour of demand on the peak use day.
- Fire flow demand is the flow rate required by the fire marshal to fight a fire at each hydrant. Demands are based on building size, material, and use. Fire flow demands are modeled in addition to MDD system demands.
- Equivalent Dwelling Units (EDUs) are used to quantify water demands for all forms of development in terms of typical water demand for single family residential units. Water demand per EDU is calculated as the total water demand for all single-family residential units in the system divided by the total number of single-family residential units.

Demand Summary

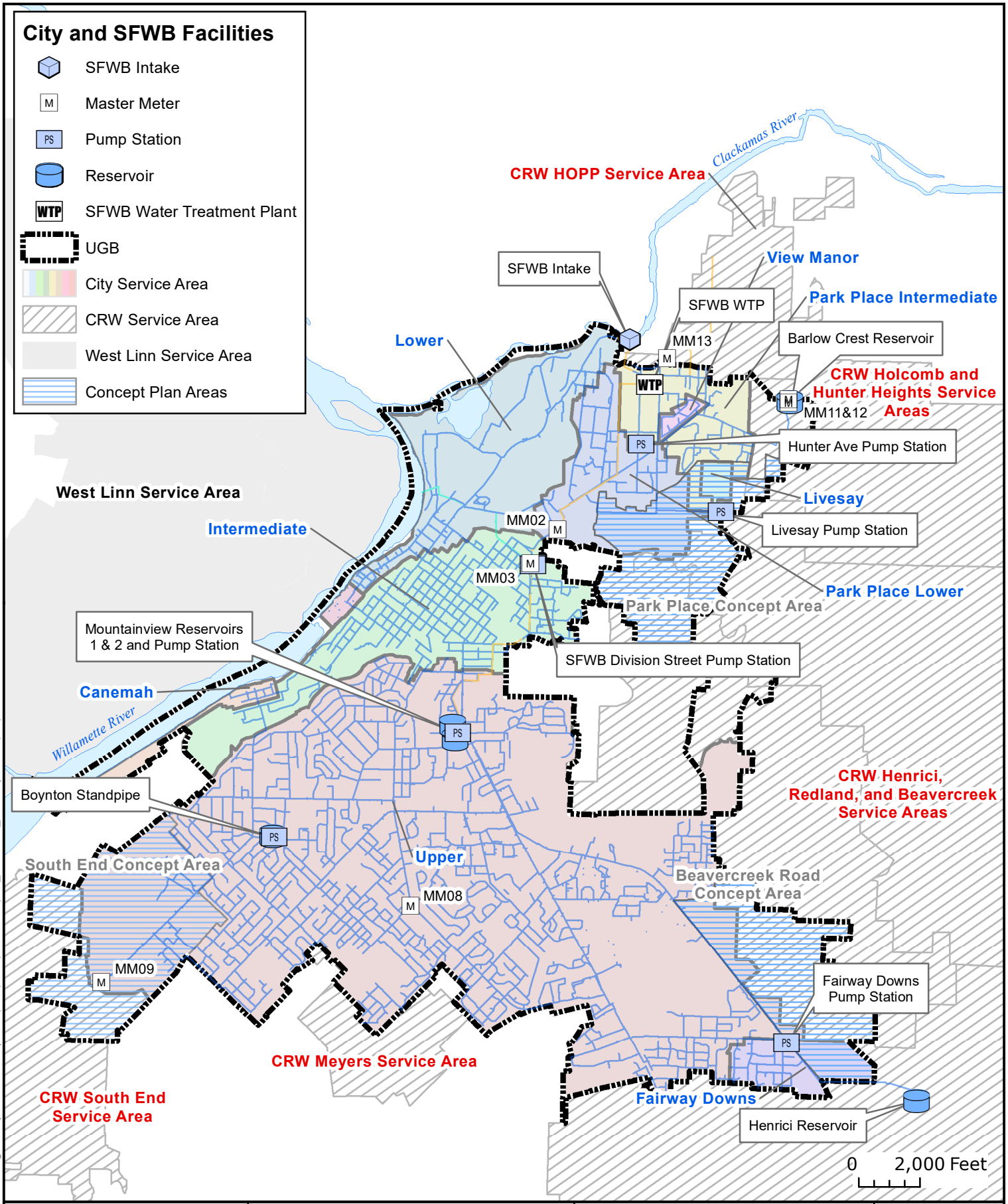
Demand projections were developed for Oregon City pressure zones and relevant master meters from individual water provider projections and are summarized in Tables 1 and 2. Demand projections include existing through the year 2040. The existing condition was approximated as the City's 2015 demands, as these were the most recent data available at the start of the CIP update process, and 2016 demands for West Linn and CRW.

City demands were calculated on a parcel level using Metro and Clackamas County household and employment projections (*Population Forecasts for Clackamas County Service Districts*, EcoNorthwest, 2016). EDUs were developed for each parcel based on residential, commercial, and industrial zoning classifications. Parcels were spatially assigned to the nearest model node within the same pressure zone and demands for each time period were calculated using 2012 WDSMP unit demands of 287 gallons per day per EDU (gpd/EDU). Water demand forecasts assume development occurs within the City's UGB and for the three concept plan areas as illustrated in Figure 1. These include the Park Place Concept Area, the South End Concept Area, and the Beavercreek Road Concept Area.

City MDD and PHD were calculated using peaking factors typical of similar systems in the region. Peaking factors of 2.3 for MDD:ADD and 2.0 for PHD:MDD were used.

CRW demands were distributed to master meter locations based on actual 2016 billing records and projected using a 1.5% per year growth rate, as presented in CRW's *Table 101.B South Storage Capacity Summary (1.5% Growth Forecast)* (CRW 2016, Appendix E).

West Linn demands were projected from actual 2016 billing records and the same 1.5% growth rate as used in CRW demand projections.



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OREGON CITY

City of Oregon City Water CIP Analysis

Figure 1 Study Area

August 2020 17-2119

Table 1
Oregon City ADD/MDD/PHD Existing through Year 2040 Conditions by Pressure Zone

Demand by Zone	ADD (mgd)					MDD (mgd)					PHD (mgd)				
Zone	EXST	2020	2025	2035	2040	EXST	2020	2025	2035	2040	EXST	2020	2025	2035	2040
Lower	0.2	0.3	0.4	0.5	0.6	0.5	0.8	1.0	1.2	1.3	1.0	1.6	1.9	2.4	2.5
Intermediate	0.5	0.5	0.5	0.6	0.6	1.2	1.2	1.2	1.3	1.4	2.3	2.4	2.4	2.6	2.7
Upper	2.3	2.7	2.9	3.4	3.5	5.4	6.2	6.8	7.9	8.2	10.5	12.1	13.3	15.5	16.0
Fairway Downs	0.02	0.03	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.1	0.1	0.1	0.1	0.2	0.2
Park Place Lower	0.2	0.2	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.8	0.9	1.1	1.2
Park Place Intermediate	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.8	0.8
Park Place Livesay	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.02	0.03	0.04	0.00	0.02	0.04	0.06	0.1
Park Place View Manor	0.04	0.04	0.04	0.04	0.05	0.10	0.10	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
Canemah	0.01	0.01	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.03	0.05	0.06	0.06	0.06	0.07
Total	**3.4**	**3.9**	**4.3**	**5.1**	**5.2**	**7.9**	**9.1**	**10.0**	**11.7**	**12.1**	**15.4**	**17.8**	**19.5**	**22.9**	**23.7**

Notes:

1 ADD = average day demand; MDD = maximum day demand; PHD = peak hour demand; mgd = million gallons per day

2 EXST = Existing conditions reflecting 2015 data for the City pressure zone demands.

Table 2
CRW and West Linn Demands

Demand (meter)	ADD (mgd)					MDD (mgd)					PHD (mgd)				
Zone	EXST	2020	2025	2035	2040 to BO	EXST	2020	2025	2035	2040 to BO	EXST	2020	2025	2035	2040 to BO
West Linn Total - MM03	2.9	3.1	3.3	3.9	6.0	7.2	7.8	8.4	9.7	15.2	14.1	15.1	16.3	18.9	29.6
CRW Zones- MM02	1.3	1.4	1.5	1.7	2.6	3.3	3.5	3.8	4.4	6.9	6.4	6.9	7.4	8.6	13.4
Barlow Crest PS - MM12	0.2	0.2	0.3	0.3	0.5	0.7	0.8	0.8	1.0	1.5	1.4	1.5	1.7	1.9	3.0
HOPP Forsythe - MM13	0.02	0.02	0.02	0.02	0.04	0.05	0.05	0.05	0.06	0.10	0.09	0.1	0.1	0.1	0.2
Leland/Meyers - MM08	0.09	0.09	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.6
South End - MM09	0.04	0.04	0.04	0.05	0.07	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.4
CRW Metered Total	1.6	1.8	1.9	2.2	3.4	4.3	4.6	5.0	5.8	9.0	8.3	9.0	9.7	11.2	17.6

Notes:

1 BO = buildout; ADD = average day demand; MDD = maximum day demand; PHD = peak hour demand; mgd = million gallons per day

2 EXST = Existing conditions reflecting 2016 data for the West Linn and CRW demands.

3 Future buildout demands include growth as determined by each water service provider.

Design Criteria

System Pressures

Water systems are constrained by service pressures and pipe velocity. For typical water systems, the acceptable service pressure range under ADD operating conditions is 40 to 100 pounds per square inch (psi). Where mainline pressures exceed 80 psi, services must be equipped with individual pressure reducing valves (PRVs) to protect water heaters per the *Oregon Plumbing Specialty Code (Section 608.2, 2014)*. Many of the City's customers fall within this category. During a fire flow event or emergency, the minimum service pressure is 20 psi as required by *Oregon Health Authority, Drinking Water Program* (OAR 333.061.0050(8)(e)) regulations. Recommended service pressure criteria are summarized in **Table 3**.

Table 3
Recommended Service Pressure Criteria

Service Pressure Criterion	Pressure (psi)
Normal range, during ADD	50-100
Maximum without PRV	80
Minimum, during emergency or fire flow	20

The acceptable flow velocity under MDD conditions is less than 4 feet per second (fps) velocity. The system should also be able to provide fire flow at less than 10 fps. However, velocity criteria are secondary to pressure and fire flow requirements.

Fire Flow Demands

Fire flow demands within the City's system are assigned based on land use type and summarized in **Table 4**. Fire flow requirements are set by the fire marshal and are consistent with tables in **Appendix B** of the *Oregon Fire Code* (OFC, 2014).

Table 4
Required Fire Flow Summary

Land Use Type	Required Fire Flow (gallons per minute)[1]	Required Duration (hours)
Single Family and Duplex Residential <3,600 sq ft	1,000	2
Single Family and Duplex Residential >3,600 sq ft	1,500	2
Medium Density Residential, Neighborhood and Community Service (Commercial)	2,500	2
High Density Residential, Commercial, Industrial, and Institutional	3,000	3

Notes:

1 A minimum service pressure of 20 psi is required at all services throughout the system during all fire flow.

Facility Criteria

Pump stations to zones with gravity storage are required to supply MDD with the largest pump out of service (firm capacity). This standard applies to all pump stations with the exception of the Fairway Downs Pump Station, which currently pumps to a closed zone (no reservoir) and thus is required to provide adequate supply for MDD and fire flow. In the future, the Fairway Downs zone is expected to be served by a new reservoir, eliminating the additional pumping capacity requirements for fire flow.

Reservoirs storage is allocated into multiple components including emergency, fire, equalization, and operational. Emergency storage is based on the amount of risk a system is willing to accept and is intended for supply during a treatment plant outage, or other emergency. A typical volume for emergency storage is two times ADD. Reservoir storage for fire flow demands is required for the maximum combination of fire flow demand and fire flow duration within each pressure zone. For an entirely residential zone, this value is 180,000 gallons (1,500 gpm x 2 hours). Equalization storage is the volume differential between MDD and PHD. Sometimes a value of 0.25xADD is substituted for equalization in place of an exact volume. Finally, operational storage is available to limit pump cycling or to sustain system pressures. This is the volume of water typically cycled throughout the day while supply is off, or the water surface required to sustain minimum pressures within the pressure zone. **Table 5** lists the water system facility criteria used to evaluate the City's system.

Table 5
Water System Facility Criteria

Water Facility Type	Criteria
Pump Station to Gravity Storage	Firm capacity for MDD
Pump Station to Closed Zone	Firm capacity for MDD + fire flow
Reservoir Storage (sum of components)	Emergency = 2xADD Fire flow = maximum fire flow x duration within zone Equalization = 0.25xADD Operational = Based on zone specific HGL or Pump Cycling

System Evaluation

Distribution and Fire Flow Deficiencies

The system was evaluated at existing and future demands, based on the pressure design criteria presented in **Table 3** and the fire flow criteria presented in **Table 4**. The results of both analyses (existing and future) were similar.

Figure 2 highlights areas of high velocity and low pressures under existing MDD. For both existing and year 2040 conditions, low pressures are generally not an issue, although higher velocities can be seen in one of the parallel Molalla Avenue transmission mains near the Mountainview Site.

Figure 3 highlights available fire flow at existing MDD throughout the system. Based on minimum pressure and fire flow criteria, the system performs adequately with fire flow deficiencies generally isolated to small diameter or dead-end pipes. This is true for both existing and future demand scenarios, although these deficiencies are typically more extreme under future system demands.

The results of the existing MDD condition analysis are shown in Figures 2 and 3, as deficiencies visible under the existing condition remain localized to the same areas under future conditions.

The City operates many of its zones at the higher end of pressure recommendations (Figure 2). This places stress on distribution piping and increases risk of water losses. For new developments, distribution piping should be designed within the recommended pressure ranges including redundant PRVs where pressures are in excess of 80 psi. Individual PRVs owned and maintained by the property owner may be required to further reduce local distribution pressure.

City staff have expressed concerns about balancing supply and demand between the Henrici Reservoir and Boynton Standpipe. While filling the Henrici Reservoirs from the Mountainview Pump Station, the system experiences high pressures and increased water losses. Additional transmission capacity is required to improve supply to and from the Henrici Reservoir while maintaining pressures within recommended ranges and is documented in Appendix F, *Molalla Avenue Streetscape Concurrent Waterline Improvements* (Murraysmith, October 2018).

Reservoir Capacity Analysis

Reservoir storage is provided for four purposes: emergency supply, fire flow, equalization, and operations. The total distribution storage requirement is the sum of the components. An evaluation of reservoir storage was performed including a review of each component. Because some zones can be supplied by multiple reservoirs or supplemented by pump station capacity, the following assumptions were developed for the reservoir storage analysis:

- Barlow Crest Reservoir supplies Park Place Intermediate Zone, View Manor, Livesay, and CRW MM13 (Forsythe)
- Mountainview Reservoirs 1 & 2 supply the Lower Zone, Intermediate Zone, and Canemah
- Boynton & Henrici Reservoirs supply Upper Zone, Fairway Downs, CRW MM08 (Leland) and MM09 (South End)
- The Upper Zone storage deficiencies can be supplied by the excess storage in Mountainview Reservoirs 1 & 2 depending on adequate pumping capacity at the Mountainview Pump Station.
- Proposed reservoirs for the Beavercreek Road Concept Area (Fairway Downs Reservoir) and the Park Place Concept Area (Holly Lane Reservoir) were included in the analysis and sized for growth within their respective service areas.

- Many zones can be alternately supplied by either the Barlow Crest or Mountainview Reservoirs via control valves and PRVs which provides system redundancy. For the purposes of this analysis, demands from these zones were only assigned to one of the supplying reservoirs.

- SFWB Water Treatment Clear Well supplies the Park Place Lower Zone. As discussed in the SFWB *Water Master Plan* (2016), the 2 million-gallon (MG) clear well has adequate capacity for storage within the zone.

The reservoir storage analysis is presented in **Table 6**. A negative value in available storage represents the additional storage required.

Table 6
Reservoir Storage Calculations

Reservoir	Existing Storage (MG)	Total Storage Required (MG)					Available Storage (MG)				
		Existing	2020	2025	2035	2040	Existing	2020	2025	2035	2040
Barlow Crest	1.75	0.7	0.7	0.8	0.9	1.0	1.1	1.0	1.0	0.8	0.7
Mountainview	12.5	2.7	3.0	3.2	3.6	3.8	9.8	9.5	9.3	8.9	8.7
Henrici/Boynton[1]	4	6.7	7.7	8.4	9.8	10.5	-2.7	-3.7	-4.4	-5.8	-6.5
Holly Lane	0	na				0.5	na				
Fairway Downs	0	na				1.1	na				

Notes:
1 MG = millions of gallons, na = not applicable
2 Existing condition assumed to be 2015/2016 depending on data source.
3 Storage deficit shown in Henrici/Boynton by 2035 can be provided by the excess storage in the Mountainview Reservoirs, if the Mountainview Pump Station can meet the MDD demands of the Upper Zone and emergency power supply at the station is adequate for operation.

Through the 20-year time frame (2040), all zones have adequate storage. For the Upper and Fairway Downs Zones, this assumes that any storage deficiency is minimized by pumping capacity at the Mountainview Pump Station. For 2040, this results in 6.5 MG of emergency storage for the upper zones located in the Mountainview Reservoirs, which places additional risk on the City. Therefore, an additional 6.5 MG storage is recommended within the Upper Zone beyond the year 2040, the 20-year time frame. A future update of the 2012 WDSMP and this Amendment should include further evaluation of the need for this additional storage.

Pump Station Capacity Analysis

Two types of systems are considered in the pump station analysis. The first is an open system, with at least one reservoir that sets the hydraulic grade for the pressure zone. In an open system, the pump station firm capacity must be equal to or greater than MDD for the pressure zone(s) served by the pump station. The second is a closed system, which is a zone without a reservoir. In a closed

system, the pump station must be able to provide MDD + fire flow with the largest pump out of service.

Only the existing Fairway Downs Pump Station supplies a closed zone. With the development of the upper Beavercreek Road Concept Area, a new reservoir and pump station will be required. An open system will replace the existing closed system, and the reservoir will be sized to supply the fire flow needs of the expanded Fairway Downs Pressure Zone. As previously summarized, storage requirements in the Intermediate Zone and limitations in storage at Henrici/Boynton should be considered in sizing the Fairway Downs Reservoir and associated pump station.

As shown in **Table 7**, all existing pump stations meet system demands for the next 20 years through year 2040. Improvements to the Mountainview Pump Station firm capacity may be required beyond 2040 in conjunction with additional storage in the Upper Zone.

Table 7
Pump Station Capacity Calculations

Pump Station	Firm Capacity (GPM)	MDD (GPM)					Available Pumping Capacity (GPM)				
		Existing[4]	2020	2025	2035	2040	Existing[4]	2020	2025	2035	
Hunter Ave	1,800	800	850	900	1,100	1,250	1,000	950	900	700	550
Mountain-view[1]	8,000	3,900	4,500	4,950	5,800	6,300	4,100	3,500	3,050	2,200	1,700
Fairway Downs[2]	1,050	50	50	50	50	na	0	0	0	0	na
Holly Lane	na	na				100	na				
Fairway Downs[3]	na	na				250	na				

Notes:

GPM = gallons per minute, MDD = maximum day demand, na = not applicable

1 Mountainview Pump Station required to also have emergency power supply for MDD supply operations, as some emergency storage for the Upper Zones is located in the Mountainview Reservoirs.

2, 3 Existing Fairway Downs Pump Station to be decommissioned when development occurs and replaced by new Fairway Downs Pump Station. Existing station pumps to closed zone, therefore pumping capacity required at MDD + fire flow (1,000 gpm). Check valves from Upper Zone also available for fire flow in the zone. Additional fire flow demand not required for new pump station with gravity storage.

4 Existing condition assumed to be 2015/2016 depending on data source.

Figure 2
City of Oregon City
Static Pressure Analysis

SFWB Intake and WTP

Barlow Crest Reservoir and Pump Station

Hunter Ave Pump Station

SFWB Division Street Pump Station

Mountainview Reservoirs 1&2 and Pump Station

Boynton Standpipe

Fairway Downs Pump Station

Henrici Reservoir

PIPE VELOCITY
- < 4 fps
- 4 - 10 fps
- > 10 fps

STATIC PRESSURE
- < 20 psi
- 20 - 40 psi
- 40 - 80 psi
- 80 - 120 psi
- > 120 psi
- CRW MAINS
- UGB

PRESSURE ZONE
- CANEMAH DISTRICT
- FAIRWAY DOWNS
- INTERMEDIATE ZONE
- LOWER ZONE
- PAPER MILL ZONE
- PARK PLACE - INTERMEDIATE
- PARK PLACE - LIVESAY RD
- PARK PLACE - LOWER
- PARK PLACE - VIEW MANOR
- UPPER ZONE

Water Facilities
- SFWB, Intake
- SFWB, WTP
- Master Meter
- SFWB, Pump Station
- CRW, Pump Station
- CRW, Reservoir
- OC, Pump Station
- OC, Reservoir
- OC, PRV

Note: Figure shows existing MDD conditions of 8.44MGD. Buildout MDD demands did not significantly impact results therefore, this figure is representative of existing and buildout conditions.

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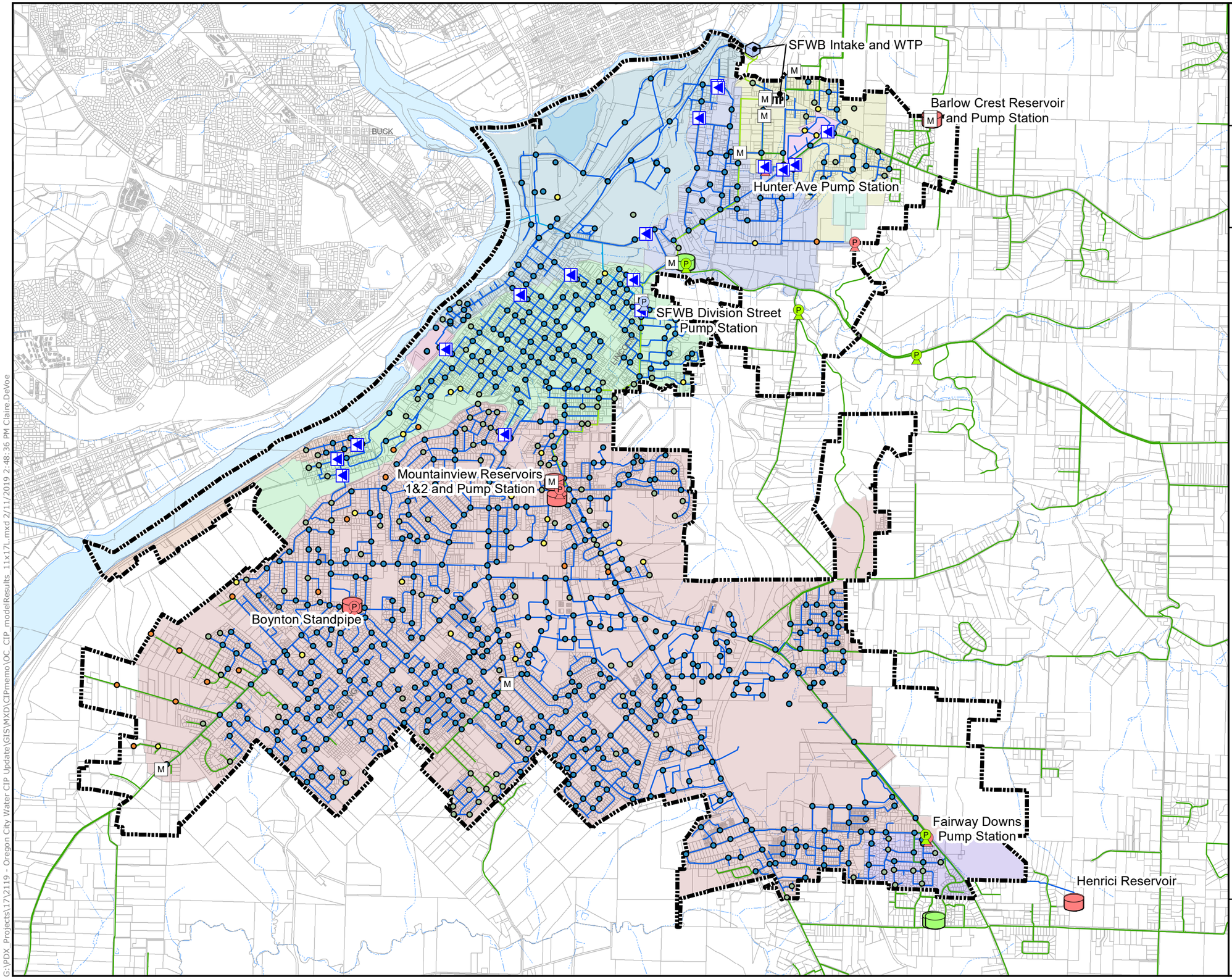

Figure 3
City of Oregon City
Available Fireflow

AVAILABLE FIREFLOW
- 0
- <1000
- 1000 - 1500
- 1500 - 3000
- >3000

WATER MAINS
- OREGON CITY
- SFWB
- WEST LINN
- CRW
- UGB

PRESSURE ZONE
- CANEMAH DISTRICT
- FAIRWAY DOWNS
- INTERMEDIATE ZONE
- LOWER ZONE
- PAPER MILL ZONE
- PARK PLACE - INTERMEDIATE
- PARK PLACE - LIVESAY RD
- PARK PLACE - LOWER
- PARK PLACE - VIEW MANOR
- UPPER ZONE

Water Facilities
- SFWB, Intake
- SFWB, WTP
- Master Meter
- SFWB, Pump Station
- CRW, Pump Station
- CRW, Reservoir
- OC, Pump Station
- OC, Reservoir
- OC, PRV

Note: Figure shows existing MDD conditions of 8.44MGD. Buildout MDD demands did not significantly impact results therefore, this figure is representative of existing and buildout conditions.

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August 2020 17-2119

Capital Improvement Program

Capital projects were developed based on deficiencies identified in the system evaluation and future year 2040 system demands including new growth areas. The Capital Improvement Program (CIP) is divided into three types of improvement projects: "Capacity and Operations," "Development and Growth," and "Repair and Replacement." Descriptions of these categories are defined below and further summarized in Table 8.

- Capacity and Operations - Projects are typically those to meet existing system demands, reservoir turnover, or to meet the needs of areas within the system that will require upsizing to provide for in-fill growth. Dead-end pipes with fire flow limitations where at least 500 gpm of fire flow is available were excluded from the capacity improvements.

- Development and Growth - Projects differ in that they are specifically targeted at new large development areas and are typically not required to supply existing demands.

- Repair and Replacement - Projects include both routine repair and replacement of pipes, pump replacement, reservoir maintenance, and PRV repair/replacement.

Table 8
Capital Improvement Program Projects

Improvement Type	Improvement Addresses:	Timing Trigger
Capacity and Operations	Capacity limitations and system operations	Mitigate projected deficiencies
Development and Growth	New development areas	Developer driven
Repair and Replacement	Routine maintenance on infrastructure and annual pipe replacement	Annual and cyclical investments based on infrastructure life cycle

Cost Assumptions

All project descriptions and cost estimates are consistent with Class 5 budget estimates, as established by the *American Association of Cost Engineers* (AACE). This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +30 to +100 percent on the high end. The cost estimates are consistent with the definition of OAR 660-011-0005(2) and OAR 660-011-035. Cost estimates are intended to be used as guidance in establishing funding requirements at the project planning level based on information available at the time of the estimate. Estimates exclude land acquisition, financing, inflation, and operations. Costs were developed in 2018 dollars with markups for contractor profits, overhead, engineering, and construction contingency. Since construction costs change periodically, an indexing method to adjust present estimates in the future is useful. The Engineering News-Record (ENR)

Construction Cost Index (CCI) is a commonly used index for this purpose. For purposes of future cost estimate updating; the August 2018 ENR CCI (20-city average) is 11124.

Joint Work with CRW and Neighboring Provider Upgrades

The City participates in joint infrastructure planning and supply discussions with regional water suppliers and distributers such as SFWB, CRW, Lake Oswego, and West Linn. Neighboring communities have recognized the benefits of collaborative planning and have worked together through Intergovernmental Agreements (IGAs) and joint projects like the South End supply line and Barlow Crest supply, to provide water to regional customers. This collaboration encourages purveyors to invest in essential facilities, without building redundant infrastructure. As communities develop, this collaboration will continue to be important to efficiently serve all customers. In addition, an increased focus on system interties has improved regional resiliency, in the event of a major failure at one or more of the water treatment plants within the region. Recent and anticipated system intertie investments include:

- CRW's Backbone Project to extend CRW WTP supply to CRW zones south of the Clackamas River.
- Continued operation and maintenance of City/CRW and SFWB/CRW interties.
- Operation and maintenance of the West Linn-Lake Oswego emergency connection booster station. This provides West Linn an alternate supply from the newly completed Lake Oswego–Tigard WTP upgrades, and improves regional resiliency through interconnections.

Improvements identified in the City CIP exclude analysis of alternatives related to major regional projects such as the CRW Backbone Project. The City will continue to explore opportunities for collaboration with neighboring providers at which time some of the City capital projects may be modified to account for a broader regional supply and/or distribution solution.

Improvement Descriptions

Capacity and Operations Projects

Capacity and operations projects were identified through model evaluations, discussions with City staff, and pump station/reservoir capacity reviews. These improvements are summarized for both the City and SFWB, although only the City improvements are included in the CIP.

SFWB Improvements

SFWB improvements identified in the *SFWB Water Master Plan* (CH2M and MWH, 2016) are required to maintain system operations, expand capacity, and address redundancy. These projects address limited capacity in the 30-inch SFWB supply line which causes operational difficulties at the Division Street Pump Station, and eventual capacity limitations in the rest of the SFWB system. A 42-inch connection on Cleveland St between the 30-inch and 42-inch SFWB supply lines

(referenced earlier in *System Supply and Demands*) was completed recently in December 2018. Key SFWB transmission improvements include:

- Increased transmission capacity between the WTP and the Mountainview Pump Station (upsizing the existing 30-inch line)
- Increased capacity at the Division Street Pump Station

Henrici Reservoir Operations

Based on existing transmission capacity, the City has difficulties keeping the Henrici Reservoir filled and the Boynton Standpipe from overflowing. Both reservoirs provide storage for the Upper Zone and are simultaneously filled by the Mountainview Pump Station. The Boynton Standpipe is centrally located while the Henrici Reservoir is located beyond the perimeter of the Upper Zone to the southeast. When the Mountainview Pump Station output is increased to fill the Henrici Reservoir, high pressure issues are seen near the pump station. This is especially problematic in summer months when the pump station must operate at a higher flow rate to keep up with Upper Zone demands.

Project constraints and opportunities include:

- Existing transmission main(s) in heavily trafficked Beavercreek Road
- Secondary transmission route(s) in backyards and other difficult to access locations
- Concurrent streetscape improvement project along Molalla Avenue
- Additional transmission and distribution requirements for growth including the expanded Fairway Downs Zone

After evaluating alternatives, a parallel transmission route was identified along Molalla Avenue, and a new transmission line was identified between Glen Oak Road and the Henrici Reservoir. The combined improvements provide additional capacity and improved transmission to and from the Henrici Reservoir. The projects will likely be constructed in multiple phases with the Molalla Avenue portion of the project constructed first to align with the streetscaping work. Both improvements are required to provide the full operational benefits. Table 9 presents a flow split analysis between Boynton and Henrici Reservoirs under existing ADD. Without improvements, approximately 67% of the available excess flow from the Mountain View Pump Station is conveyed to the Boynton Standpipe and 33% is conveyed to Henrici. With all improvements, the flow split is approximately 50% between the reservoirs.

Table 9
Reservoir Filling Rates - Mountainview to Henrici Transmission Upsizing

Scenario	Boynton Standpipe (gpm)[1]	Henrici Reservoir (gpm)[1]
No Improvements	4,200	2,100
Parallel Main on Molalla Ave	4,200	2,500
Upsize Beavercreek Transmission from Glen Oak Road to Henrici Reservoir	3,600	2,900
Both improvements: Parallel Main on Molalla Ave and Upsize Beavercreek Transmission	3,500	3,500

Note:
1 Filling rates during existing ADD, 2 pumps on at Mountainview Pump Station, reservoirs at low set points.

Development and Growth Projects

Development improvements were identified through a variety of means including discussions with the City and reviewing existing concept plans. Most projects include only the main line infrastructure required to serve the development areas, and do not include full distribution piping. Pipe layouts were based on either proposed street networks or additional studies, if available. Unless otherwise noted, development areas can be served by extending existing transmission and distribution piping.

Park Place Development

The Park Place Concept Area is located east of Oregon City and Highway 213, north and south along S Redland Road, and east and west along S Holly Lane. Portions of the area are currently served by CRW and development is described in the *Park Place Concept Plan* (2008). Proposed improvements for the area include pipe looping into the existing City system at the Park Place Intermediate and the Park Place Lower zones, a new 1.0MG reservoir and pump station, and intermediate PRV's.

Joint transmission along S Redland Road to CRW's Holly Lane and Redland Pump Stations has been discussed between the City and CRW. This is advantageous to both providers as it limits unnecessary parallel infrastructure, provides emergency connections between both systems and provides a secondary supply to the City via CRW.

Details of the pressure zone delineation for the Park Place Concept Area are presented in Table 10.

Table 10
Park Place Concept Area Supply

Location	Ground Elevation (ft)	HGL (ft)	Supply	Storage
East of Trail View Dr	>400	794	CRW via Barlow Crest PS	CRW Hunter Heights Reservoir
North of S Redland Rd	>310	549	New transmission piping from Park Place Intermediate	Barlow Crest Reservoir
North of S Redland Rd	200-310	430	PRV'd from Park Place Intermediate	Barlow Crest Reservoir
Along S Redland Rd	40-200	320	Master Meter from SFWB supply at Redland Rd and Anchor Way	SFWB WTP Clearwell
South of S Redland Rd	>200	350	New Park Place PS	New Holly Lane Reservoir

Beavercreek Road Development

The Beavercreek Road Concept Area is located within the existing UGB, northeast of Beavercreek Road. The area will require service to the City's Upper and Fairway Downs Zone pressure zones. The City and CRW have discussed service in this area extensively in the *Joint Engineering Study Technical Memorandum* (Appendix D) and the prior meetings leading up to that document. Various alternatives were explored, including joint construction of a reservoir to serve both CRW and the Fairway Downs Zone. City staff reviewed the alternative approaches with the City Commission and confirmed the City's desire to pursue development of City-owned infrastructure, independent of CRW, to serve the Beavercreek Road Concept Area within the UGB. The capital improvements presented in this 2012 WDSMP Amendment reflect this direction.

Pipe networks were based approximately on planned street alignments, as presented in the *Beavercreek Road Concept Plan* (Otak 2008). The Fairway Downs Zone is expected to serve areas above 480-feet elevation, within the UGB at a pressure zone hydraulic gradeline of 650-feet. Pumps will be sized to meet MDD demands, with additional peak hour or fire flow supply available from the new 1.75 MG reservoir.

Repair and Replacement Projects

Significant investment in infrastructure repair and replacement will be required as infrastructure reaches the end of its useful life. A Repair and Replacement Program is intended to apply proactive investment for reservoir coatings, PRV repair/replacement, pump station mechanical/electrical replacement, and pipeline repair/replacement. The program priorities are established based on

condition assessments with funding established based on standard life spans for facility types as shown in Table 11.

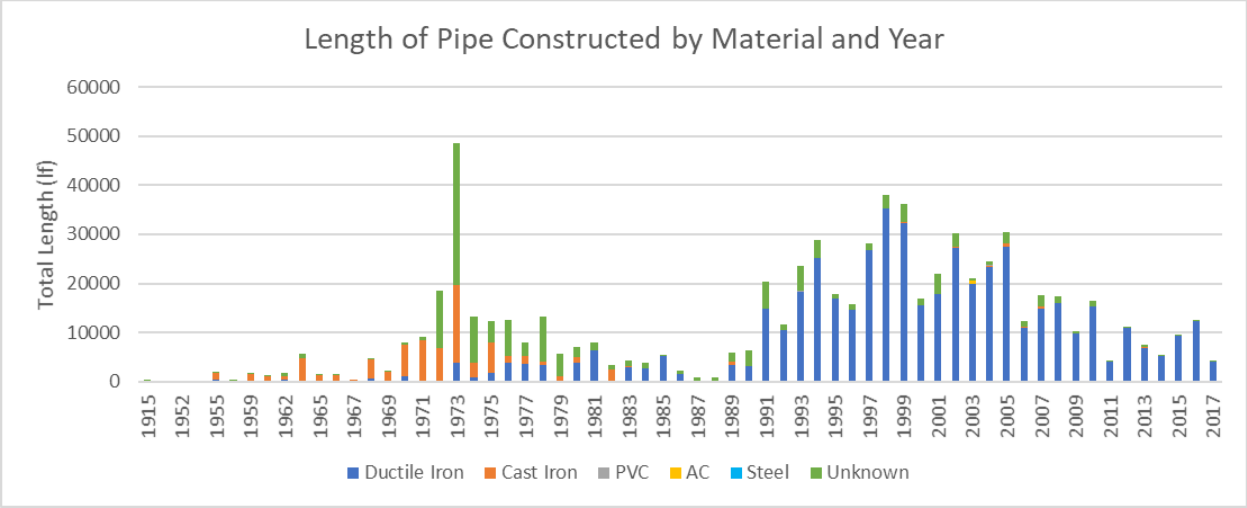
Table 11
Repair and Replacement Summary

Facility	Work Required	Frequency
Pipeline	Repair or Replacement	75 years
PRV	Inspection	Annual
	Major Rehabilitation and Rebuild	5 years
	Replacement	25 years
Reservoir – Steel	Exterior Overcoat	15 years
	Interior Removal and Recoat	30 years
	Exterior Removal and Recoat	30 years
Reservoir – Concrete	Minor Touch Up Rehabilitation	Annual
	Major Rehabilitation and Repairs	25 years
Pump Station - Mountainview	Pump, Mechanical & Electrical Replacements	10 years
Pump Station – Hunter Ave	Pump, Mechanical & Electrical Replacements	20 years
Pump Stations - Other	Pump, Mechanical & Electrical Replacements	20 years

Pipe Replacement

An evaluation was performed to identify the length of pipeline reaching the end of its useful life within the year 2035, 20-year planning horizon. An age distribution for piping was extracted from the City GIS and is presented in Figure 4. Pipe installations older than 75-years or with known leakage issues were identified for the 20-year planning horizon. This amounts to 90,000 linear-feet of pipe or approximately 4,500 linear-feet of pipe per year over 20-years as shown in Table 12. Specific pipe segments were identified for the 0 to 5-year time frame by City staff based on the known condition and leak issues. These include pipelines located along Main Street between 10th Street and 15th Street, between the Mountainview Reservoirs and Gaffney Lane to the south, crossing I-205 near the intersection of Agnes Avenue and Main Street, and those listed in the CIP Table 17 as an "Oregon City Operations – Small Waterline Replacement" project. Specific information on small water projects are also summarized in Appendix G.

Figure 4
Pipe Distribution by Age and Material



Note:

1 Approximately 18 percent of pipe has unknown installation date, not shown in **Figure 4**. The pipe construction material is approximately evenly split between Ductile Iron, Cast Iron, and Unknown. Installation dates were assumed evenly distributed over 50 years between 1943 and 1993.

Table 12
Pipe Replacement Projects

Timeframe	Length of Pipe for Repair and Replacement (linear-feet) [1]	Location Description
0 – 5 Years	29,000	Including but not limited to: - Main Street between 10th Street and 15th Street - Between Mountainview Reservoir and Gaffney Lane - I-205 crossing near Agnes Avenue and Main Street - OC Operations, Small Waterline Replacement Projects
6 – 10 Years	17,000	3,500 linear-feet per year based on pipe condition assessments
11 – 20 Years	43,000	4,500 linear-feet per year based on pipe condition assessments
TOTAL	**89,000**	

Notes:

1 Approximately 18-percent of pipe has unknown installation date. Assumed replacement of those pipes to be evenly distributed over 50 years.

Pressure Reducing Valve Station Rehabilitation, Repair, and Recommended Settings

Pressure Reducing Valve (PRV) stations are vital for supply to zones without gravity storage. The PRVs should be inspected and maintained annually with major rehabilitation scheduled every 5 years, and replacement scheduled every 25 years. **Table 13.1** lists the approximate condition and year slated for rehabilitation for the PRV stations throughout the system.

Table 13.1
Pressure Reducing Valve Rehabilitation Schedule

Pressure-Reducing Valve Station	Installation Year	Condition	Notes	Expected Rehabilitation and Rebuild (scheduled every 5 years)	Expected Replacement (scheduled every 25 years)
11th St & Washington St	1993	Fair / Dirty	Cleaning required	2021/2022	2026/2027
15th St & Madison St	2016	New		2021/2022	2041/2042
16th St & Division St	1971	Bad	Used to buffer intermediate zone from high pressures caused by the Division Street Pump Station. Small diameter valve inoperable.	Needs Replacement	2019/2020
18th St & Anchor Way	1992	Bad/Fair		Needs Replacement	2019/2020
3rd St & Bluff	2018	New		2023/2024	2043/2044
4th Ave & Jerome St	1958	Bad	Redundant to 3rd & Ganong, for high demand both PRVs required	Needs Replacement	2019/2020
5th Ave & Canemah	1958	Bad	Required to adequately supply Canemah Zone	Needs Replacement	2019/2020 and add power
99E & Main St	1997	Out of service	Abandon and remove the 99E and Main PRV Station, replace with pipe connection between the Paper Mill Zone and Lower Zone that results in eliminating the Paper Mill Zone and expands the Lower Zone (Appendix H)	NA	NA
Abernethy Rd & Redland Rd	1963	Bad	Required based on location and distance from redundant PRVs	Needs Replacement	2019/2020
Apperson Blvd & La Rae Rd	1999	Fair		2022/2023	2027/2028

Pressure-Reducing Valve Station	Installation Year	Condition	Notes	Expected Rehabilitation and Rebuild (scheduled every 5 years)	Expected Replacement (scheduled every 25 years)
Harley Ave & Forsythe Rd (North)	1988	Fair	Remove South PRV, reconfigure piping as needed for continued operation of North PRV. Relief valve settings need updating. Individual Customer PRV's required on service lines as needed for service pressures exceeding 70psi per City Standard.		2021/2022
Harley Ave & Forsythe Rd (South)	1973	Bad	Remove South PRV and coordinate project with improvements to North PRV as noted above.	Removal 2021/2022	Removal 2021/2022
Jennifer Estates	2002	Fair	Ground settling around vault.	2022/2023	2027/2028
Swan Ave & Holcomb Blvd	1999	Fair		2022/2023	2027/2028
View Manor	1999	Fair	Remove PRV with property redevelopment. Existing piping in poor condition – PRV settings updated to minimize pressure impacts on the local pipe.	Maintain until PRV removal with property redevelopment	Removal with redevelopment
3rd Ave & Ganong St	2008	Good		2028/2029	2033/2034
Hunter Ave Pump Station	1998	Good		2022/2023	2027/2028
East St & Maple St	2015	Good		2021/2022	2040/2041

Table 13.2 lists the valve diameters and settings for existing City PRVs. Photo documentation of PRV stations by the City is included in Appendix G. Additional analysis for redevelopment of the Paper Mill Zone and related PRV stations is provided in Appendix H, *Mill Redevelopment Water Distribution Analysis* (Murraysmith, 2018).

Table 13.2
Pressure Reducing Valve Recommended Settings

Pressure Reducing Valve Station	Valve 1 Size	Valve 2 Size	Valve 3 Size	Valve 1 Setting	Valve 2 Setting	Valve 3 Setting
11th St & Washington St[1]	3	10		67	58	
15th St & Madison St[1]	2	6		61	56	
16th St & Division St	1.252	6		na	100	
18th St & Anchor Way	4	8		53	48	
3rd St & Bluff[1]	3	8		42	39	
4th Ave & Jerome St	2	6		55	50	
5th Ave & Canemah	1.25	4		83	78	
99E & Main St			To be removed			
Abernethy Rd & Redland Rd[1]	4	8		102	97	
Apperson Blvd & La Rae Rd[1]	2	4	6	84	79	77
Harley Ave & Forsythe Rd (North)[1]	12			61		
Harley Ave & Forsythe Rd (South)			To be removed			
Jennifer Estates	4	8		51	46	
Swan Ave & Holcomb Blvd	4	8		65	55	
View Manor	4	8		40	35	
3rd Ave & Ganong St	2	6		79	79	
Hunter Ave Pump Station	3	6		45	51	
East St & Maple St	6			46		

Notes:
Updated PRV settings recommended in the *Mill Redevelopment Technical Memorandum* (Murraysmith, 2018) (Appendix H).
Valve is not currently functioning.

Facility Rehabilitation and Repair

The lifespan of system reservoirs and pump stations can be significantly increased if regular rehabilitation and repairs are made. It is recommended that regular maintenance on Oregon City's steel tanks (Barlow Crest, Boynton, and Henrici) include periodic exterior overcoats, and less frequent complete exterior and interior removal and recoat. Regular maintenance on the concrete tanks (Mountainview 1 & 2) is recommended to include frequent touch up and rehabilitation, and major repairs when needed. Costs for this rehabilitation are dependent on facility condition, age, material, and size. Table 14 includes an approximate schedule for rehabilitation of existing reservoirs. Table 15 includes an approximate schedule for safety and seismic upgrades, and suggested improvements. When new reservoirs are constructed, they will need to be added to the rehabilitation schedule.

Pump stations require annual inspection and maintenance with pump, mechanical, and electrical replacement generally every 20 years, with the exception being Mountainview pump station replacement schedule every 10 years. Costs for pump replacement depend on pump size and condition. **Table 16** includes an approximate schedule for pump station improvements.

Table 14
Reservoir Coating and Rehabilitation Schedule

Facility		Concrete	Steel		
Name	Construction/ Rehab Year	Major Repairs	Exterior Overcoat	Interior Removal and Recoat	Exterior Removal and Recoat
Barlow Crest	1999	-	2024	2024	2039
Mountainview 1	2007	2032	-	-	-
Mountainview 2	1952/2007[1]	2032	-	-	-
Boynton	1984	-	-	-	2028
Henrici	1994	-	2019/2020	2019/2020	2035

Notes:
1 Mountainview 2 built in 1916 and expanded in 1952, underwent seismic upgrades and rehabilitation in 2007.
2 Limited redundancy for Barlow Crest Reservoir means it is difficult to take offline. Coordination with CRW to PRV water from Hunter Heights
3 Biannual minor repairs for Concrete tanks, annual exterior touch-up for steel tanks. Assumed within O&M budget, separate from CIP budget.

Table 15
Reservoir Seismic and Safety Improvements

Facility	Seismic Analysis/Seismic Upgrades	Safety Upgrades
Barlow Crest	2019/2020	2024
Mountainview 1	-	-
Mountainview 2	-	2020
Boynton	2022/2023	-
Henrici	2019/2020	2019/2020

Table 16
Pump Station Rehabilitation and Maintenance Schedule

Pump Station	Pump Install Year	Replacement Year	Pump, Mechanical, and Electrical Rehab or Replacement
Hunter Ave	1999	2019/ 2022	Drives, PLC/ Pumps, SCADA electrical, transfer switch generator
Mountainview	2018	2023/ 2028	Drives/ Pumps, SCADA electrical
Fairway Downs	2018	NA	Pump station to be removed with Beavercreek Road Concept Area Development
Boynton	1984	Removal Project 2022	Remove pumps (non-operational), decommission pump station
Livesay	2012	NA	Decommission pump station when Park Place Concept Area Develops

Capital Improvement Program Summary

The capital projects are described in **Table 17,** "Capital Improvement Program" including project descriptions, priorities, and Class 5 costs estimates. Projects are illustrated in **Figure 5**. A summary of total CIP costs is presented in **Table 18**.

Table 17
Capital Improvement Program

Improvement Category	Project Type	MAP ID	Timeframe	Facility Type	Description	Length (lf)	Dia (in)	Capacity	SDC Eligible	Cost Estimate[1]
Central Point	Development	1	Project recently completed by development	Pipe	New 8” looped distribution pipe along Skellenger/Orchard Grove area		8			Developer-constructed project
Leland McCord	Development	2	2-5	Pipe	New transmission along Leland Rd	1300	12		100%	$370,000
	Development	3	2-5	Pipe	New distribution along McCord Rd	2,400	12		100%	$681,500
	Operations (City/CRW)	4	2-5	Master Meter	Move the Master Meter, MM08, to the UGB and update CRW connection, timing based on development				0%	$200,000
South End	Development	5	15-20	Pipe	New distribution within development - backbone only	19,000	12		100%	$5,394,500
	Operations (City/CRW)	6	15-20	Master Meter	Move the Master Meter, MM09, to the UGB and update CRW connection, timing based on development				0%	$200,000
Upper Zone	Development	7	2-5	Pipe	New distribution loop North of Beavercreek and South of Hilltop	2,200	12		100%	$624,500
	Capacity	8	5-10	Pipe	Finish looping along Maplelane Road to increase transmission to existing area	1,600	12		26.89%	$454,500
	Pipe Replacement	34	0-5	Pipe	Replace aging 16" piping near Molalla Ave (replacement size may be 12-inch or smaller if MAP ID 22 is implemented prior to MAP ID 34)	8,800	12 to 16-inch		26.89%	$2,498,500
	Operations	37	0-5	PRV	New PRV on Newell Ct to manage high pressures				26.89%	$200,000
Lower Zone	Capacity	9	0-5	Pipe	Upsize existing I-205 crossing to improve fire flow and distribution looping	700	12		26.89%	$199,500
	Capacity	35	5-10	Pipe	Upsize existing piping on Abernethy Road for fire flow supply to Lower Zone	2,600	12		100%	$738,000
	Pipe Replacement	36	0-5	Pipe	Replace aging pipe on Main between 10th and 15th	1,400	12			$397,500
Park Place Concept Area	Development	10	0-5	Pipe	Joint OC/CRW transmission from SFWB along Redland Rd for replacement of aging pipe and new transmission to Park Place Concept Area	6,900	24		100%	$3,538,000
	Development	11	2-5	Pipe	Transmission at the Park Place Intermediate Level (above 310')	1,300	12		100%	$370,000
	Development	12	2-5	Pipe	Transmission from the 16" Barlow Crest Transmission to PP Int Concept (above 310') - redundant transmission and adequate fire flow above 200'	2,600	12		100%	$738,000
	Development	13	2-5	PRV	New PRV from 550' to 430' (supply to area between 200' and 310'). Note: Livesay Pump Station shall be removed with redevelopment of this area along S Livesay Rd				100%	$200,000
	Development	14	4-6	Pipe	New 430' distribution piping (supply to area between 200' and 310')	1,700	12		100%	$483,500
	Development	15	5-10	PRV	New PRV from 430' to 320' (alternate emergency supply and fire flow to PP Concept Area)				100%	$200,000
	Development	16	5-10	Pipe	New 320' distribution piping (supply to area below 200')	6,200	12		100%	$1,760,500
	Development	17	5-10	Pipe	Replace existing 320' distribution piping (supply to area below 200')	2,100	12		100%	$597,000
	Development	18	15-20	Reservoir	New 350' Reservoir (supply to area above 110')			1MG	100%	$2,000,000
	Development	19	15-20	Pump Station	New Pump Station from 320' to 350' (supply to area above 110')			100 GPM	100%	$1,194,000
	Development	20	15-20	PRV	New PRV from 350' to 320' (emergency fire flow to PP Concept Area from new reservoir)				100%	$200,000
	Development	21	15-20	Pipe	New 350' transmission and distribution (supply above 350' and transmission to new Holly Lane PS)	10,000	12		100%	$2,839,000

Improvement Category	Project Type	MAP ID	Timeframe	Facility Type	Description	Length (lf)	Dia (in)	Capacity	SDC Eligible	Cost Estimate[1]
Henrici Transmission Improvements	Capacity	22	5-10	Pipe	Parallel transmission line between Mountainview Reservoirs and Beavercreek Rd - Increase transmission to Henrici Reservoir	4,200	24		100%	$2,153,500
	Capacity	23	0-5	Pipe	Parallel transmission line between Beavercreek Rd and Glen Oak Rd along Streetscape improvements - Increase transmission to Henrici Res	7,300	18		100%	$2,963,000
	Capacity	24	0-5	Pipe	New crossing north of Glen Oak Rd from Molalla to OC Public Schools property - distribution for development, increase transmission to Henrici	2,600	12		100%	$738,000
	Capacity	25	5-10	Pipe	OC HS crossing to Beavercreek Rd - Increase looping and transmission to Henrici	3,000	12		100%	$852,000
	Capacity	26	0-5	Pipe	New parallel transmission between Fairway Downs and Henrici Reservoir	4,000	24		100%	$2,051,500
Beavercreek Road Concept Area	Development	27	5-10	Pipe	New Upper Zone distribution - supply new development below 480', improve transmission	11,900	12		100%	$3,379,500
	Development	28	5-10	Pipe	New Fairway Downs distribution - supply new development below 480'	13,700	12		100%	$3,890,500
	Development	29	5-10	PRV	New PRV between Fairway Downs and Upper Zone - emergency fire flow				100%	$200,000
	Development	30	0-5	Reservoir	New Fairway Downs Reservoir - supply new development			1.75 MG	80%	$3,500,000
	Development	31	0-5	Pump Station	New Fairway Downs Pump Station - supply new development			250 GPM	80%	$1,194,000
	Development	32	0-5	Pipe	New Fairway Downs Transmission - supply new development	5,000	16		80%	$1,654,000
	Development	33	0-5	Pipe	Transfer existing Henrici transmission to Fairway Downs transmission - supply new development				80%	$200,000
Oregon City Operations – Small Waterline Replacement List [2]	Pipe Replacement		0-5	Pipe	S. Center St from S. 2nd to 1st St	700	8		0%	$134,000
	Pipe Replacement		0-5	Pipe	Barker Ave from South End Rd to Barker Rd	800	8		0%	$154,500
	Pipe Replacement		0-5	Pipe	Warner-Parrott Rd from King Rd to Boynton St	1,100	12		0%	$313,000
	Pipe Replacement		0-5	Pipe	Belle Ct and Glenwood Ct from Holmes Ln to Linn Ave	1,500	8		0%	$288,500
	Pipe Replacement		0-5	Pipe	Valley View Dr from Park Dr to McCarver Ave	1,000	8		0%	$192,000
	Pipe Replacement		0-5	Pipe	Canemah Ct from Canemah Rd to Telford Rd	1,700	8		0%	$326,000
	Pipe Replacement		0-5	Pipe	Randall St from Canemah Rd to Hartke Lp	700	8		0%	$134,000
	Pipe Replacement		0-5	Pipe	Hartke Lp and Alderwood Pl	3,700	8		0%	$712,000
	Pipe Replacement		0-5	Pipe	Harrison St from 7th St to Division St	600	8		0%	$115,000
	Pipe Replacement		0-5	Pipe	Division St from Harrison St to 13th/14th St	4,300	8		0%	$827,000
	Pipe Replacement		0-5	Pipe	Division St from Anchor Way PRV Station to Davis Rd	1,300	8		0%	$250,500
Maintenance and Repair Projects	Pipe Replacement		0-5	Pipe	Repair and Replacement Program	18,000	8-12			$3,699,000
			5-10	Pipe	Repair and Replacement Program	14,500	8-12		26.89%	$2,996,500
			10-20	Pipe	Repair and Replacement Program	41,000	8-12		26.89%	$8,033,500
	Facility Rehabilitation (PRV Rebuild and Replacement)		0-5	PRV Rebuild	11th St & Washington St, 15th St & Madison St, 3rd St & Bluff, Apperson Blvd & La Rae Rd, Jennifer Estates, Swan Ave & Holcomb Blvd, Hunter Ave Pump Station, East St & Maple St, View Manor – continue to schedule rehabilitation and rebuilds every 5 years until the PRV is removed with redevelopment, 99E & Main St – removal of PRV Station with re-zoning the Paper Mill Zone to the Lower Zone	10			26.89%	$100,000

Improvement Category	Project Type	MAP ID	Timeframe	Facility Type	Description	Length (lf)	Dia (in)	Capacity	SDC Eligible	Cost Estimate[1]
Maintenance and Repair Projects			0-5	PRV Replacement	16th St & Division St, 18th St & Anchor Way, 4th Ave & Jerome St, 5th Ave & Canemah, Abernethy Rd & Redland Rd, Harley Ave & Forsythe Rd (North) including removal of Harley Ave & Forsythe Rd (South)	6.5			26.89%	$1,300,000
			5-10	PRV Rebuild	3rd Ave & Ganong St	1			26.89%	$10,000
			5-10	PRV Replacement	11th St & Washington St, Apperson Blvd & La Rae Rd, Jennifer Estates, Swan Ave & Holcomb Blvd, Hunter Ave Pump Station	5			26.89%	$1,000,000
	Facility Rehabilitation (Reservoir Coating/Rehab, Seismic/Safety)	Barlow Crest	0-5	Reservoir	Barlow Crest Reservoir- Exterior Overcoat				62.86%	$722,000
		Barlow Crest	0-5	Reservoir	Barlow Crest Reservoir-Safety Upgrades				62.86%	$100,000
		Barlow Crest	0-5	Reservoir	Barlow Crest Reservoir-Seismic Analysis/Seismic Upgrades[3]				62.86%	$975,000
		Barlow Crest	0-5	Reservoir	Barlow Crest Reservoir-Steel Interior Removal and Recoat				62.86%	$789,000
		Barlow Crest	10-20	Reservoir	Barlow Crest Reservoir-Steel Exterior Removal and Recoat				62.86%	$1,059,000
		Boynton	0-5	Reservoir	Boynton Reservoir-Seismic Analysis/Seismic Upgrades (may require new reservoir)[3]				0%	$975,000
		Boynton	10-20	Reservoir	Boynton Reservoir-Steel Exterior Removal and Recoat				0%	$1,059,000
		Henrici	0-5	Reservoir	Henrici Reservoir- Exterior Overcoat				0%	$722,000
		Henrici	0-5	Reservoir	Henrici Reservoir-Safety Upgrades				0%	$100,000
		Henrici	0-5	Reservoir	Henrici Reservoir-Seismic Analysis/Seismic Upgrades[3]				0%	$975,000
		Henrici	0-5	Reservoir	Henrici Reservoir-Steel Interior Removal and Recoat				0%	$789,000
		Henrici	10-20	Reservoir	Henrici Reservoir-Steel Exterior Removal and Recoat				0%	$1,059,000
		Mountainview	0-5	Reservoir	Mountainview 2 Reservoir-Safety Upgrades				53%	$100,000
		Mountainview	10-20	Reservoir	Mountainview 1 Reservoir-Concrete Major Repairs				53%	$200,000
		Mountainview	10-20	Reservoir	Mountainview 2 Reservoir-Concrete Major Repairs				53%	$200,000
	Facility Rehabilitation (Pump Stations)	Hunter Ave	0-5	Pump Station	Hunter Ave PS - PLC, Pumps, drives, SCADA/ electrical, transfer switch generator				26.89%	$375,000
		Mountainview	0-5	Pump Station	Mountainview PS - Drives				26.89%	$95,000
		Mountainview	5-10	Pump Station	Mountainview PS - Pumps, SCADA/electrical				26.89%	$380,000
	Facility Rehabilitation (Decommission)	Fairway Downs	5-10	Pump Station	Decommission				0%	$50,000
		Boynton	0-5	Pump Station	Decommission				0%	$50,000
		Livesay	5-10	Pump Station	Decommission				0%	$50,000

Notes:

1 All project cost estimates are consistent with Class 5 budget estimates, as established by the *American Association of Cost Engineers* (AACE). This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +30 to +100 percent on the high end. The cost estimates are consistent with the definition of OAR 660-011-0005(2) and OAR 660-011-035. Cost estimates are intended to be used as guidance in establishing funding requirements at the project planning level based on information available at the time of the estimate. Estimates exclude land acquisition, financing, inflation, and operations. Costs were developed in 2018 dollars with markups for contractor profits, overhead, engineering, and construction contingency.

2 Oregon City Operations – Small Waterline Replacement Projects not shown on CIP map.

3 Seismic upgrade costs are placeholders. Additional evaluations required to refine cost estimates, risk, and improvement strategies for reservoir seismic improvements.

4. The project list may be updated pursuant OAR 660-011-0045 and ORS 223.309

Table 18
Total Water CIP Summary Costs

Year	Development, Capacity & Operations Costs[1]	Pipe Replacement Costs[1]	Facility Rehabilitation Costs[1]	Total CIP Project Costs[1]
0 – 5 Years	$19,905,500	$10,041,500	$8,167,000	$41,010,000
5 – 10 Years	$14,225,500	$2,996,500	$1,490,000	$18,712,000
10 – 20 Years	$11,827,500	$8,033,500	$3,577,000	$23,438,000
TOTAL	**$45,958,500**	**$18,175,500**	**$13,234,000**	**$80,264,000**

Notes:

1 All project cost estimates are consistent with Class 5 budget estimates, as established by the *American Association of Cost Engineers* (AACE). This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +30 to +100 percent on the high end. The cost estimates are consistent with the definition of OAR 660-011-0005(2) and OAR 660-011-035. Cost estimates are intended to be used as guidance in establishing funding requirements at the project planning level based on information available at the time of the estimate. Estimates exclude land acquisition, financing, inflation, and operations. Costs were developed in 2018 dollars with markups for contractor profits, overhead, engineering, and construction contingency.

SFWB Intake and WTP

Barlow Crest Pump Station and Reservoir (1.75MG, 549' OF)

Hunter Ave Pump Station

SFWB Division Street Pump Station

New Holly Lane Pump Station and PRV

New Holly Lane Reservoir (1.0MG, 350' OF)

Mountainview Pump Station and Reservoirs 1 & 2 (2.0 & 10.5MG, 490' OF)

Boynton Standpipe (2.0MG, 592' OF)

Fairway Downs Pump Station

Henrici Reservoir (2.0MG, 592' OF)

New Fairway Downs Reservoir (1.75MG, 650' OF)

New Fairway Downs Pump Station

MM01 MM02 MM08 MM09

Clackamas River

Tualatin River

WILLAMETTE FALLS

0 2,000 4,000 Feet

City of Oregon City Water CIP Analysis

Figure 5 CIP Projects

PRESSURE ZONE
- Canemah
- Fairway Downs
- Intermediate
- Lower
- Paper Mill
- Park Place - Intermediate
- Park Place - Livesay
- Park Place - Lower
- Park Place - View Manor
- Upper

CIP Facilities
- PRV
- Tank
- Pump Station
- Emergency PRV

Existing Facilities
- Intake
- Master Meter
- PRV
- Pump Station
- Reservoir
- WTP
- Abandon Pump Station

- CIP Projects
- OC Water Mains
- CRW Water Mains
- SFWB Water Mains
- UGB
- taxlots

murraysmith

August 2020 17-2119

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Appendix

APPENDIX A
WATER DISTRIBUTION MODEL CALIBRATION TECHNICAL MEMORANDUM, MURRAYSMITH

Technical Memorandum
Water Distribution Model Calibration
Oregon City, Oregon

Date: June 20, 2017

Project: 16-1915

To: Jon Archibald
City of Oregon City

From: Shad Roundy, PE
Sven MacAller, EIT
Murraysmith

Re: City of Oregon City, Water Distribution Model Calibration

Model Calibration

Model calibration is performed to ensure that results of model simulations reflect what is happening in a real-world system and involves adjusting model parameters to match field data. For a water distribution system, hydraulic models attempt to reflect flow and pressure within the system by adjusting parameters such as pipe geometry, friction coefficients, demand distribution, boundary conditions, and operational parameters.

The required level of model accuracy can vary by type and size of the water system including system operations. Ultimately, model accuracy depends on the quality of data used to populate the model and the quality of the data that has been collected in the field. Boundary conditions such as pressure reducing valve (PRV) settings, pump operation, and reservoir levels are critical.

Oregon City Field Tests

For calibration of the Oregon City Distribution System, 22 fire flow tests were conducted to collect field data. These tests were distributed throughout the system and at least one was performed in each pressure zone except Jennifer Estates and Paper Mill. The Jennifer Estates zone had not been identified at the time the calibration plan was developed and the Paper Mill zone does not currently serve any customers. Fire flow tests were conducted between January 5th 2016 and

January 30th 2016 including both a static pressure reading and a flow and residual pressure reading. Boundary condition data including reservoir level and pump operation was collected during the fire flow testing period and was used for the model calibration effort. Model calibration confidence levels were evaluated using the criteria shown in Table 1.

The model calibration process has two steps. The first component of model calibration is to match field-measured static pressure with model simulated pressure. Demand distribution, system connectivity, service elevations, and reservoir water surface elevations are verified during the static model calibration.

Table 1
Calibration Confidence

Confidence Level	Static Test Percent Error	Residual Fire Flow Pressure Difference
High	0 – 5%	≤10 psi
Medium	5 – 10%	10-20 psi
Low	> 10%	>20 psi

The second component of calibration utilizes fire flow tests to verify pipe diameters, system connectivity, friction coefficients, and pump operations. Fire flow testing consists of recording static pressure at a hydrant and then "stressing" the system by flowing an adjacent hydrant. While the adjacent hydrant is flowing, residual pressure is measured at the first hydrant to determine the pressure drop. Boundary condition data, such as reservoir levels and pump on/off status, must also be known to accurately model the system conditions during the time of the flow test. The recorded time of each fire hydrant flow test was used to collect boundary condition information from the City's system supervisory control and data acquisition (SCADA) system.

Calibration Results

For static pressure calibration, error is measured as a percent pressure difference between model results and results measured in the field. A negative sign (-) indicates that the model pressure is lower than the field test, and a positive sign indicates that the model is over estimating pressure compared to test data. The static tests for the Oregon City distribution system calibrated between 3 and 5-percent of field measured values resulting in a high level of accuracy. A summary of the static test calibration results is shown in Table 2 and Figure 1.

Fire flow tests are used to simulate pressure drops within the system due to high demands. Calibration results for these tests are expressed as a difference in the pressure drop recorded in the field and the modeled system. For example, if field results show a pre-flow test pressure of

100 psi and 80 psi during the fire flow test, the pressure drop is 20 psi. If the model also shows 100 psi as a static condition and 85 psi during the fire flow test, the modeled pressure drop is 15 psi. The differential between these two pressure drops (5 psi) is the "Residual Fire Flow Pressure Difference". A negative sign on the "Residual Fire Flow Pressure Difference" indicates that the model is overpredicting the pressure drop caused by the fire flow test, while a positive sign indicates that the model is underpredicting the pressure drop. Overpredicting the pressure drop is preferred as it adds conservatism to the model. Because the reported result is based on comparing pressure drop as opposed to actual pressure, any error in the static calibration is not carried over to the fire flow calibration.

As with the static pressure, the fire flow tests calibrated to a high confidence level. All pressure differentials are within a 10-psi range (17 tests are within 5 psi and 5 tests are between 5 and 7 psi). A summary of the fire flow test calibration results is shown in Table 2 and Figure 2.

Calibration Notes

Pressure Reducing Valves

The Oregon City Distribution system is relatively complex with numerous pressure zones, PRVs, pump stations, and reservoirs. The system is sensitive to operational settings at these facilities. PRV settings were initialized from the City's master plan document and may not reflect the current operational settings. Several PRV settings were modified slightly in the model to improve model calibration. These changes were done only after exhausting other potential operational settings (reservoir levels, pump settings) and after adjusting pipe friction coefficients. PRV settings were changed at the 5th and Canemah, Abernathy and Redland, and Harley and Forsythe PRV stations within a 5-psi range of those reported in the master plan.

View Manor is served by a single PRV and is a small, closed pressure zone. Based on static and fire flow tests, the initial setting of 100 psi at the PRV was unrealistic as only 38 psi was measured during the static test and 30 psi during the fire flow test. The initial setting of 100 psi was reduced to 39 psi for the model calibration.

The Canemah pressure zone is served by two PRVs at 3rd and Ganong, and 4th and Jerome. During fire flow testing, both PRVs should open to supply water demand. The 3rd and Ganong PRV station is on a 2-inch line, while the 4th and Jerome station is on a 6-inch line. Using the initial PRV settings, the zone was served primarily by the 3rd and Ganong station and there was significant headloss in the 2-inch pipe resulting in modeled pressure drop significantly higher than what was recorded during fire flow testing. This was an indication that more flow was entering via the 6-inch line and the 4th and Jerome PRV station. In order to increase flow through the 4th and Jerome PRV, the setting was changed to allow the PRV to open at a higher pressure. The final settings used in the calibration at the 4th and Jerome PRV station were 65 and 70 psi for the large and small PRVs respectively (master plan settings indicated 50 and 65 psi settings).

Fairway Downs Pressure Zone

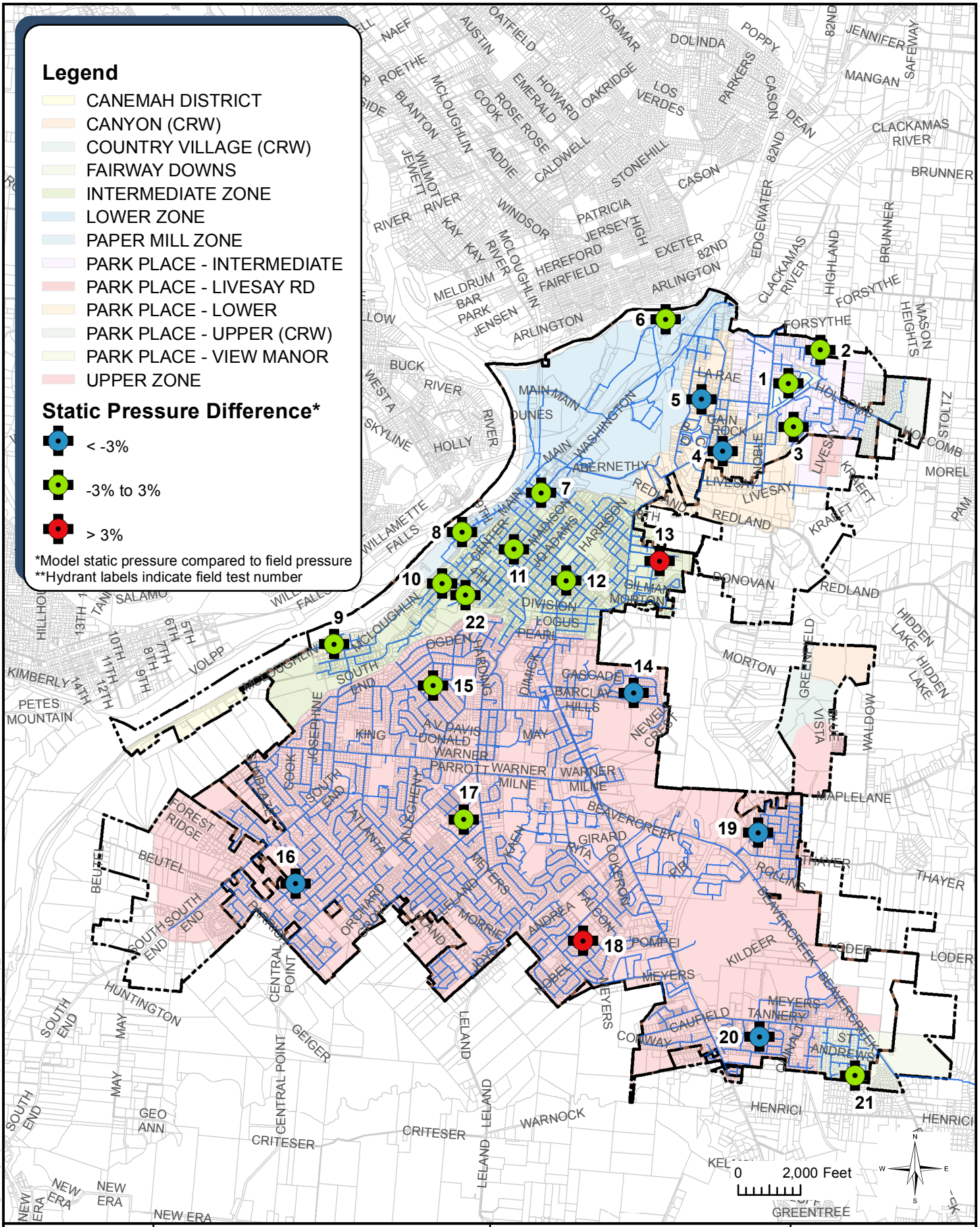
The Fairway Downs pressure zone is served by the Fairway Downs Pump Station and a check valve that bypasses the pump station and supplies water from the Upper Zone. City staff reported that during this flow test the pumps were operating at a diminished capacity (approximately 850 gpm total) and the check valve opened. In the model, the pressure drop from the fire flow test could not be replicated with the check valve open, even if all pumps were off. A good calibration was achieved using only pump 1 and 2, both at approximately 85% capacity and the check valve closed. This discrepancy indicates that there is either significant additional headloss in the check valve that is not replicated in the model or significant headloss in the piping within the pressure zone. When using the model to evaluate this pressure zone, care should be taken with regard to pump and check valve operation and further investigation of pumping capacity and check valve operation may be required.

Division Street Pump Station

Adjacent to the Division Street Pump Station there is a valve that recirculates water from the discharge side to the suction side of the pump station. This operational scheme is implemented to ensure adequate pressure to supply the CRW demand and the suction side pressure demands of the 16th and Division Street Pump Station. This operation is somewhat unique and should be considered when using the model for system evaluation. There may be a more efficient operational scheme that could be implemented in the future.

Table 2
Calibration Results

Test	Pressure Zone	Static Test Percent Error	Residual Fire Flow Pressure Difference
1	PP View Manor	-1%	1.5
2	PP Intermediate	-2%	0.8
3	PP Intermediate	-1%	3.4
4	PP Lower	-5%	6.4
5	PP Lower	-4%	3.3
6	Lower	-2%	6.9
7	Lower	-2%	2.2
8	Lower	0%	-2.7
9	Canemah	1%	-2.8
10	Intermediate	0%	5.2
11	Intermediate	1%	-1.7
12	Intermediate	-2%	-3.2
13	Intermediate	3%	-7.0
22	Intermediate	1%	-3.3
14	Upper	-5%	-1.8
15	Upper	2%	2.2
16	Upper	-5%	0.7
17	Upper	-3%	-1.3
18	Upper	4%	-7.1
19	Upper	-3%	2.3
20	Upper	-4%	-3.3



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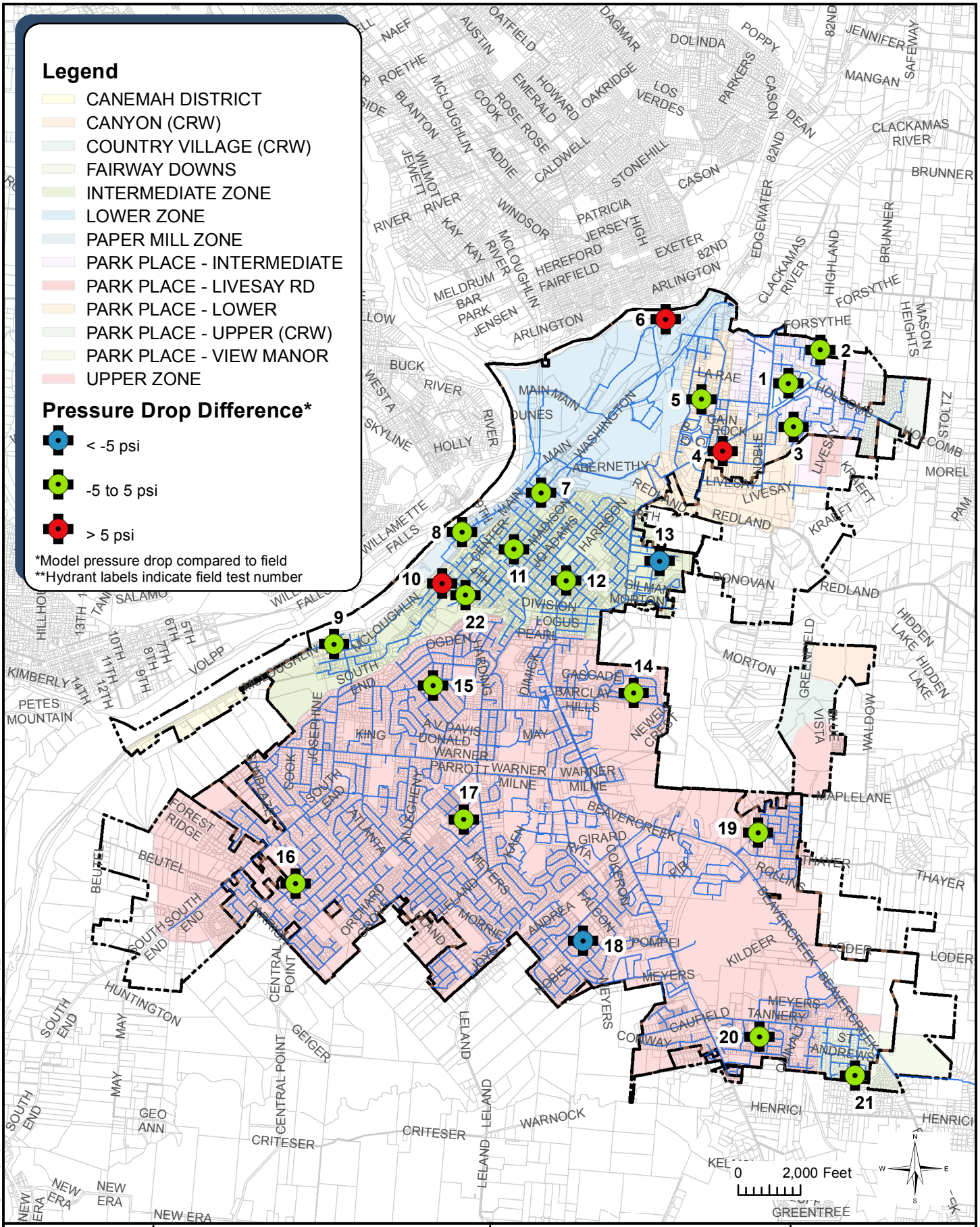
City of Oregon City Hydraulic Model Update

Figure 1 Calibration Results Static Pressure

OREGON CITY

May 2017 16-1915



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City of Oregon City Hydraulic Model Update

Figure 2 Calibration Results Fireflow Tests

OREGON CITY

May 2017 16-1915

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APPENDIX B
HYDRAULIC PROFILES

Figure B1
Existing Combined SFWB/Oregon City/Clackamas River Water Hydraulic Schematic

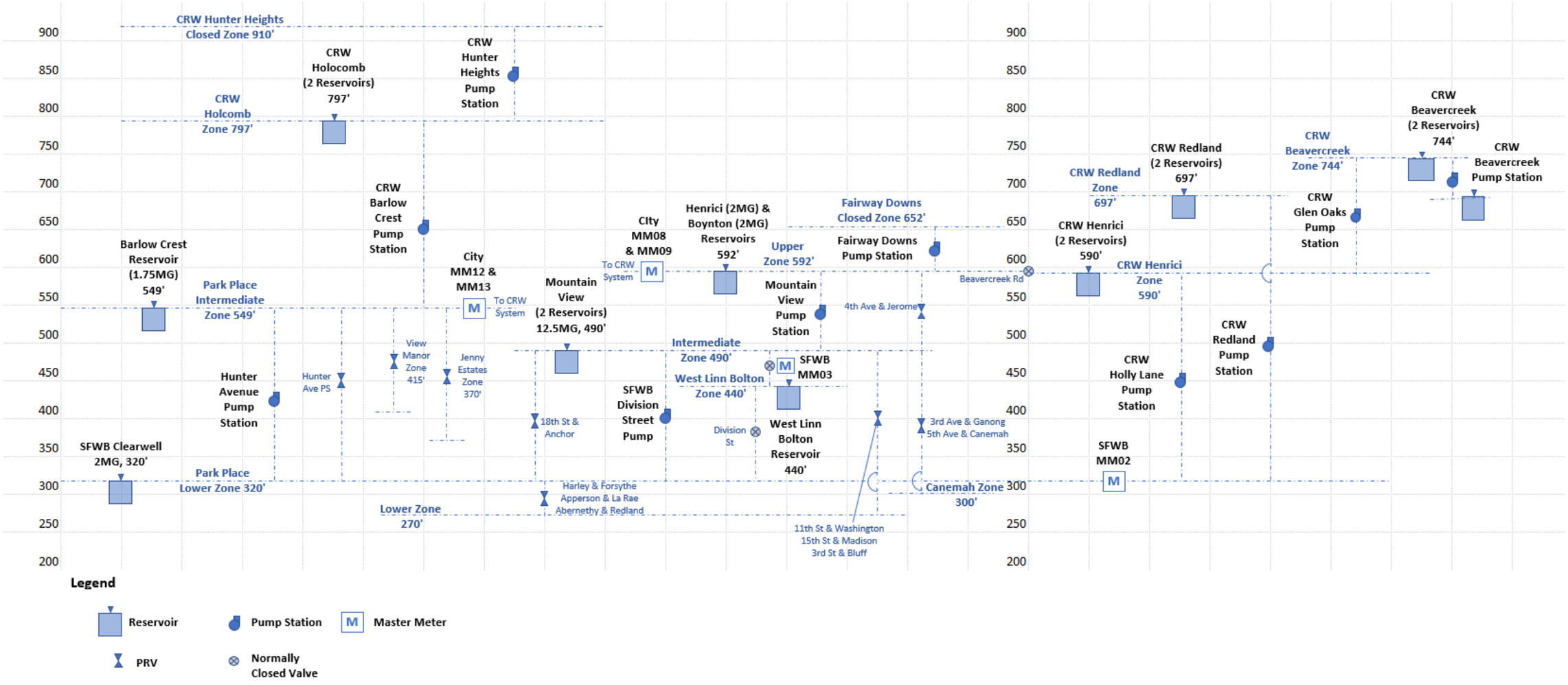
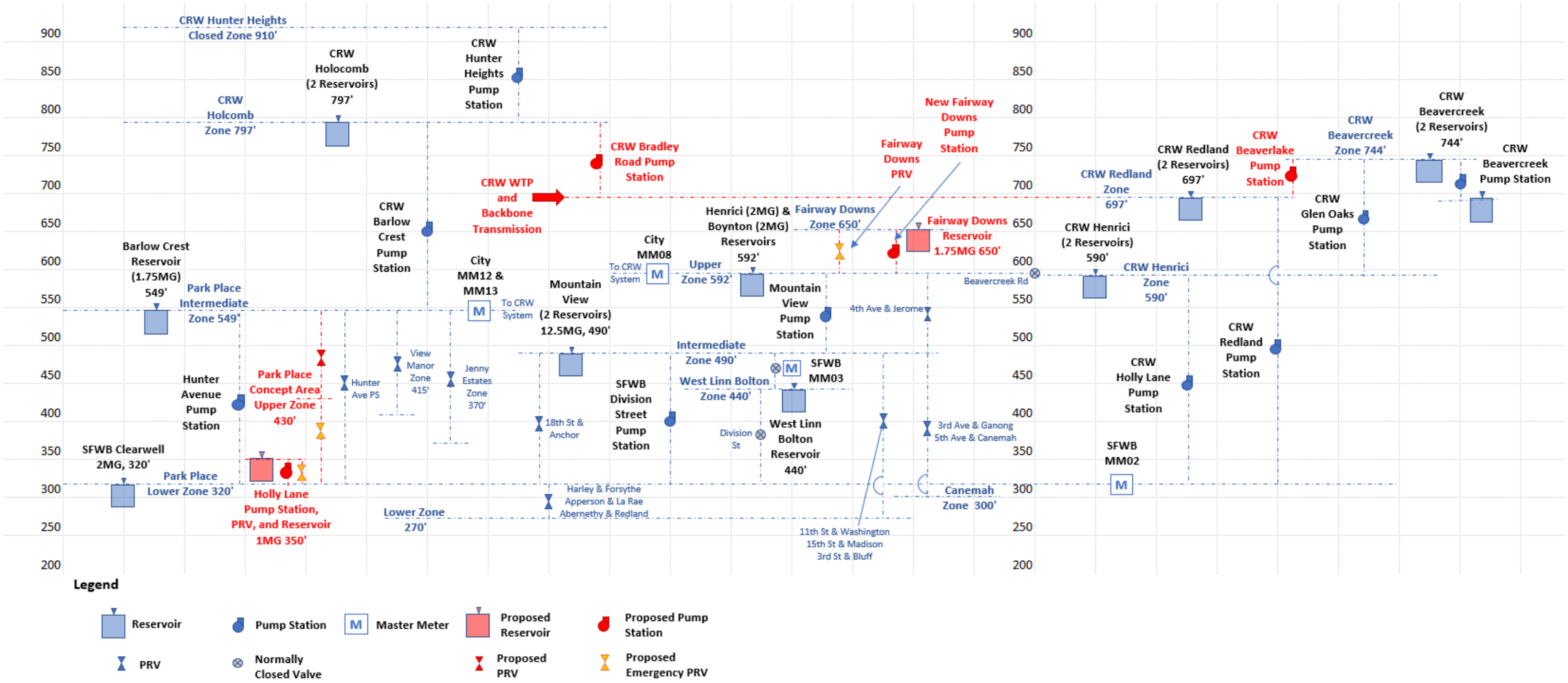


Figure B2
Proposed Combined SFWB/Oregon City/Clackamas River Water Hydraulic Schematic



APPENDIX C
EMERGENCY WATER SUPPLY ANALYSIS TECHNICAL MEMORANDUM, MURRAYSMITH

Technical Memorandum

Date: February 25, 2019

Project: Oregon City Water Distribution System CIP Update (17-2119)

To: Mr. Martin Montalvo
Aleta Froman-Goodrich, PE
City of Oregon City

From: Shad Roundy, PE
Claire DeVoe, EIT
Murraysmith

Re: Emergency Water Supply Analysis

Introduction

The City of Oregon City (City) is in the process of updating its Capital Improvement Program (CIP) developed in the Water System Master Plan (WMP, 2012). Amendment No. 1 to the CIP Update includes documentation of emergency water supply operations. Specifically, the emergency water supply may be required if the South Fork Water Board (SFWB) 30-inch main on Quail Ct and Hiram Ave is out of operation due to repair and during completion of a 42-inch pipeline capital improvement project on Cleveland Street planned for November 2018. This technical memorandum documents the findings and recommendations of the Emergency Water Supply Analysis.

Existing Conditions

SFWB Supply and Transmission

The SFWB supplies treated drinking water to the City of Oregon City, the Clackamas River Water District (CRW) south of the Clackamas River, and the City of West Linn. Two transmission lines supply water from the SFWB Water Treatment Plant (WTP): a 30-inch line to City and CRW master meters and the Division Street Pump Station, and a 42-inch line to the Hunter Ave Pump Station.

As described in the SFWB Water Master Plan (2016), the 30-inch line may be undersized by 2021. To increase transmission capacity, the CIP includes a 42-inch connection along Cleveland Road between the existing 42- and 30-inch lines. In late August 2018, an existing leak in the 30-inch supply main intensified. In response, the SFWB and the City installed dewatering pumps. According to the City, the situation has stabilized, but there are concerns the entire line may fail,

if any attempts are made at repairs. Therefore, the City and SFWB have accelerated the process for the 42-inch connection.

West Linn Intertie Upgrades

In 2015, the City of West Linn improved its Lake Oswego Booster Station Intertie by installing two new 2,200 gallons per minute (gpm) pumps. These improvements came partly in response to the Lake Oswego – Tigard WTP expansion on the Clackamas River. This intertie is expected to be available for emergency supply.

SFWB Supply Limitations

This analysis focuses on three SFWB supply interruption scenarios:

1. Only the 30-inch line is out of service:
    a. Prior to the completion of the connection of the new 42-inch line on Cleveland Street, a failure in the 30-inch line eliminates supply to the Division Street Pump Station, without affecting the 42-inch supply to Hunter Ave.
    b. The 42-inch connection is successfully constructed, and installation requires the 30-inch line to be shut off for the duration of the final connection.
2. The SFWB WTP is completely offline and both the 30-inch and 42-inch lines are unable to provide water supply. The Division Street Pump Station is also not operable.

Under the first scenario, the City, CRW, and West Linn pressure zones supplied by the 30-inch line will either need to use alternate supply or rely on emergency storage. Under the second scenario, CRW and the City are assumed to rely on emergency storage, while West Linn uses alternate supply from Lake Oswego. The second scenario assumes that excess capacity from the Lake Oswego intertie can optionally supply CRW and the City through a back feed to the Park Place Lower Zone and the suction side of the Division Street Pump Station from the West Linn Bolton Reservoir. Pressure zone supply under all scenarios for Oregon City, CRW, and West Linn are listed in Table 1 and highlighted in Figure 1.

SFWB Supply Operations and Service Interruption

The SFWB Clear Well controls system pressure in the 30-inch and 42-inch transmission mains including suction side pressures at the Division Street and Hunter Ave Pump Stations. When the Clear Well water surface drops below a set point, a transfer valve (day/night valve) at the Division Street Pump Station opens to supply system demands and pressure from the Mountainview Reservoirs to customers supplied directly off the transmission mains. Excess head from the Mountainview Reservoirs is eliminated via an orifice plate at the valve with differential head regulated by the Clear Well water surface.

The supply interruptions described in this Emergency Plan, are different than when the WTP Clear Well is nominally offline and the Mountainview Reservoirs supply the system via the transfer valve.

During the emergency supply interruptions, the Clear Well is unavailable to regulate pressure and the transfer valve should remain closed to eliminate risk of over pressurizing the system.

During closure of the transfer valve, some services directly off the transmission mains will be without water including 27 CRW customers downstream of the CRW Redland and Anchor Way Master Meter (MM02). To avoid water service interruptions during the emergency shutdown, a new pressure reducing valve (PRV) is required at the CRW Holly Lane Pump Station to provide emergency supply from the CRW Henrici Reservoir to these customers.

Table 1
Pressure Zone Supply Alternatives

SFWB Supply Scenario	System	Alternate Supply	Emergency Storage	Normal Operations
Scenario 1: Pressure Zones Affected by 30-inch Outage including near-term 42-inch pipeline connection	Oregon City	Park Place Lower, Lower, Livesay	Intermediate, Canemah, Upper, Fairway Downs, Paper Mill	Park Place Intermediate, View Manor, Jennifer Estates
	CRW		Redland, Henrici, Beavercreek Zones and South End and Leland/Meyers Master Meters	Hunter Heights, Holcomb (City's Park Place Upper), HOPP Master Meter
	West Linn	All Zones		
Scenario 2: Pressure Zones Affected by Complete SFWB Outage	Oregon City	See note 1	All Zones	
	CRW	See note 1	All Zones	
	West Linn	All Zones (from Lake Oswego)		

Notes
1 Optional supply from Lake Oswego. Excess capacity from the Lake Oswego intertie can augment supply to CRW and the City through a back feed to the Park Place Lower Zone and the suction side of the Division Street Pump Station from the West Linn Bolton Reservoir. Valving requires field verification and emergency operations require testing.

Scenario 1: 30-inch Supply Line Outage

Under this scenario, the 30-inch transmission main is off-line, and the 42-inch transmission main continues normal operation. Therefore, the goal of any operational change is to utilize the 42-inch line and minimize demands on the Mountainview Reservoirs. These changes include:

- Shut down of the Division Street Pump Station to eliminate supply from SFWB to the Mountainview and Bolton Reservoirs. The transfer valve at the Division Street Pump Station should be closed to ensure that the Mountainview Reservoir transmission main is isolated from suction side supply piping at the Division Street Pump Station.
- West Linn to utilize the booster station intertie with Lake Oswego and close the supply from SFWB and the Mountainview Reservoirs at the automated ball valve vault located between the Division Street Pump Station and the Bolton Reservoir.
- CRW to shut off their Redland and Holly Lane Pump Stations. CRW to rely on emergency storage in their Redland, Henrici, and Beavercreek Reservoirs for zones normally supplied via MM02. A new PRV is required at the Holly Lane Pump Station to serve 27 customers adjacent to MM02.
- Oregon City to close distribution bypass pressure reducing valves (PRVs) providing supply from the Mountainview Reservoirs to zones capable of being supplied by the 42-inch line. Fire flow PRVs remain open with existing settings to passively provide fire flow demands. The updated PRV settings are listed in **Table 2** including closure of bypass PRVs at 18th & Anchor Way, 3rd & Bluff, 11th & Washington, and 15th & Madison. Fire flow PRV settings are not modified.

This scenario is useful for the near-term project to connect the new 42-inch pipeline on Cleveland Street to both the 42-inch transmission main and the 30-inch transmission main. During the connection, the 30-inch transmission main will be drained and out of service, while the 42-inch main will remain in service. The following elements should be field verified prior to connection:

- A butterfly valve and tee on the 42-inch main near Cleveland Street and Hunter Ave. The intended construction plan is to open the existing butterfly valve after pressure tests and bacterial testing are complete. A short segment of pipe will be constructed to connect the existing "CLOSED" butterfly valve to the new 42-inch piping.

Scenario 2: Complete SFWB Outage

Under this scenario, both the 30-inch and 42-inch lines are off-line. Therefore, the goal of the any operational change is to balance water stored in reservoirs with system demands. These changes include:

- Shut down of the Division Street Pump Station to eliminate supply from SFWB to the Mountainview and Bolton Reservoirs. The transfer valve at the Division Street Pump Station should be closed to ensure that the Mountainview Reservoir transmission main is isolated from suction side supply piping at the Division Street Pump Station.

- Shut down of the Hunter Ave Pump Station to eliminate supply from SFWB 42-inch to Barlow Crest and Hunter Heights Reservoirs.
- West Linn to utilize the booster station intertie with Lake Oswego and close the supply from SFWB and the Mountainview Reservoirs at the automated ball valve vault located between the Division Street Pump Station and the Bolton Reservoir.
- CRW to shut off their Redland, Holly Lane, and Barlow Crest Pump Stations. CRW to rely on emergency storage from their reservoirs in all zones.
- Oregon City to modify PRV settings and operations, providing supply from the Barlow Crest Reservoir to zones capable of being supplied by the Mountainview Reservoirs as listed in Table 2 including closure of the bypass PRV at Hunter Ave Pump Station and a slight adjustment to the Hunter Ave Pump Station fire flow PRV.
- Note that PRV isolation of the Park Place Lower and Lower Zones from the Mountainview Reservoirs is not recommended for this scenario since the Barlow Crest Reservoir supply is more limiting than the Mountainview Reservoir supply with the existing 42-inch supply line to Hunter Avenue Pump Station unavailable.

Analysis and Findings

Assumptions

The following assumptions were made for all system analysis:

- System analysis was performed under wintertime Average Day Demands (ADD), conservatively estimated at 75% of ADD and verified with 2016 master meter records.
- It was assumed all reservoirs would be filled prior to the start of work and a 20% factor of safety was assumed, limiting available storage to 80% of reservoir capacity.
- Only gravity storage was available for supply.
- All interzone pumps and PRVs were assumed operational, except where specifically listed. Therefore, pressure zones could be grouped by limiting reservoir or supply including: Oregon City Mountainview, Oregon City Barlow Crest, CRW Hunter Heights, and CRW MM02.

The analysis consisted of a calculation of supply duration available in the reservoir groups, a system pressure check in Oregon City under the updated supply scenario, and a fire flow pressure check in Oregon City under the updated supply scenario.

System Pressures and Supply Availability

Under both limited SFWB supply scenarios described in the prior section, the City can maintain adequate pressures in all zones. Pressures vary by less than 3 pounds per square inch (psi) between SFWB supply scenarios during winter time demands, therefore only Scenario 1 is presented in Figure 2. Reservoir supply duration varies between scenarios and zones and is presented in Table 3. These calculations assume that the City will continue wheeling water to CRW's master meters at South End, Meyers, and HOPP, in addition to the assumptions listed

earlier in this document. Approximately 4 days of emergency storage is available in the Oregon City system. If the Mountainview Reservoirs are not isolated from the Park Place and Park Place Lower Zones, the available storage in the Oregon City system reduces to less than 4 days.

Approximately 3 days of emergency storage is available in the CRW system with all reservoirs operations. However, it should be noted that the one of the CRW Redland Reservoirs is temporarily off-line (as of October 2018) affecting near-term emergency storage availability by approximately 50-percent in the Redland zone (see *SFWB Hydraulics – Catastrophic Failure: Emergency Water Main Repair Modeling*, Carrollo, 2018).

Fire flow Availability

If a fire occurs during limited SFWB operations, no additional changes need to be made to system operations. PRVs should be set so that fire flows will be available, even if the distribution bypass PRV is closed. It should be understood, however, that fighting a fire will significantly impact emergency storage and decrease the total time the system can operate without water shortages.

Figure 3 presents the fire flow available throughout the City's system under both Scenario 1 and Scenario 2 of reduced SFWB supply.

Table 2
PRV Settings for SFWB Supply Alternatives

PRV Station	Scenario 1: Operation under 30-inch Failure & 42-inch Connection	Scenario 2: Complete SFWB Outage	Distribution Bypass or Main Valve Setting (psi)				Fire flow Valve Setting (psi)			
			Diameter (in)	Existing	30-in Failure	Complete Outage	Diameter (in)	Existing	30-in Failure	Complete Outage
18th & Anchor Way	Closed for distribution, open during fire flow in Lower or Park Place Lower	Required for distribution and fire flow to Park Place Lower and Livesay	4	53	CLOSE	NC	8	48	NC	NC
3rd & Bluff	Closed for distribution, open during fire flow in Lower Zone	Supply to Lower, available for fire flow	3	42	CLOSE	NC	10	39	NC	NC
11th & Washington			3	67	CLOSE	NC	10	58	NC	NC
15th & Madison[2]			6	56	CLOSE	NC	6	51	NC	NC
Hunter Ave Pump Station PRV	Required for distribution and fire flow supply to Park Place Lower and Lower	Closed for distribution, available for fire flow	3	45	NC	CLOSE	6	51	NC	48

Notes:

1. NC = No change from existing settings required.
2. Additional 1.25-inch PRV also closed during Scenario 1.

Table 3
Emergency Storage Supply Availability Under Limited SFWB Supply Scenarios

SFWB Supply Scenario	Storage System/Zones	Total Storage (MG)	Available Storage (MG)	System Demands (GPM)	Available Supply (Days)
Scenario 1: Pressure Zones Affected by the 30-inch Outage	Oregon City/ Mountainview	16.5	12.1	1,898	4.4
	CRW/ MM02	3.8	3.0	651	3.2
Scenario 2: Pressure Zones Affected by Complete SFWB Outage	Oregon City/ Mountainview	16.5	12.1	2,208	3.8 – 4.8 (see note 9)
	Oregon City/ Barlow Crest	1.8	1.4	120	8.1
	CRW/ Hunter Heights	1.2	1.0	135	4.9
	CRW/ MM02	3.8	3.0	651	3.2 – 4.2 (see note 9)

Notes:

1. All tanks assumed initially full and operational. Available storage assumed to be 80% of full storage and available by gravity – Boynton Standpipe limited to minimum elevation of Henrici Reservoir at 20% full.
2. Demands at 75% of ADD. All CRW demands wheeled through Oregon City (HOPP area, South End, Leland/Meyers, and Joint User Customers) continued supply at 75% ADD. No supply to West Linn.
3. All interzone pump stations assumed operational, except where specifically shut off.
4. For scenario 1, Oregon City Mountainview Zones include Upper, Fairway Downs, Intermediate, and Canemah. For Scenario 2, additional zones include Lower and Park Place Lower and Livesay.
5. CRW MM02 Zones include Redland, Henrici, and Beavercreek. All reservoirs assumed operational. Available supply will be reduced from what is shown in the table when one of the Redland Reservoirs is offline.
6. Oregon City Barlow Crest Zones include Park Place Intermediate, Park Place View Manor, and Park Place Jenny Estates.
7. CRW Hunter Heights Zones include Hunter Heights and Holcomb (including the City customers in the Barlow Crest area).
8. For Scenario 2, Mountainview Reservoirs supply the Park Place Lower and Lower Zones to preserve supply in the Barlow Crest Reservoir. Without isolating Barlow Crest, the controlling emergency supply reduces to approximately 2 days within the Barlow Crest service area.
9. Additional supply from the booster station intertie with Lake Oswego may augment supply to CRW and the City through a back feed to the Park Place Lower Zone and the suction side of the Division Street Pump Station from the West Linn Bolton Reservoir. Valving requires field verification and emergency operations require testing. The higher-end supply times assume up to 700 gpm of excess capacity are provided by the Lake Oswego intertie to supplement storage.

Alternate Supply Analysis

Given the limited time available for supply shut down and the unpredictability of the construction process, alternate supply and distribution were explored from CRW and Lake Oswego via West Linn.

Supply from CRW's WTP may be an option for emergency supply once Phase I of the Backbone Project is completed and interties to Oregon City are established. The Backbone Project extends

transmission piping from the CRW WTP on the north side of the Clackamas to customers south of the Clackamas. Existing connections along the Backbone path were reviewed for a potential supply from the CRW zones supplied by the 42-inch to the CRW zones supplied by the 30-inch and indirectly, the Mountainview Reservoirs. However, available piping is 4-inch diameter and adequate connections are not currently available. Once the Backbone Project is complete, potential intertie locations may be located at the Barlow Crest Reservoir, CRW's Redland and Anchor Way master meter, or along Beavercreek Road. The Backbone Project and associated interties will not be implemented in time to address near-term emergency supply associated with the near-term SFWB pipe break and 42-inch pipeline improvement.

Alternate supply may be available from the Lake Oswego – Tigard WTP, via the Lake Oswego Emergency Booster Station and through West Linn's Bolton Pressure Zone to the Mountain View Reservoirs. Initial review of the system and pump curves for the emergency pump station indicate approximately 225 ft of total dynamic head (TDH) with two pumps operating. This is adequate head to pump from the Emergency Booster Station to the Mountain View Reservoirs. Based on winter-time demands, the pump station would operate almost continuously throughout the day. Two scenarios were considered:

(1) In the first scenario, the West Linn distribution piping and valving are not isolated. Maximum pressures exceed 170 psi and may affect two-thirds to three quarters of the zone.

(2) In the second scenario, portions of the West Linn distribution piping are isolated to serve as a transmission main. Maximum pressures exceed 170 psi, but only affect one-third of the zone (see Figure 4).

Because the affected customers in the Bolton Pressure Zone may not have individual PRVs to handle pressures greater than 100 psi and the distribution piping is aging with potential leakage concerns, the alternate supply scenario from the Lake Oswego Booster Station to the Mountainview Reservoirs is not recommended.

A third alternative was considered late in the emergency supply analysis. Additional supply from the booster station intertie with Lake Oswego may augment supply to CRW and the City through a back feed to the Park Place Lower Zone and the suction side of the Division Street Pump Station from the West Linn Bolton Reservoir. This operation does not affect pressures in the West Linn system. Valving requires field verification and emergency operations require testing. Excess capacity from the intertie booster may be limited after demands are supplied to West Linn during peak demand hours of the day. The benefit of the back feed from the Bolton Reservoir is to help refill City and CRW reservoirs normally supplied from the SFWB Clearwell during low demand hours of the day. The reservoir refill occurs through the Division Street Pump Station for the City and the Holly Lane and Redland Pump Stations for CRW.

Future Connections

Additional interconnects to the CRW system after the construction of the CRW backbone project may be explored. A secondary supply south of the Clackamas River greatly increases system resiliency and improves service to CRW, Oregon City, and West Linn customers. The backbone project will not be available for the immediate risks of the 30-inch leak and the 42-inch pipe connection associated with Scenario 1.

Recommendations

The following steps are recommended procedures for implementation of Scenario 1 and Scenario 2 operations. The steps should be field verified (including valve IDs) and tested prior to implementation.

During testing and implementation, all valve operations must be performed slowly to minimize the risk of water hammer and pressure transients. Prior to draining system pipelines, air/vacuum combination release valves should be identified and inspected for functionality to avoid damage from pressure transients. Draining should occur slowly to minimize risks of vacuum pressures.

Scenario 1: 30-inch Supply Line Outage

- Coordinate with the City of West Linn to change supply to the Bolton Reservoir
    - Fill the Bolton Reservoir via the Division Street Pump Station
    - Close the automated ball valve at vault between the Division Street Pump Station and the Bolton Reservoir. The valve is located near 17th on Division (Valve 50253/320, ID to be field verified)
    - Coordinate with Lake Oswego to utilize the emergency booster station for supply of the Bolton Reservoir and Bolton Pressure Zone

- Fill all City and CRW reservoirs nominally supplied by the 30-inch line prior to isolating the leak. These reservoirs include:
    - City Mountainview
    - City Henrici
    - City Boynton
    - CRW Redland
    - CRW Henrici
    - CRW Beavercreek

- Isolate the leak and close valves
    - Shut off the Division Street Pump Station
    - Verify transfer valve closure between Mountainview Reservoirs transmission main and 30-inch supply line at the Division Street Pump Station
    - Close the 16-inch gate valve located at MM01 - the City supply from the 30-inch to the Park Place Lower zone, at Hiram and Cleveland (Valve 50307/374)

    - Shut off the CRW Redland and Holly Lane Pump Stations
    - Close the 14-inch CRW line at MM02, Redland and Anchor – the CRW supply from the 30-inch to Redland, Henrici, and Beavercreek. To avoid water service interruptions during the emergency shutdown, a new PRV is required at the CRW Holly Lane Pump Station to provide emergency supply from the CRW Henrici Reservoir to customers adjacent to MM02.
    - Isolate the leak by closing adjacent valving on the 30-inch line
- Close the bypass PRVs at the following locations per recommendations listed in Table 2, to minimize demands on the Mountainview Reservoirs. Maintain fire flow valves at existing settings.
    - 18th & Anchor PRV Station
    - 3rd & Bluff PRV Station
    - 11th & Washington PRV Station
    - 15th & Madison PRV Station

- Fire watch – During the supply alternative, maintain a fire watch. It is strongly encouraged not to open valves unless necessary. If a fire occurs, valve opening between the CRW and Oregon City systems will serve to balance reservoir water supply and support fire flow durations. The valve operations are not required to supply fire flow demands initially and therefore, all valves should be operated slowly and with care to avoid water hammer and pressure transients.

Scenario 1 is useful for the near-term project to connect the new 42-inch pipeline on Cleveland Street to both the 42-inch transmission main and the 30-inch transmission main. During the connection, the 30-inch transmission main will be drained and out of service, while the 42-inch main will remain in service. The following elements should be field verified prior to connection:

- A butterfly valve and tee on the 42-inch main near Cleveland Street and Hunter Ave. The intended construction plan is to open the existing butterfly valve after pressure tests and bacterial testing are complete. A short segment of pipe will be constructed to connect the existing "CLOSED" butterfly valve to the new 42-inch piping.

Scenario 2: Complete SFWB Outage

- Coordinate with the City of West Linn to change supply to the Bolton Reservoir
    - Fill the Bolton Reservoir via the Division Street Pump Station
    - Close the automated ball valve at vault between the Division Street Pump Station and the Bolton Reservoir. The valve is located near 17th on Division (Valve 50253/320, ID to be field verified)
    - Coordinate with Lake Oswego to utilize the emergency booster station for supply of the Bolton Reservoir and Bolton Pressure Zone

- Fill all City and CRW reservoirs. These reservoirs include:
    - City Mountainview

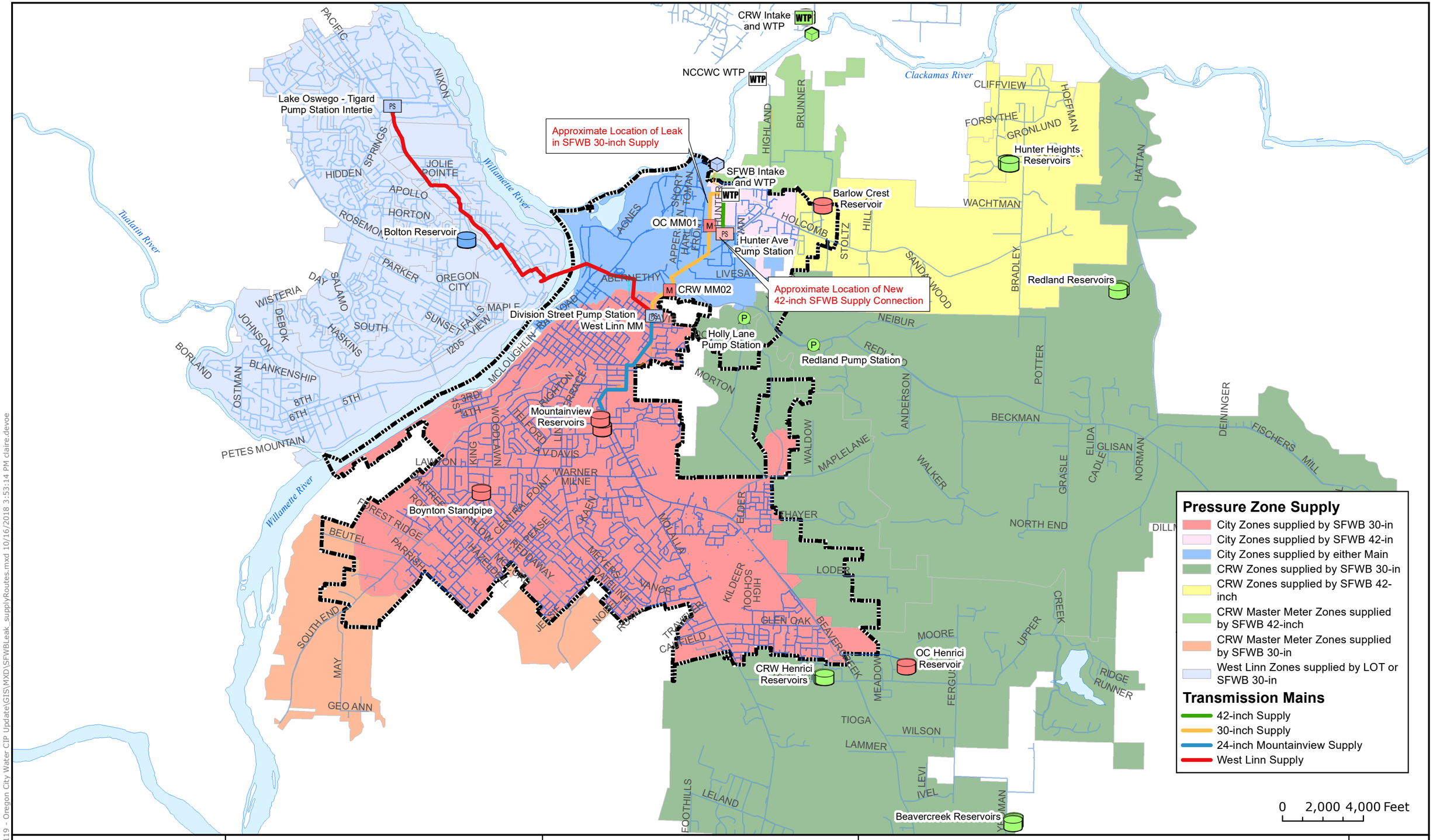
    - City Henrici
    - City Boynton
    - City Barlow Crest
    - CRW Redland
    - CRW Henrici
    - CRW Beavercreek
    - CRW Hunter Heights

- Isolate the CRW, West Linn, and Oregon City systems
    - Shut off the Division Street Pump Station
    - Verify transfer valve closure between Mountainview Reservoirs transmission main and 30-inch supply line at the Division Street Pump Station
    - Close the 16-inch gate valve located at MM01 - the City supply from the 30-inch to the Park Place Lower zone, at Hiram and Cleveland (Valve 50307/374)
    - Shut off the Barlow Crest Pump Station (CRW supply to Holcomb/Hunter Ave)
    - Shut off the CRW Redland and Holly Lane Pump Stations
    - Close the 14-inch CRW line at MM02, Redland and Anchor – the CRW supply from the 30-inch to Redland, Henrici, and Beavercreek. To avoid water service interruptions during the emergency shutdown, a new PRV is required at the CRW Holly Lane Pump Station to provide emergency supply from the CRW Henrici Reservoir to customers adjacent to MM02.
    - Shut off the Hunter Ave Pump Station
    - Close Hunter Avenue bypass PRV and adjust fire flow PRV to less than 48 psi

- Fire watch – During the supply alternative, maintain a fire watch. It is strongly encouraged not to open valves unless necessary. If a fire occurs, valve opening between the CRW and Oregon City systems will serve to balance reservoir water supply and support fire flow durations. The valve operations are not required to supply fire flow demands initially and therefore, all valves should be operated slowly and with care to avoid water hammer and pressure transients.

Note: Additional emergency supply to the City and CRW systems may be available from the booster station intertie with Lake Oswego to the Park Place Lower Zone and the suction side of the Division Street Pump Station from the West Linn Bolton Reservoir during low demand hours of the day. Valving requires field verification and emergency operations require testing.

Cc: South Fork Water Board, West Linn, Clackamas River Water, Lake Oswego



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OREGON CITY

City of Oregon City Water CIP Analysis

Figure 1: SFWB Regional Supply Limitation

Water Facilities

- Reservoir
- Pump Station
- Master Meter
- PRV
- Intake
- WTP

Note: Facility color denotes ownership:
Red - Oregon City
Green - CRW
Blue - Other

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Scenario 1: Isolate 30-inch Leak

Scenario 1: Close 18th & Anchor Way Bypass PRV

Scenario 1: Close 15th & Madison Bypass PRV

Scenario 1: Close 11th & Washington Bypass PRV

Scenario 1: Close 3rd & Bluff Bypass PRV

Scenario 2: Close CRW Supply via Barlow Crest Pump Station

Scenario 2: Close Bypass PRV at Hunter Ave Pump Station Adjust Fire Flow PRV setting

Both Scenarios: Close CRW MM02 Supply

Both Scenarios: Shut down Holly Lane Pump Station
New PRV required at pump station to supply customers immediately downstream of MM02

Both Scenarios: Shut down Redland Pump Station

Both Scenarios: Shutdown Division Street Pump Station and Close Transfer Valve

Both Scenarios: Close West Linn Supply Ball Valve; Coordinate with Lake Oswego for Emergency Booster Station supply to Bolton Pressure Zone

SFWB Intake

MM13

SFWB WTP

Barlow Crest Reservoir and Pump Station

MM12

MM01

Hunter Ave Pump Station

MM02

MM05

Division Street Pump Station

Mountainview Reservoirs and Pump Station

MM06

Boynton Standpipe and Pump Station

MM08

MM09

CRW Hunter Heights Reservoirs

CRW Redland Reservoirs

Fairway Downs Pump Station

Henrici Reservoir

CRW Henrici Reservoirs

Note: Water facility color denotes ownership:
Red - Oregon City
Green - CRW
Blue - Other

0 2,000 4,000 Feet

Model Water Mains
CRW Water Mains
OC City Limits
UGB

Static Pressure (PSI)
< 25
25 - 40
40 - 80
80 - 100
> 100

Water Facilities
Reservoir
Pump Station
Master Meter
PRV
Intake
WTP

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OREGON CITY

City of Oregon City Water CIP Analysis

Figure 2: SFWB Supply Limitation Static Pressure

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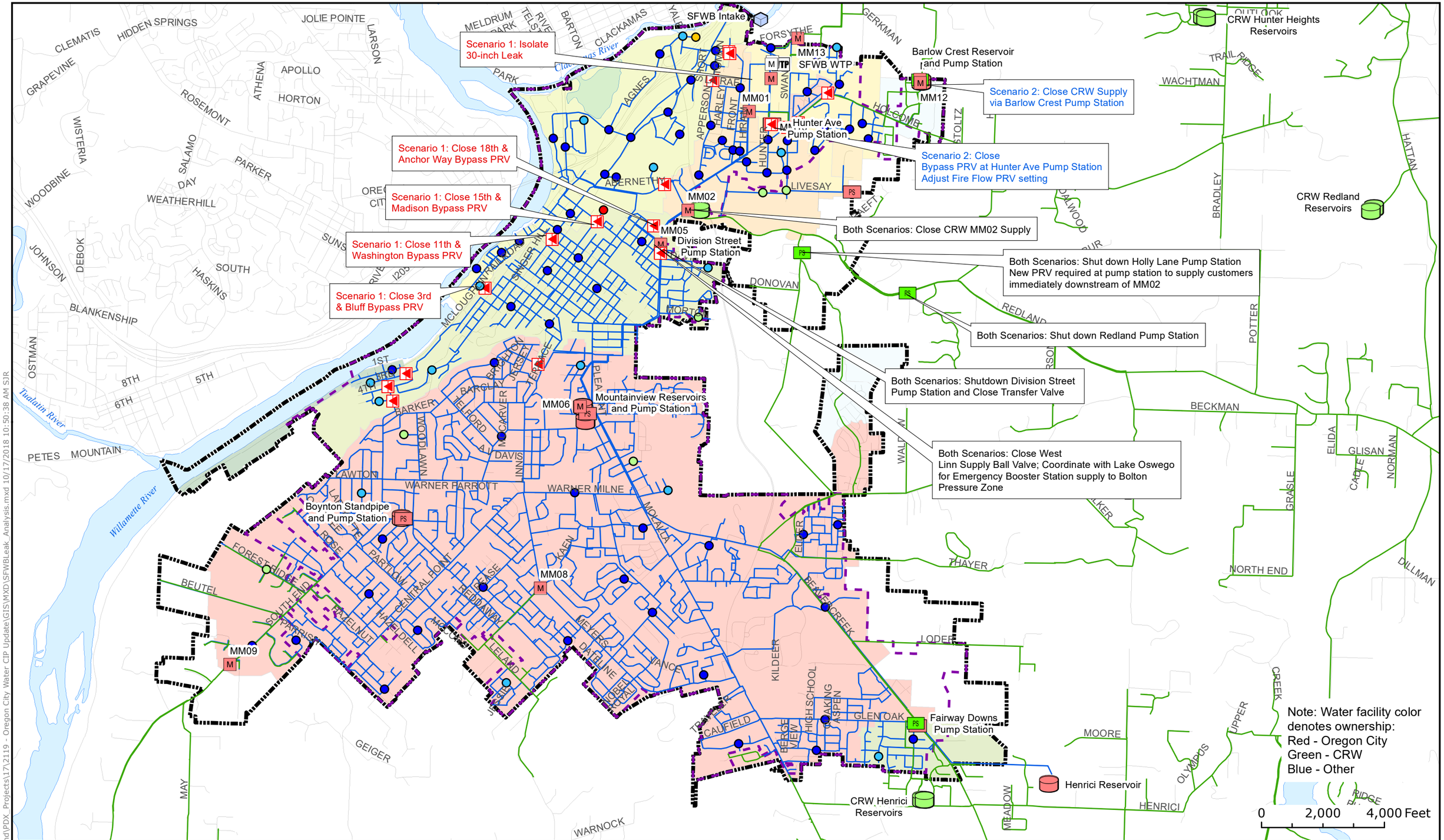

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OREGON CITY

City of Oregon City Water CIP Analysis

Figure 3: SFWB Supply Limitation Fireflow Availability

Model Water Mains
CRW Water Mains
OC City Limits
UGB

Available Fireflow (GPM)
< 500
500 - 1000
1000 - 1500
1500 - 3000
> 3000

Water Facilities
Reservoir
Pump Station
Master Meter
PRV
Intake
WTP

N W E S

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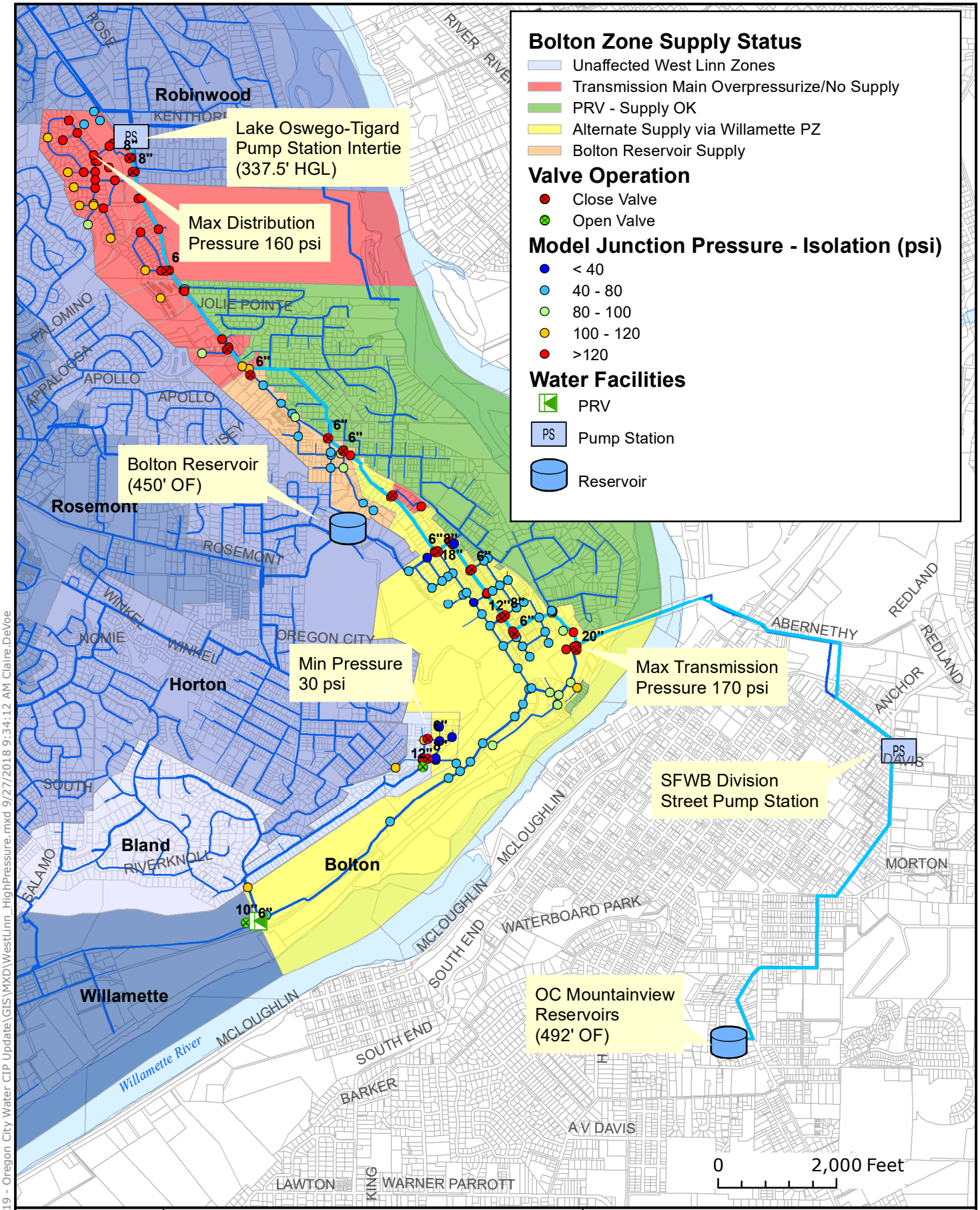

Figure 4:
SFWB Supply Main Failure
Alternate Supply Analysis

Lake Oswego-Tigard Supply
West Linn Pressures
Transmission Isolation

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September 2018 17-2119

APPENDIX D
JOINT ENGINEERING STUDY TECHNICAL MEMORANDUM, MURRAYSMITH

Technical Memorandum

Date: June 11, 2018

Project: 16-1922

To: Mr. Martin Montalvo – Operations Manager
Ms. Aleta Froman-Goodrich, PE – City Engineer
City of Oregon City

Mr. Bob George, PE – Chief Engineer
Clackamas River Water District

From: Brian Ginter, PE
Mike Carr, PE
Claire DeVoe
Murraysmith

Re: Clackamas River Water / City of Oregon City Joint Engineering Analysis
Water Service Dual interest Area Technical Analysis

Purpose

Clackamas River Water (CRW) and the City of Oregon City (City) are engaged in discussions with the goal of defining their adjoining service area boundaries for existing and future conditions to provide more efficient and economic water service to all customers. Murraysmith was selected by both providers to perform the engineering analysis and facilitate discussions between the two water providers.

The purpose of this white paper is to develop a framework for defining current and long-term service area boundaries, orderly service transfers, and infrastructure management through a study of current dual interest areas and overlapping service identified by the providers. This report will:

- Present the historical events regarding boundary realignment
- Identify typical dual interests present between service providers
- Document the identified water service dual interest focus areas
- Propose individual or policy-based solutions for each dual interest area
- Develop an approach to guide future dual interest resolution
- Provide an action plan for the next steps

This report also fulfills the study requirements set forth in the May 2014 Settlement Agreement between CRW and the City.

Introduction

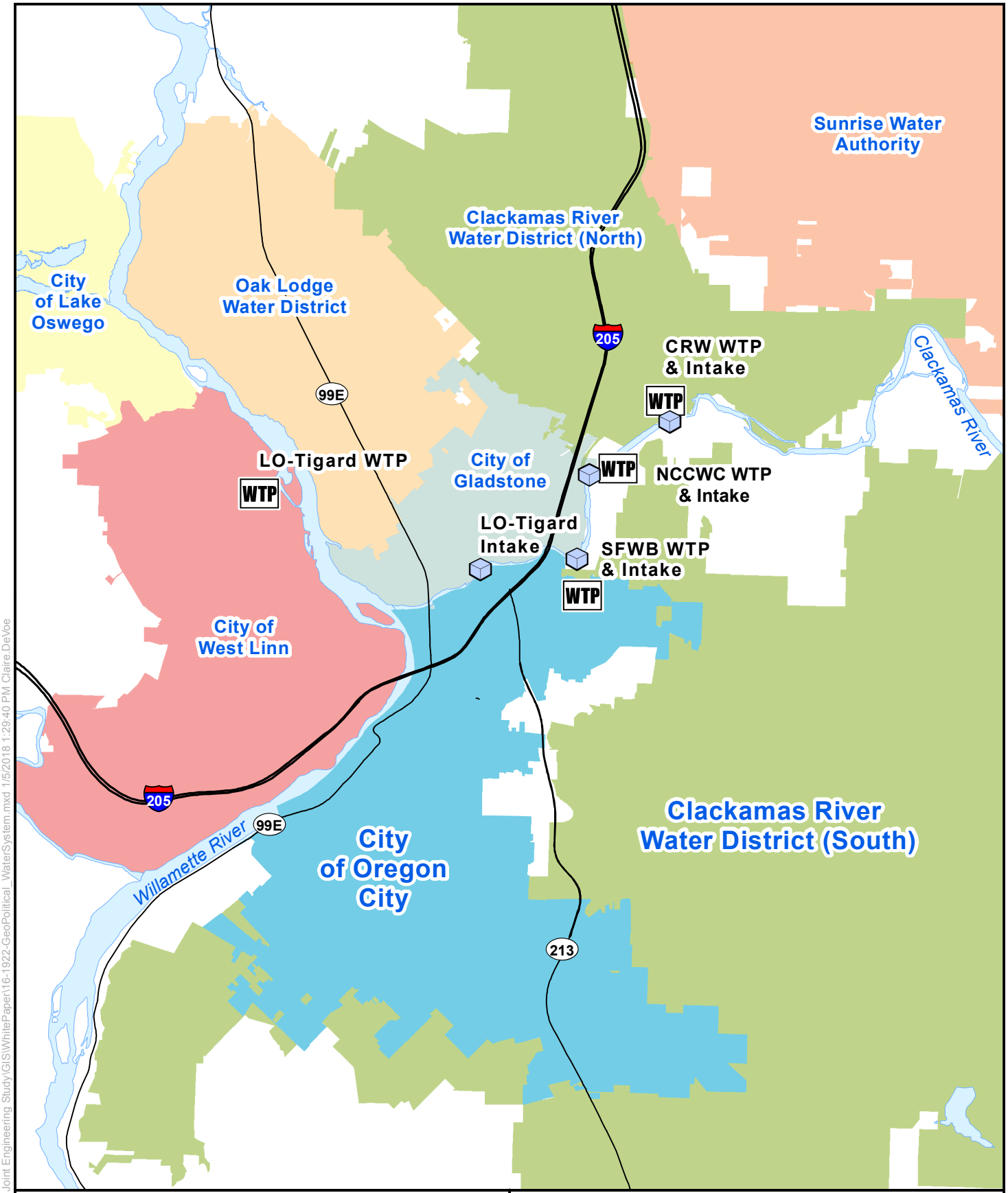
The Clackamas River is the primary water source for municipal water supply to Oregon City and the surrounding urban and semi-urban areas, as illustrated in **Figure 1**. Three separate Water Treatment Plants (WTPs) along the river supply six different water providers, including the City and CRW (**Table 1**).

Table 1
Water Treatment Facilities along the Clackamas River

Water Treatment Plant	South Fork Water Board WTP	North Clackamas County Water Commission WTP	Clackamas River Water WTP
Water Provider Served	Oregon City	Sunrise Water Authority	Clackamas River Water (North)
	West Linn	Gladstone	Sunrise Water Authority
	Clackamas River Water (South)	Oak Lodge Water District	

Historically, these water providers have coexisted and provided service to separate areas. Cities generally supplied the urban centers and water districts or water authorities have served the semi-urban areas both within and outside the Metro Urban Growth Boundary (UGB). With development and subsequent UGB expansion cities can legally serve areas that were once limited to water district or water authority service. Under ORS 222.520 to 222.580, a city may annex and withdraw territory, and assume facilities, from special districts if the facilities are non-essential to the operation of the remaining district water system. This same rule does not apply to water authorities – their service areas are protected and cannot be withdrawn by cities.

This study is the result of a legal dispute over the right to withdraw territory between Oregon City and CRW. As a municipal corporation, the City provides water service to residents within city limits and some areas within the UGB, but is limited in its ability to serve customers outside the UGB. CRW, a domestic water supply district organized under ORS 264, borders the City to the north, south, and east and primarily serves customers within unincorporated Clackamas County outside the UGB, as well as customers within the city limits and the UGB.



City of Oregon City
Clackamas River Water District
City of Gladstone
City of Lake Oswego
Oak Lodge Water District
Sunrise Water Authority
City of West Linn

Major Roads
Water Intake
Oregon City UGB
WTP Water Treatment Plant

N
1 inch = 6,000 feet

Oregon City - Clackamas River Water Joint Engineering Study

Figure 1
Vicinity Map

OREGON CITY
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Clackamas River Water

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In November of 2013, CRW and Sunrise Water Authority (SWA) approved Ordinance 03-2013 and Resolution 2013-02 respectively (collectively known as the 190 Agreement) to form the Clackamas Regional Water Supply Commission (CRWSC). CRW and SWA created the CRWSC to oversee the efficient supply of domestic water services within the two water providers' service areas. The City and South Fork Water Board (SFWB) were concerned the 190 Agreement would extend SWA boundary protection rights under ORS 450.987 as a Water Authority to CRW, thus limiting the City's right to annex and withdraw CRW territory.

In December of 2013, the City and SFWB filed an appeal to the Land Use Board of Appeals (LUBA) stating that the creation of the CRWSC infringed on the City's expansion rights and constituted material harm to the City and SFWB. This appeal led to discussions between CRW and the City regarding the goals of the CRWSC. In May 2014, a Settlement Agreement was signed by the City and CRW calling for this engineering study to provide direction for existing and future disputes.

This study is focused only on service provision dual interests between Oregon City and CRW. For the remainder of this study, areas and service providers north of the Clackamas River and west of the Willamette River will be ignored.

Dual interest Characterization

Neither party disputes the City's right to annex and withdraw CRW territory. Rather it is how prior annexations and withdrawals have occurred that is the primary driver of dual interest. The agreements for service transitions are outdated or do not address the current challenges, which has led to irregular policies and an uncertainty in long-term service provider boundaries. This uncertainty has led to CRW's reluctance to invest in areas that might soon be taken by the City, animosity over the condition of existing infrastructure in areas that are eligible for annexation, and a general short-term perspective on coordinated planning. The lack of a clear plan has at times resulted in annexation without withdrawal of territory resulting in continued uncertainty for both water providers related to long-term service requirements. All compiled, this has meant customers of both providers have seen failing infrastructure, frequent road repairs, higher costs, and a lack of clarity regarding long term service. As annexations and withdrawals are becoming more and more frequent, and in order to efficiently and effectively plan for the long-term service to all customers in the area, the parties concluded that a formalized process should be developed that is acceptable to both water providers.

Remuneration for Assets

Typically, urbanization and city expansion occurs where there is no existing public water service provider. However, CRW already provides water service to much of the semi-urban area surrounding the City. When the City expands service into these area, existing CRW infrastructure, often with remaining useful life, might be present, however the infrastructure may be inadequate by City standards. This creates a potential source of dual interest between the two water providers associated with:

- CRW's willingness to invest in the renewal or replacement of aging infrastructure that may ultimately be withdrawn by the City;

- The City's desire to efficiently transfer service to City rate payers without constructing redundant facilities; and

- Identification of critical infrastructure that must remain within CRW's ownership for continued water service to CRW customers.

In order to address these sources of dual interest, both water providers have acknowledged the need to develop a fair and objective remuneration policy that encourages coordinated planning and equitable, long-term focused investment in infrastructure development and renewal.

Reduce Isolated CRW Service Areas

When newly annexed areas are inconsistently withdrawn, isolated pockets of CRW customers are created within City service area. To supply these customers, either parallel and redundant infrastructure must be constructed and maintained, or the City must wheel water through their infrastructure to supply CRW infrastructure and customers. Traditionally, the latter has been chosen and facilitated in two ways – as a master meter connection or as Joint Users. These two mechanisms are detailed below:

- Master Meters: Master meters cleanly divide two systems and retain infrastructure maintenance responsibility with the system paying for the water by recording the totalized flow through a single supply point. They can supply entire pressure zones or a limited area such as a single road. Typically, master meters are used in areas that are not predicted to transition soon, or where a significant number of customers are served in the receiving system.

- Joint Users: Joint users are CRW customers that are supplied through City, CRW, or jointly owned infrastructure without an intervening master meter. Joint Users are not ideal in that the supplying system must take on a significant amount of risk if the receiving system does not adequately maintain its pipes but certain conditions such as system looping, or a limited number of customers, prevent the use of master meters.

Master meters and Joint Users are both integral solutions to serving isolated customers. The problem arises when these short-term solutions are selected without thought to long-term service goals.

For long term service, the simplest technical solution is often annexation and withdrawal of CRW service areas. However, political motives and a reluctance to be included in city limits stalls this type of solution. The City currently has a policy (Oregon City Municipal Code 13.04.260B) to charge 1.5 times the retail rates for service to customers outside of city limits. This policy may discourage orderly transition of service in the interest of protecting the customer as Master Metered or Joint User customers currently only pay their system's nominal rate.

The inconsistent application of master meters and Joint Users, the lack of certainty regarding annexation and withdrawal of territory, and the economic consequences for both water providers and customers require the development of an approach to isolated service that can be consistently and fairly applied.

Water Service Provider Goals

The consultant team met individually with CRW and City staff to understand both providers' goals (without the influence of the other provider). The following goals that influence each water providers' definition of success in this study were identified in the discussions.

- Joint Engineering Study Goals for Both Providers
    - The City and the CRW are both committed to providing high quality potable water service to customers at reasonable rates.
    - Both providers recognize the benefits of continued collaboration to provide seamless service to dual interest area customers that may be transferred, but each also recognizes their first duty is to customers within their own long-term service areas.
    - Both providers desire certainty of long-term water service area boundaries to inform ongoing system development and renewal/replacement capital investment.
    - Both providers are amenable to wheeled water from the other purveyor's WTP in cases where a higher level of service could be provided more economically and long-term agreements are in place to support investments needed to achieve and maintain the level of service.
    - Both providers recognize the value of interconnected systems with redundant emergency supply and are committed to working together with neighboring water providers to minimize impacts on customers during emergencies as well as periods of growth and transition.
- City Specific Goals
    - The City wants to be the water service provider to existing and future annexed City residents and businesses.
    - The City is part owner of SFWB, and therefore prefers to supply the City's customers with water sourced from the SFWB WTP, thereby serving he City's ultimate service area and customers. This results in better utilization of excess capacity at the WTP, higher certainty and control of water supply, control over water supply costs, control over planning and implementation of capacity expansions, etc.

- CRW Specific Goals
    - CRW prefers to supply the district's customers with water sourced from the CRW WTP as this results in better utilization of excess capacity at the WTP, higher certainty and control of water supply, control over water supply costs, control over planning and implementation of capacity expansions, etc.

Keeping these goals in mind, existing dual interests and solutions to key areas identified during scoping will be explored in the next section.

Study Area

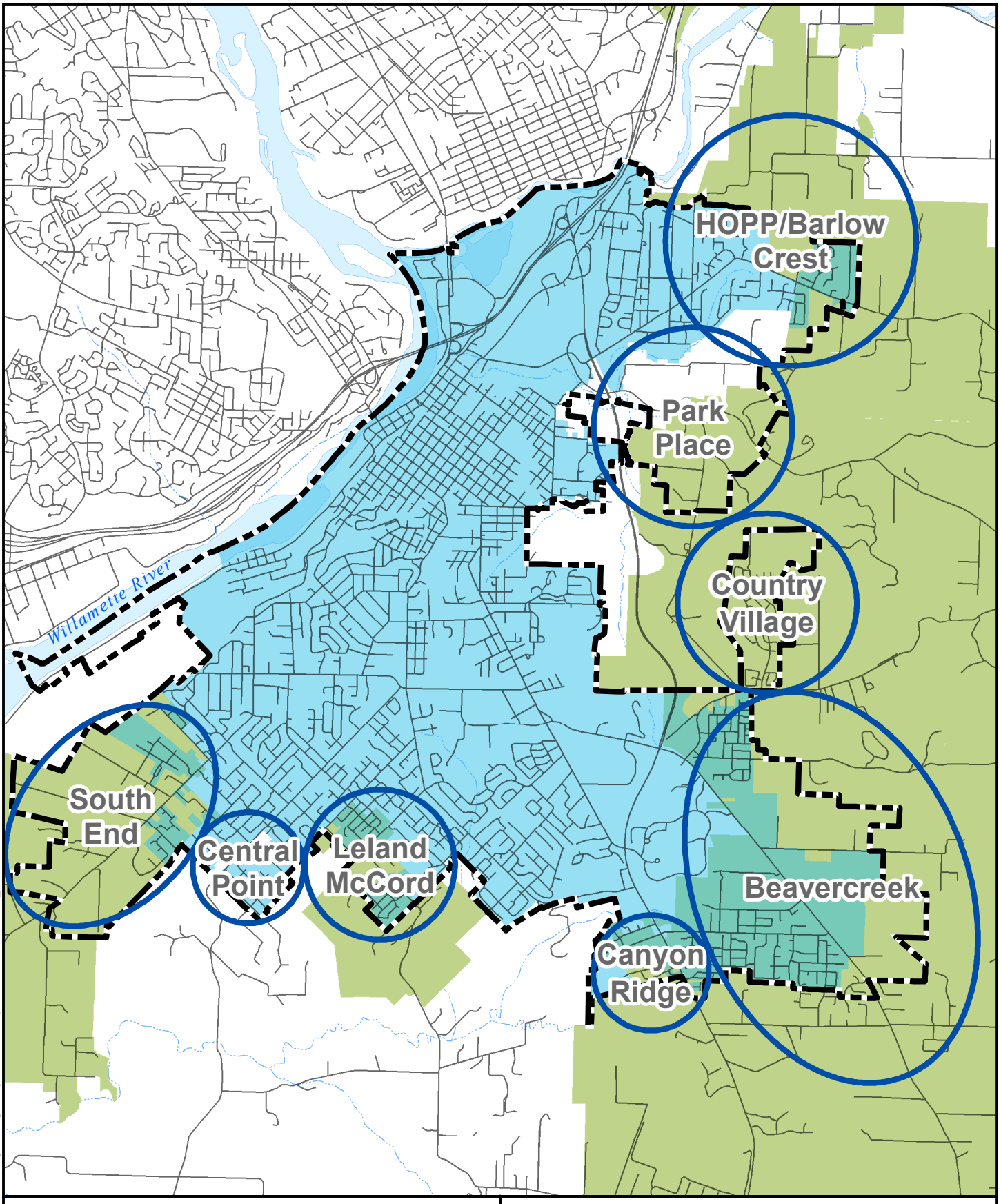
Figures 2A and 2B highlights the overall study area of this white paper and identifies the individual focus areas discussed in detail later in this section. Study dual interest areas are generally located near the Oregon City city limits or the edge of the UGB, where annexation and withdrawals occur.

Focus Areas:

- South End
- Central Point
- Canyon Ridge
- Leland McCord
- Country Village
- Beavercreek
    - Beavercreek Concept Plan
    - Fairway Downs
    - Thayer and Loder Roads
    - Henrici Ridge
    - Park Place
- HOPP/Barlow Crest

Study Area Discussion

The following section details existing conditions, dual interests, and proposed solutions for each study area. While specific solutions are unique, the general goals described in the previous section helped drive a common approach to the solution process.



Urban Growth Boundary (UGB)
Oregon City City Limits
Clackamas River Water District Boundary
Areas of Overlap
Focus Area
Road
River

N

1 inch = 4,000 feet

Oregon City - Clackamas River Water Joint Engineering Study

Figure 2A
Study Area

OREGON CITY

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Clackamas River Water

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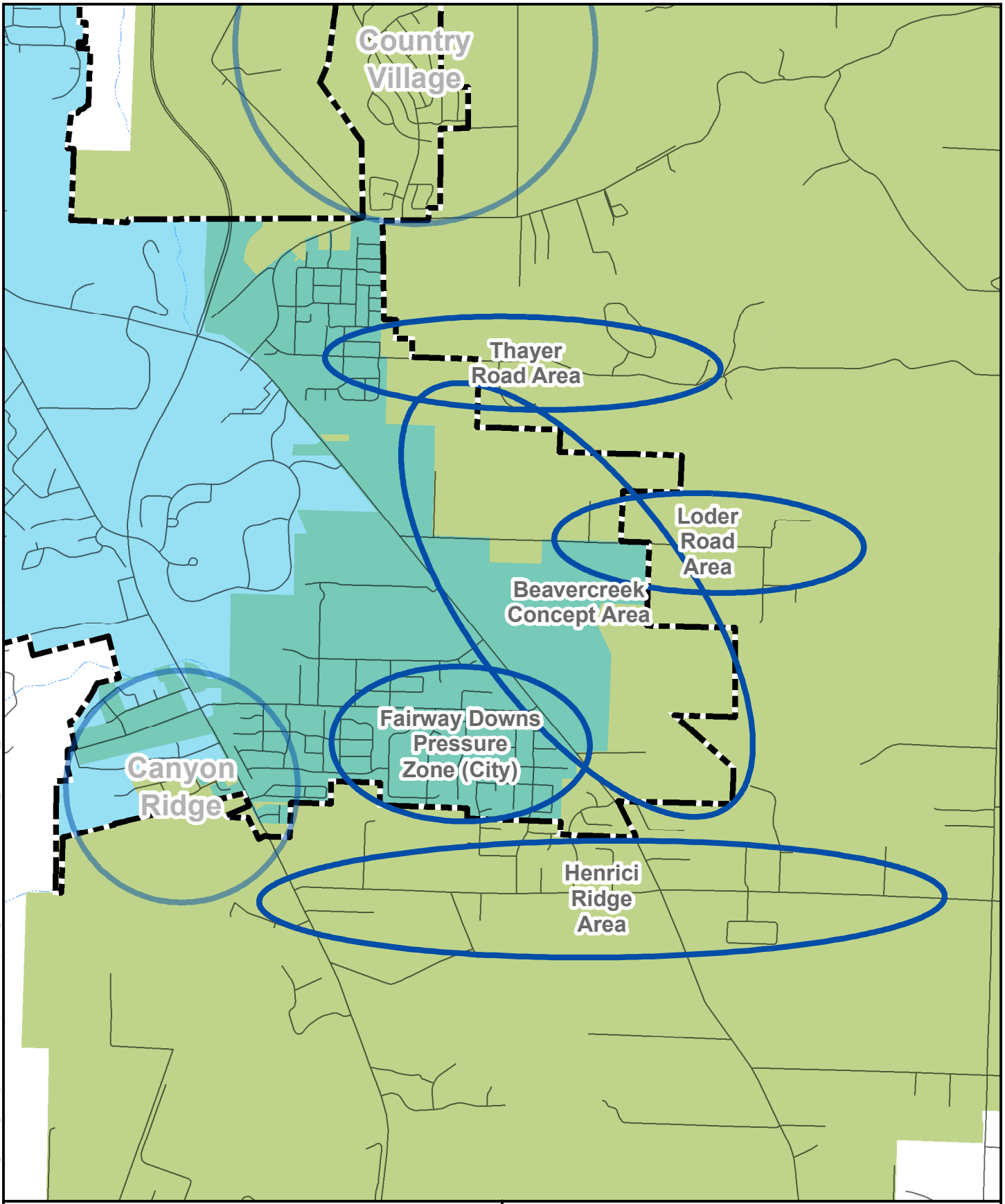

Urban Growth Boundary (UGB)
Oregon City City Limits
Clackamas River Water District Boundary
Areas of Overlap
Focus Area
Beavercreek Areas
Road
River

N

1 inch = 2,000 feet

Oregon City - Clackamas River Water Joint Engineering Study

Figure 2B
Study Area - Beavercreek

OREGON CITY

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Clackamas River Water

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Comments Regarding Mapping

The figures in this section present the existing and proposed service conditions in the focus areas. Existing infrastructure is color coded: dark blue represents City ownership, green CRW ownership, light blue joint ownership, and yellow SFWB or other ownership. Taxlots currently served by CRW are highlighted in colors representing either their existing or future service category. City taxlots have not been highlighted because there is assumed to be no change of service at the individual customer scale. Future conditions maps are only presented if deemed necessary and are intended to be used as a guide for long-term service; intermediate steps may be necessary to achieve this configuration and other alternatives may be preferred, based on actual timing and character of annexation and urban development. Finally, all mapping is limited by the accuracy of the data provided by the City and CRW. Best efforts have been made to resolve lingering inaccuracies but due to ongoing service transitions and the nature of two separate system databases, some inaccuracies are likely.

South End

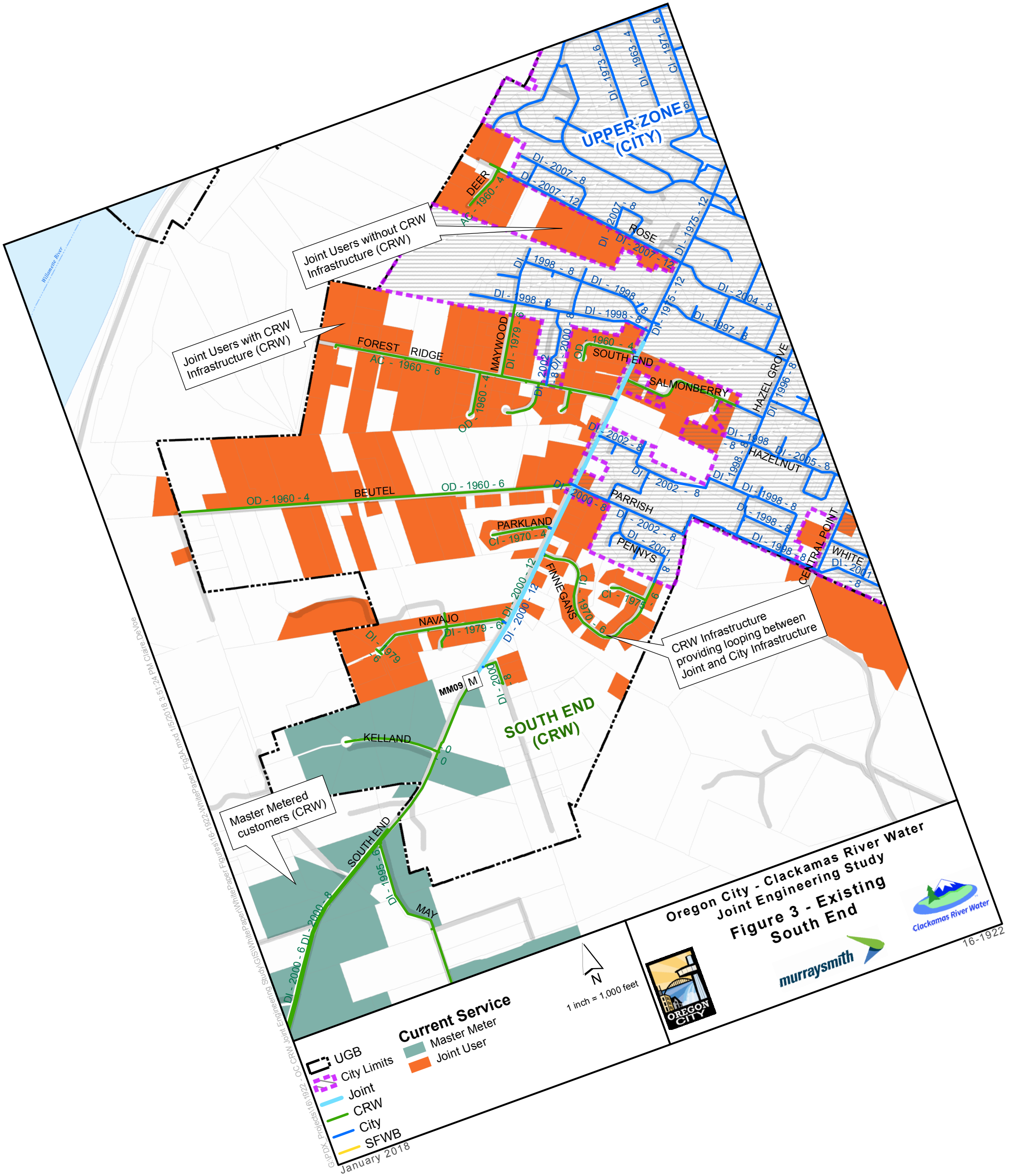
The South End Concept Area is a prime example of dual interests that arise when service transitions occur without a long-term service plan. As the City developed, the geopolitical boundary and service area expanded south into CRW service areas, effectively isolating the CRW South End Area from the rest of the CRW system. Additionally, City annexation occurred at the individual taxlot level, resulting in an inconsistent patchwork of City and CRW service areas and infrastructure. Both providers will continue to collaborate to develop a long-term solution in this area. In this study, the existing condition will be explained and key areas of agreement will be noted, but a finalized solution and transition phasing was not developed.

Most customers in the South End Area are served via a jointly-owned 12-inch diameter transmission main in South End Road and supplied with water wheeled through the City system from the SFWB WTP. CRW customers south of Impala Way are master metered, while north of Impala Way CRW and City mains are served as City customers and CRW joint users. Figure 3 presents the existing system infrastructure and service provider for taxlots currently served by CRW in the South End area.

Both providers have recognized the need for a consistent approach to service and infrastructure transitions in South End. To achieve this goal, policy-level agreements are required, including:

- A remuneration methodology and agreement for the transfer of infrastructure assets
- An updated cost-assignment for installation and maintenance of shared and interfacing (master meter) infrastructure
- A methodology and agreement of triggers for the transfer of service area
- A methodology and agreement for wheeled service (master meter or Joint User status) and development of a wheeling charge

Each of these policy level agreements will continue to appear throughout the discussions of the dual interest areas and are explained in greater detail in the Typical Dual interest/Solutions section


UPPER ZONE (CITY)
Joint Users without CRW Infrastructure (CRW)
Joint Users with CRW Infrastructure (CRW)
DEER
ROSE
FOREST RIDGE
MAYWOOD
SOUTH END
SALMONBERRY
HAZEL GROVE
HAZELNUT
BEUTEL
PARKLAND
PARRISH
PENNYS
CENTRAL POINT
WHITE
FINNEGANS
NAVAJO
KELLAND
SOUTH END
MAY
MM09
M
SOUTH END (CRW)
CRW Infrastructure providing looping between Joint and City Infrastructure
Master Metered customers (CRW)
Willamette River
UGB
City Limits
Joint
CRW
City
SFWB
Current Service
Master Meter
Joint User
1 inch = 1,000 feet
N
Oregon City - Clackamas River Water
Joint Engineering Study
Figure 3 - Existing
South End
Clackamas River Water
murraysmith
OREGON CITY
16-1922
January 2018
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(page 19 of this report). Given the complexity of the South End area water service boundary overlap and uncertainty of future development timing and character, a specific plan for service transfers and infrastructure/territory withdrawal was not developed. A general understanding that the City will ultimately annex and withdraw all territory within the UGB was agreed upon.

Resolution: Ongoing collaborative communication and planning will be required; service agreements (especially Joint User) addressing ongoing leak detection and mitigation.

Central Point

The Central Point area is an example of incomplete annexation and withdrawal. Existing infrastructure in the area is entirely City owned and CRW customers are classified as Joint User served via City mains. **Figure 4** illustrates the existing service configuration in Central Point.

Both providers agreed that given the lack of CRW infrastructure and the adjacent City service area, the City should provide service to all customers in this area. Recently, local development has been the primary driver of provider transitions, and additional efforts should be made to complete all transitions in the near future. There may be a few remaining taxlots outside the present UGB that will necessitate Joint User service, but within the UGB, all efforts should be made to withdraw these customers. One specific issue that will need to be addressed is the City's policy (Oregon City Municipal Code 13.04.260B) for water service outside the City limits. Currently, these customers pay 1.5 times the City retail rate.

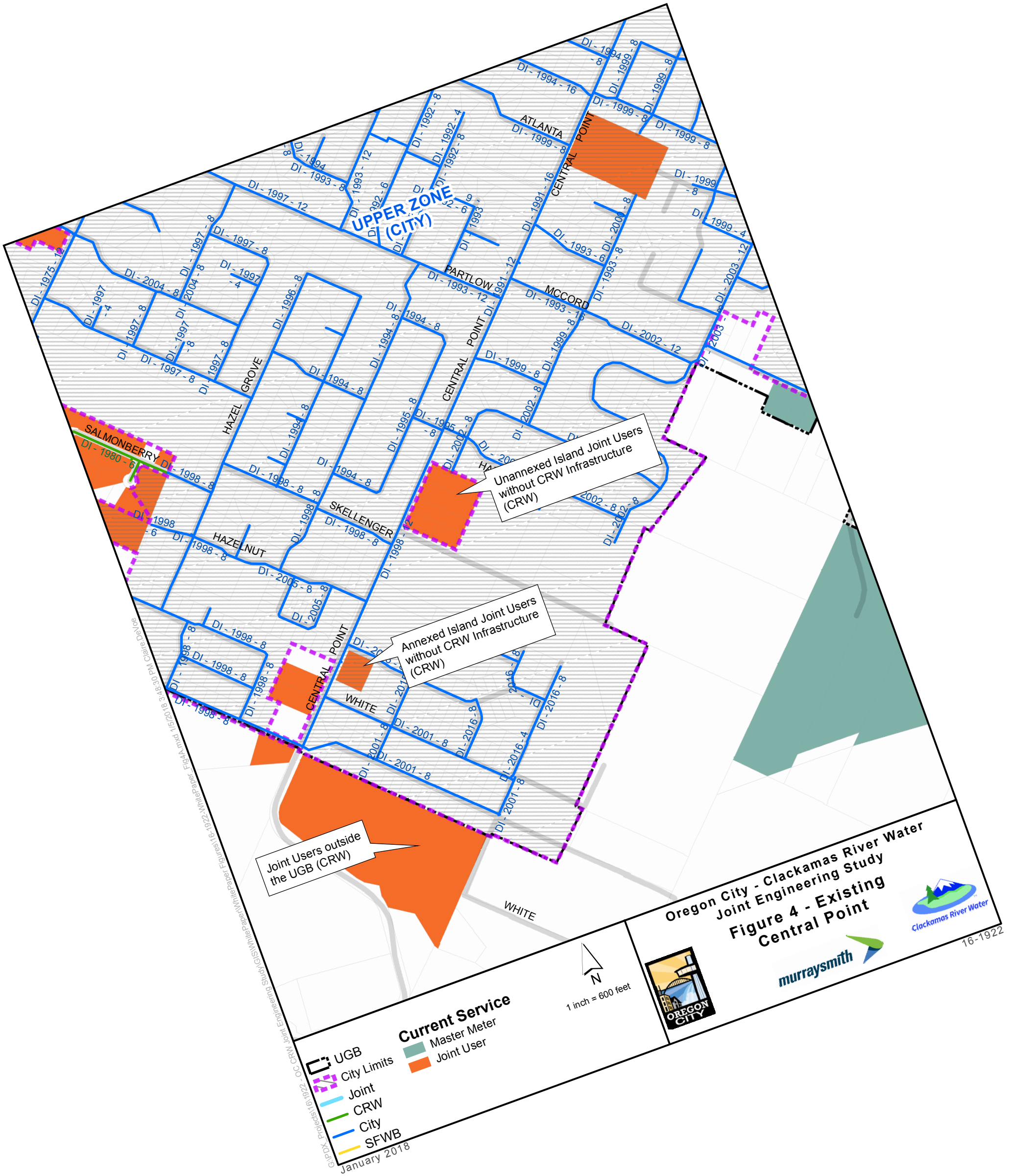
Resolution: All customers within the UGB to be withdrawn by the City; Joint Users remain outside the UGB; City to pursue current extraterritorial service policy change.

Canyon Ridge

The Canyon Ridge area is another example of a CRW service area completely reliant on City supply, although without an intervening master meter. Existing service is provided by CRW through the Joint User agreement via CRW distribution mains in Canyon Ridge Drive and City mains in Molalla Avenue. Canyon Ridge customers are primarily single family homes within the UGB and outside of city limits while others CRW customers are large lots outside the UGB. **Figure 5** shows the current service configuration in Canyon Ridge.

City development west of Canyon Ridge is expected to require looping to the CRW main in Canyon Ridge Drive. To maintain service area continuity and minimize the need for redundant infrastructure, the City should annex and withdraw all CRW customers and infrastructure within the UGB. Taxlots outside the UGB will necessarily remain CRW Joint Use customers served from City mains. East of Molalla Ave these areas are Urban Reserve while west of Molalla customers are Rural Reserve and as such cannot be considered for UGB expansion for several decades, if ever.

Resolution: City to withdraw customers and infrastructure within the UGB; Joint Users remain outside the UGB; City to pursue current extraterritorial service policy change.


UPPER ZONE (CITY)
ATLANTA
CENTRAL POINT
PARTLOW
MCCORD
HAZEL GROVE
SALMONBERRY
SKELLENGER
HAZELNUT
WHITE
Unannexed Island Joint Users without CRW Infrastructure (CRW)
Annexed Island Joint Users without CRW Infrastructure (CRW)
Joint Users outside the UGB (CRW)
UGB
City Limits
Joint
CRW
City
SFWB
Current Service
Master Meter
Joint User
N
1 inch = 600 feet
Oregon City - Clackamas River Water
Joint Engineering Study
Figure 4 - Existing
Central Point
Clackamas River Water
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January 2018
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UPPER ZONE (CITY)

Unannexed Island Joint Users with CRW Infrastructure (CRW)

Unannexed Island Joint Users without CRW Infrastructure (CRW)

Joint Users outside the UGB (CRW)

BEAVERCREEK (CRW)

MEYERS

HIGH SCHOOL

GLEN OAK

PASSAGE

CAUFIELD

HWY 213

TALAWA

CONWAY

CANYON RIDGE

HENRICI

SHELLY SCOTT

QUAIL CREST

Beaver Creek

DI - 1992

DI - 1992 - 16

DI - 2004 - 16

DI - 1999 - 16

DI - 2006 - 8

DI - 2010 - 8

DI - 1999 - 8

DI - 2004 - 8

DI - 2009 - 8

DI - 2003 - 8

DI - 1993 - 8

DI - 1995 - 8

DI - 1980 - 6

OD - 1960 - 6

DI - 1988 - 8

DI - 2001 - 16

DI - 2007 - 12

OD - 1970 - 6

DI - 1977 - 6

DI - 1970 - 6

Current Service
- Beavercreek
- Joint User

- UGB
- City Limits
- Joint
- CRW
- City
- SFWB

N

1 inch = 700 feet

Oregon City - Clackamas River Water
Joint Engineering Study
Figure 5 - Existing
Canyon Ridge

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Leland McCord

The Leland McCord area is similar to the South End area in that supply to CRW customers is entirely dependent on water wheeled through the City system. The City supplies water to a master meter at the intersection of Leland and Meyers Road. CRW and City mains run parallel in Leland Road to just south of Kalal Court, beyond which CRW mains continue in Leland past the UGB. Additional City development and infrastructure has continued along the south-east edge of the UGB, further isolating CRW service area. Figure 6A shows the existing infrastructure and service boundaries in the Leland McCord area.

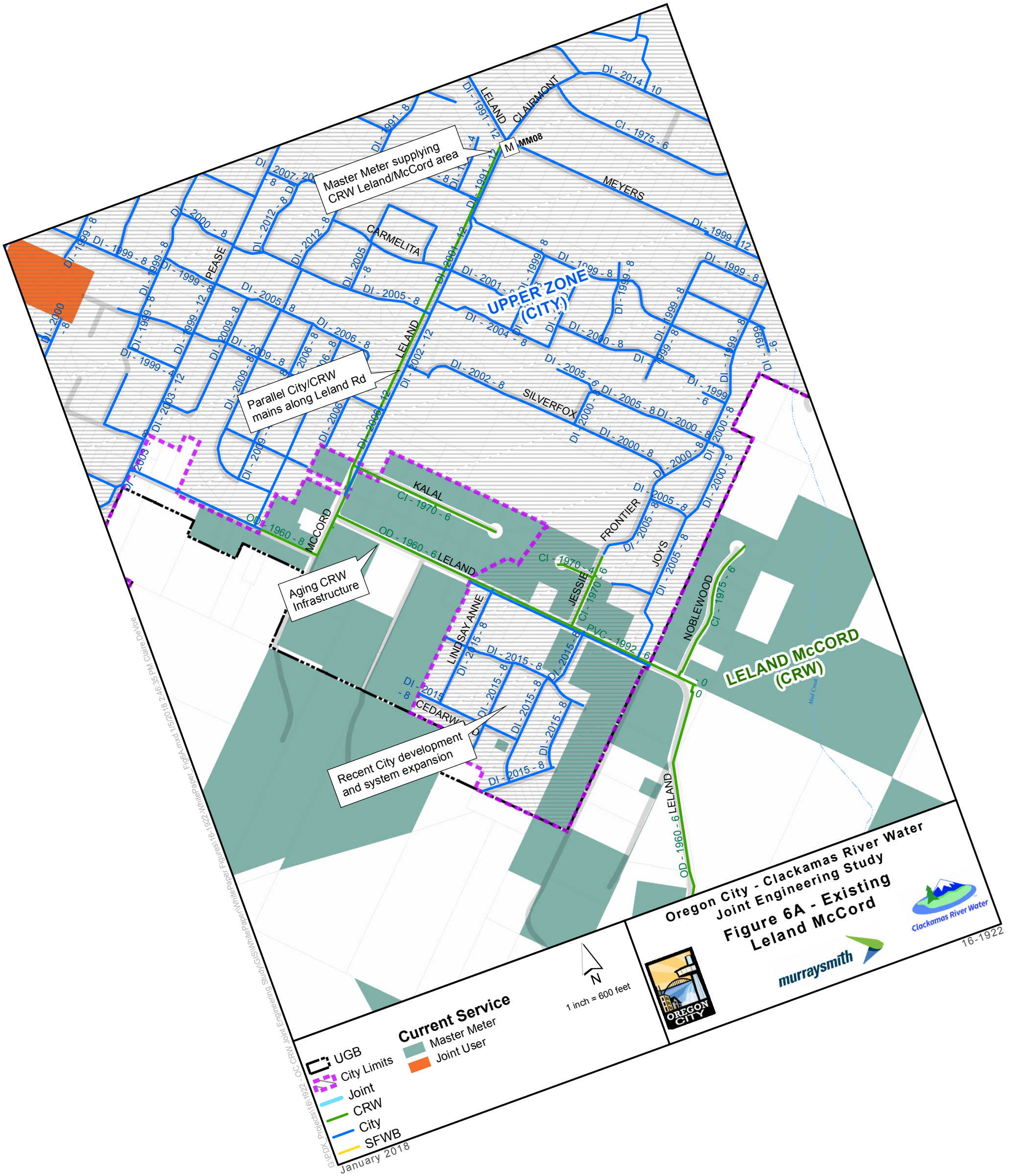
Following the logic used for South End and Central Point, the City should serve customers in the Leland McCord area within the UGB. A master meter should be installed at the UGB to serve remaining CRW customers outside the UGB from the existing CRW distribution main. Figure 6B shows the long-term resulting infrastructure and customer configuration after transfers.

Recent City development south of Jessie Ave to the UGB has extended City infrastructure to the point where looping through the CRW service areas is required and will necessitate either redundant infrastructure or infrastructure withdrawal. However, most of the CRW infrastructure is failing 1960's steel pipe which the City will not withdraw from the district. Both parties prefer to minimize the construction of unnecessary parallel infrastructure. CRW, however, is reluctant to replace the mains without guaranteed return on investment while the City is unwilling to accept the immediate risk by withdrawing the failing infrastructure. Development of a remuneration policy for infrastructure withdrawal would minimize investment in parallel infrastructure, and incentivize system renewal in dual interest areas to the benefit of both City and CRW customers.

Resolution: Continued collaboration; eventual transition to City service within UGB with development; Master meter for customers outside the UGB; City to pursue current extraterritorial service policy change; collaboration for replacement of Leland Road and McCord Road CRW mains applying the remuneration methodology.

Country Village

Country Village is unique in that it is an area served by CRW with limited drivers for development already within the UGB. The area is served by CRW from a single critical transmission main that is not eligible for City withdrawal. This CRW transmission main is the primary supply main from the CRW Holly Lane Pump Station to the CRW owned Henrici Reservoirs, feeding SFWB wholesale water to CRW's Henrici and Beavercreek pressure zones. Because the main is vital to the CRW transmission network, a redundant line would be necessary for the City to annex, withdraw, and provide service. Figure 7 illustrates the focus area, key infrastructure, and service areas.


Master Meter supplying CRW Leland/McCord area
MM08
Parallel City/CRW mains along Leland Rd
Aging CRW Infrastructure
Recent City development and system expansion
UPPER ZONE (CITY)
LELAND McCORD (CRW)
LELAND
CLAIRMONT
MEYERS
CARMELITA
PEASE
SILVERFOX
KALAL
McCORD
FRONTIER
JOYS
JESSIE
NOBLEWOOD
LINDSAY ANNE
CEDARWOOD
DI - 1999 - 8
DI - 2000 - 8
DI - 2001 - 8
DI - 2002 - 8
DI - 2004 - 8
DI - 2005 - 8
DI - 2006 - 8
DI - 2009 - 8
DI - 2012 - 8
DI - 2015 - 8
DI - 1991 - 12
DI - 1999 - 12
DI - 2001 - 12
DI - 2002 - 12
DI - 2003 - 12
DI - 2005 - 12
DI - 2006 - 12
DI - 2014 - 10
CI - 1975 - 6
CI - 1970 - 6
CI - 1970 - 4
OD - 1960 - 8
OD - 1960 - 6
PVC - 1992 - 6
UGB
City Limits
Joint
CRW
City
SFWB
Current Service
Master Meter
Joint User
N
1 inch = 600 feet
Oregon City - Clackamas River Water
Joint Engineering Study
Figure 6A - Existing
Leland McCord
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CRW Infrastructure
to be abandoned -
Master Meter and Leland main

Planned CRW replacement
with withdrawal and
remuneration

Transfer and loop
to City infrastructure

Master Meter moved
to UGB (CRW)

UPPER ZONE
(CITY)

LELAND McCORD
(CRW)

Leland MM

MM08

CLAIRMONT
MEYERS
CARMELITA
PEASE
LELAND
SILVERFOX
KALAL
McCORD
FRONTIER
JOYS
JESSIE
NOBLEWOOD
LINDSAY ANNE
CEDARWOOD
Mud Creek

DI - 2014 - 10
CI - 1975 - 6
DL - 1999 - 12
DI - 1999 - 8
DI - 2000 - 8
DI - 2001 - 8
DI - 2004 - 8
DI - 2005 - 8
DI - 2005 - 6
DI - 2002 - 8
DI - 2002 - 12
DI - 2006 - 8
DI - 2009 - 8
DI - 2012 - 8
DI - 2003 - 12
DI - 1991 - 12
DI - 1991 - 8
DI - 2015 - 8
CI - 1970 - 6
CI - 1970 - 4
OD - 1960 - 8
OD - 1960 - 6 LELAND
PVC - 1992 - 6
DI - 2015 - 8

Future Service
- Master Metered
- Joint User
- City
- UGB
- City Limits

- Joint
- CRW
- City
- SFWB
- Transfer
- New Main
- Abandon

N

1 inch = 600 feet

Oregon City - Clackamas River Water
Joint Engineering Study
Figure 6B - Future
Leland McCord

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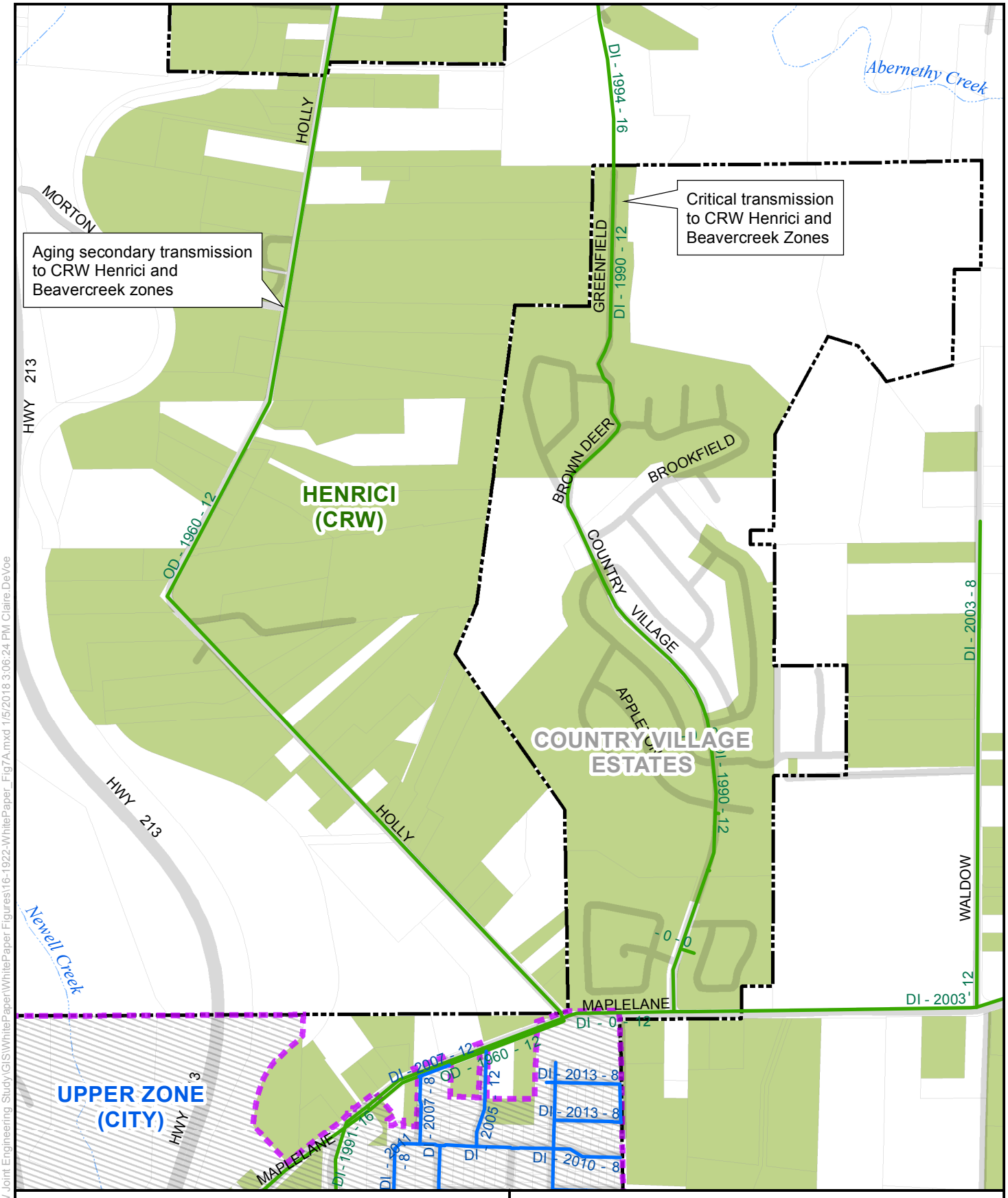

UGB
City Limits
Joint
CRW
City
SFWB

Current Service
Henrici

N

1 inch = 750 feet

Oregon City - Clackamas River Water Joint Engineering Study

Figure 7 - Existing Country Village

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Clackamas River Water

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Additionally, the area is not adjacent to other City service and there is minimal development expected between Country Village Estates and City service areas. Although customers are within the UGB, CRW should continue to serve existing and future customers in the area, until such a time that the City has either built out infrastructure to serve the area or redevelopment requires annexation and extension of other City services to the area.

Resolution: No change from present service arrangement.

Beavercreek and Surrounding Areas

Service to the Beavercreek area affects recommendations for both City and CRW service areas including the City's Beavercreek Concept Area, the City's Upper Zone, the City's Fairway Downs Zone, CRW's Beavercreek Zone, CRW's Henrici Zone, the Henrici Ridge Area, and the City's Park Place Concept Area. Because the Beavercreek area is so highly linked to both systems, an opportunity to minimize redundant existing and future facilities, and potentially provide additional flexibility and resiliency to both systems, is present if both providers agree to the development of jointly owned facilities.

Existing Service

Currently, CRW and the City have essentially duplicate pressure zones at similar hydraulic grades serving partially redundant areas: CRW's Henrici zone (590 ft reservoir overflow) and the City's Upper zone (592 ft). The City's Upper Zone serves most of the southern part of the City within the UGB while CRW's Henrici Zone serves areas outside the UGB and provides some overlapping service along the eastern limits of the UGB.

Because of these essentially redundant zones, there are two separate pathways for water to reach an HGL of 590 ft. Within the City's system, water can be pumped from the SFWB WTP via the SFWB Division Street Pump Station to the City's Intermediate Zone (490 ft), then via the City's Mountainview Pump Station to the City's Upper Zone and City Henrici Reservoir (592 ft). Within CRW's system, water can be delivered from the SFWB WTP through the Anchor Way master meter, then pumped via the CRW Holly Lane Pump Station to the CRW Henrici Zone and CRW Henrici Reservoirs (590 ft). Two interties exist between the two systems at the 590 ft level, and could allow for supply in either direction.

Both systems also provide service to elevations requiring hydraulic grades greater than 590 ft. The City serves the closed Fairway Downs Pressure Zone (652 ft) via the Fairway Downs Pump Station. Supply to this zone is provided by the City's Upper Zone. CRW serves the Beavercreek Pressure Zone (744 ft) via the Glen Oak Pump Station. Supply to this zone is provided by CRW's Henrici Zone.

Figure 8 illustrates the configuration of existing infrastructure serving the Beavercreek area and associated service areas.

WTP
WTP (SFWB)
PARK PLACE ZONES (CITY)
LOWER (CITY)
HOLCOMB (CRW)
Anchor Way MM To CRW
M
Holly Lane PS (CRW)
PS
Division St PS (SFWB)
REDLAND (CRW)
INTERMEDIATE (CITY)
Mountainview Res & PS (City)
HENRICI (CRW)
Areas presently within both providers' service areas
UPPER (CITY)
Parallel City/CRW transmission in Beavercreek Rd
Areas presently above existing City service
Fairway Downs PS (CITY)
Glen Oak PS (CRW)
Henrici Res (City)
Henrici Urban Reserve (3F)
FAIRWAY DOWNS (CITY)
Henrici Res (CRW)
BEAVERCREEK (CRW)
Beavercreek Res & PS (CRW)

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UGB
City Limits
CRW
City
SFWB
Parallel City/CRW

PRESSURE ZONES
City
CRW

N
1 inch = 3,750 feet

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Oregon City - Clackamas River Water Joint Engineering Study

FIGURE 8 - EXISTING BEAVERCREEK

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Clackamas River Water

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16-1922

Expected Development

Development is expected in the Beavercreek area, although there is uncertainty over timing and extent. Within the UGB and north of Beavercreek Road, the City's Beavercreek Concept Plan calls for a mixed-use neighborhood. This development is expected to be served primarily by the City's Upper zone, and elevations above 480-ft (approximately south of Loder Road) will require a hydraulic grade similar to the City's existing Fairway Downs zone. However, the City's existing Fairway Downs Pump Station does not have capacity for this expansion and additional investment will be required to serve this area.

Continued development is expected in the CRW service areas outside the UGB, with the added confusion of possible service area withdrawal within the development timeframe. This is especially key for the Henrici Ridge area, which is currently designated as Urban Reserve and will be among the areas next considered for UGB expansion. When that occurs, City service to the area (to be consistent with service area goals) would require an even higher hydraulic grade than the City's Fairway Downs zone.

To meet the developing needs of the Beavercreek area, additional storage and transmission facilities will be required for both the City and CRW. Both providers have independently developed alternatives for service to the area, and through extensive discussions, we have developed a shared infrastructure alternative that may be more cost effective and in-line with the providers' goals set forth earlier in this report.

Demand and Storage Characterization

Existing and buildout demands and storage capacities for applicable CRW and City service areas were calculated and are presented in Table 2. For this analysis, storage needs for the existing pressure zones serving elevations in the Beavercreek area and the pressure zones supplying these zones were evaluated. Service area transfers likely to occur were included in buildout figures. Based on these estimates, the City will need to build additional storage at the City's Upper zone elevation and CRW will require additional storage at the CRW Beavercreek zone level. A summary of key assumptions for this analysis follows:

- Since the existing City Fairway Downs zone does not have existing storage, the *Existing Average Day Demand* (ADD) of this zone is included in the City Upper zone demands for the purposes of calculating existing storage needs. This also applies to demands for the CRW areas served from master meters at South End and Leland.

- *Build-out Average Day Demand* is based on recent planning documents and future service area boundaries described in this report. A comprehensive analysis of City and CRW pressure zone boundaries and a refined estimate of build-out development needs has not been completed. This analysis is intended to provide an order of magnitude estimate of storage volume needs for the purpose of evaluating alternatives.

- *Total Available Storage* is based on the volume of storage currently serving each pressure zone. For the City's Upper Zone, the 2010 Water System Master Plan considers the full volume of the City's Mountain View Reservoir No. 1, which provides suction supply to the City's Mountain View Pump Station serving the Upper zone, to be available storage for the Upper zone. This assumption should be verified before final decisions regarding City Upper zone storage needs are made, as it could result in a change to the long-term storage need in the Upper zone.

- *Existing Storage Need* and *Build-out Storage Need* are the sum of the three components of water system storage – equalizing, fire suppression and emergency – as defined in each water provider's Water System Master Plan. These volumes are calculated based on the zone's existing and build-out demand projection.

- *Existing Available Capacity* and *Build-out Available Capacity* are calculated as the difference between the *Total Available Storage* and *Existing (or Build-out) Storage Need* for the zone. A negative value represents a capacity deficit.

Table 2
Beavercreek Area Demands and Storage Capacity

	Existing Average Day Demand (MGD)	Build-out Average Day Demand (MGD)	Total Available Storage (MG)	Existing Storage Need (MG)	Existing Storage Surplus (MG)	Build-out Storage Need (MG)	Buildout Storage Surplus (MG)
City Upper	2.9	5.5	14.5	9.1	5.4	16.5	-2.0
City Fairway Downs	--	0.6	--	--	--	1.8	-1.8
CRW Henrici	0.2	0.2	1.5	0.6	0.9	0.6	0.9
CRW Beavercreek	0.6	1.7	2.0	1.8	0.2	4.7	-2.7

Notes:

1. MG = Million Gallons; MGD = Million Gallons per Day

The individual and shared infrastructure alternatives will need to address these storage requirements to be considered viable. **Table 3** presents a summary of each alternative and planning level cost estimates for service to the Beavercreek Area. More detailed descriptions of each alternative are given in the following sections.

Table 3
Supply Alternatives to the Beavercreek Area

	City Independent Infrastructure Alternative			CRW Independent Infrastructure Alternative			Shared Infrastructure Alternative			Preliminary Buildout Cost Sharing	
	Item	Size	Total Cost[1]	Item	Size	Total Cost[2]	Item	Size	Total Cost[3]	City Cost	CRW Cost
Pump Stations	Fairway Downs Improvements		100,000	Beaver Lake	3MGD	1,700,000	New Station at the City's Henrici Site	3MGD	1,700,000	500,000	1,200,000
Reservoirs	Beavercreek	2 MG	4,000,000	Beavercreek Elevated	3.5 MG	7,000,000	Beavercreek Elevated	2x2.75 MG	11,000,000	4,000,000	7,000,000
Transmission	Fairway Downs Pump Station to New Reservoir	16-inch 10,750 lf	3,400,000	Grasle Road	12-inch 13,480 lf	3,200,000	New Pump Station to Beavercreek Reservoirs	12-inch 3,200 lf	800,000	200,000	500,000
	Total		$ 7,500,000	Total		$ 11,900,000	Total		$ 13,500,000	$ 4,700,000	$ 8,700,000
									Cost decrease:	37%	27%

Notes:

1. City costs updated from 2013 City Technical Memo
2. CRW costs updated from 2015 Backbone Project Memo
3. Unit costs for shared infrastructure solution – reservoir 2$/gal; Pipe 20$/in-lf
4. Joint costs consistent with CRW pump station cost, study unit costs
5. Cost division based on buildout demand for pump station and transmission piping, storage requirements for elevated reservoirs

The values presented are only planning level estimates and need to be verified prior to development of infrastructure designs. In particular, the capacity of existing City Upper Zone and CRW Henrici zone transmission piping to supply the expanded Beavercreek service area at build-out will need to be confirmed as additional transmission improvements to address existing deficiencies may have a significant impact on cost estimates.

A. City Service to Beavercreek Concept Area and Fairway Downs

In the Oregon City Technical Memorandum dated November 5, 2013, the City presented three options to serve the Beavercreek area within the UGB. Based on our understanding that CRW does not have excess capacity in the existing CRW Beavercreek Reservoirs, two of the three options are infeasible. The remaining option for the City would be to build a new 2 MG Beavercreek Reservoir with a 16-inch diameter transmission main and improve the existing Fairway Downs Pump Station (City Independent Infrastructure Alternative in Table 3).

Additional costs and political investment would be incurred during the land acquisition and permitting process. The City does not currently own property for a reservoir at the proper elevation. This is a significant hurdle, and should not be disregarded.

While the City has planned for service within the existing UGB, the planning does not provide adequate pressures for the Henrici Ridge area that is currently designated as Urban Reserve. If this alternative is selected, the City will need to consider capital costs for additional infrastructure to serve this higher elevation area once development occurs.

B. CRW Service to Beavercreek Pressure Zone and Fairway Downs

CRW's current planning for improved service to their Beavercreek pressure zone is part of the larger CRW Backbone Project. Overall, the project is designed to improve system connectivity and transmit water from the CRW WTP to CRW service areas south of the Clackamas River. Phase 1 of the Backbone Project is currently in various stages of design and construction and will transmit water to the Redland Reservoirs and associated pressure zone. Phase 2 would construct transmission and pumping improvements to transmit water from the Redlands Reservoirs south to the Henrici and Beavercreek pressure zones as well as north to the Holcomb pressure zone (CRW Independent Infrastructure Alternative in Table 3).

Phase 2 currently plans for service to the entire existing Beavercreek pressure zone. However, it is probable that some of this area will eventually be City territory and supplied by the City, rendering some of the Phase 2 facilities oversized and unused with remaining useful life. CRW cost estimates in Table 3 were updated similarly to City estimates, and storage capacity in the elevated tank was decreased to reflect the volume required to serve CRW customers to buildout.

C. Shared Infrastructure to Serve the Beavercreek Area

Typical of dual interests between the City and CRW, planning in the Beavercreek area has been limited by boundaries that are subject to change. It is expected that the lifespan of infrastructure built now will extend beyond the lifespan of the current UGB. Opportunity to develop shared infrastructure to serve both providers' customers and facilitate transfer of service area without construction of parallel redundant infrastructure is a goal of this study. Already, the City and CRW serve similar elevations from their Henrici Reservoirs. Emergency interties exist between the two systems and additional overlap of service and infrastructure is expected with continued development if coordination does not occur.

To optimize the use of existing infrastructure, one possible alternative would be a new pump station at the City's Henrici Reservoir to replace CRW's Glen Oak Pump Station, new transmission main along Henrici Road to increase the capacity of CRW's existing transmission to CRW's Beavercreek Reservoirs, and two new elevated tanks at the existing CRW Beavercreek Reservoir site for additional storage for both providers (Shared Infrastructure Alternative in Table 3). A PRV and meter could be installed at the existing City Fairway Downs Pump Station to supply the City's expanded Fairway Downs zone.

Benefits of Shared Infrastructure Development

Shared infrastructure will allow for greater flexibility with construction phasing, minimize the land acquisitions required, provide redundant supply pathways, reinforce emergency supply pathways

and allow for future infrastructure consolidation. Other potential benefits include minimizing operational & maintenance costs and future infrastructure renewal needs.

Given the uncertainty of development timing, shared infrastructure could be built in stages, with existing facilities providing supply until upgrades are required. The shared Beavercreek Reservoirs could be built one at a time, allowing for future demolition of the existing ground level tank to provide a site for the second elevated tank. The CRW Glen Oak Pump Station can continue to be used to supply the Beavercreek zone as is, until the new shared Henrici Pump Station is completed. When the UGB is expanded and/or CRW areas are annexed by the City, shared infrastructure would simplify the transition process because independent infrastructure service to the area would require significant parallel and costly redundant facilities throughout the area. Ultimately, with a shared solution there will be opportunity to decommission aging redundant facilities when the cost to maintain these facilities exceeds their value as backup infrastructure. This is specifically true for the City's existing Fairway Downs Pump Station, CRW's Henrici Reservoir and CRW's Glen Oak Pump Station.

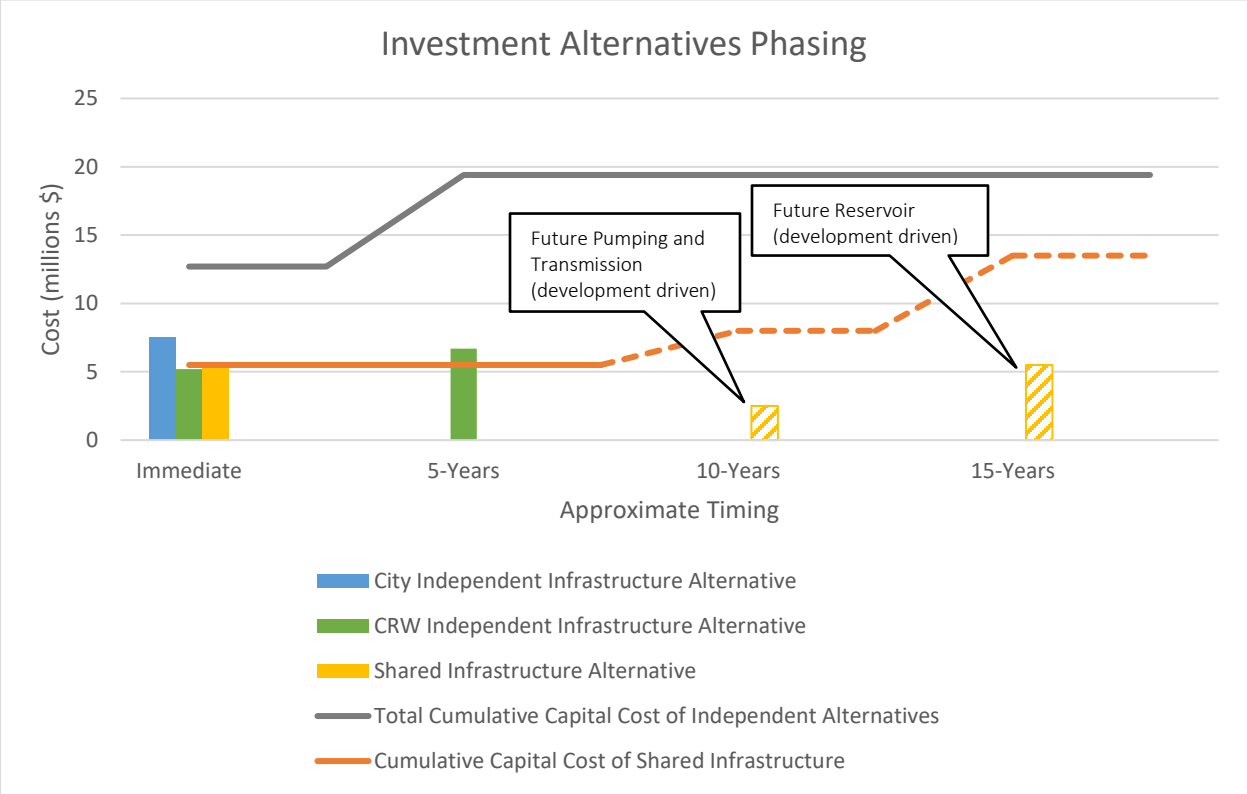
Figure 9 illustrates the capital cost over time of the individual and shared infrastructure alternatives. The shared infrastructure alternative is based on a potential phasing schedule, with the first reservoir built immediately, the transmission and pump station built in 10 years, and the second reservoir built in 15 years. These dates are conceptual to illustrate the potential phasing opportunity and are dependent on development of the City's Beavercreek concept plan area. The individual alternatives must be built within the next 5 years, if not sooner, with limited flexibility for shifts in development timing.

Utilizing existing infrastructure will minimize both monetary and political cost of additional land acquisition for new infrastructure siting. The City's Henrici Reservoir site has capacity for both a new pump station and additional reservoir, if deemed necessary in the future. CRW's Beavercreek site has capacity for at least one additional reservoir, with a second reservoir potentially able to be built at the site of the existing ground level tank.

The shared infrastructure alternative will also provide redundant pathways for service and emergency supply to the Beavercreek and Fairway Downs zones. Given recent emphasis on seismic resiliency this redundancy aligns with resiliency goals. The primary supply via the SFWB Division Street Pump Station and the City's Mountainview Pump Station have adequate supply for normal service. The secondary supply via the master meter at Redland and Anchor Way, the CRW Holly Lane Pump Station, and the emergency intertie between the City and CRW at Beavercreek provides redundancy not necessarily guaranteed in independent infrastructure alternatives.

Another benefit of a shared infrastructure alternative is the potential for continued consolidation of redundant and aging infrastructure. As the system is served today, the City and CRW have redundant pressure zones at the 590 HGL. Four tanks, (two CRW and two City-owned), serve this zone, although none of the tanks currently meet updated seismic standards and some are approaching the end of their useful lives. A shared infrastructure solution lays the groundwork for continued development of efficient infrastructure investment through partnership.

Figure 9
Infrastructure Investment Phasing Alternatives



Service Transitions in Affected Areas

Within each pressure zone, there are additional specific areas that will be affected more than others by the solutions to serve the Beavercreek Area.

Thayer and Loder Roads:

At present, CRW supplies customers along Thayer and Loder Roads via CRW distribution mains branching from the CRW transmission line along Beavercreek Road. Both mains begin within city limits and extend outside the UGB. In both cases, areas within the UGB are part of the City's Beavercreek Concept Area and should be annexed and withdrawn by the City. The City will then need to connect the existing CRW mains in each road to the City transmission main in Beavercreek Road. This will transition supply from the CRW Henrici zone to the City's Upper zone. At the UGB, master meters or Joint User status may be negotiated to supply remaining CRW customers outside the UGB.

Henrici Ridge:

Henrici Ridge is the area just south of the UGB along Henrici Road that cannot be served by the City's existing grades. As an Urban Reserve area, it is expected to eventually be annexed into the UGB and City service. If the shared infrastructure alternative is not selected, future service by the City to this area will require significant investment in parallel infrastructure.

Park Place Concept Area:

The Park Place area is located entirely within the UGB and outside of city limits. The area, currently served by CRW, is supplied from SFWB via the Redland and Anchor Way Master Meter and pumped up to higher pressures by the Holly Lane or the Redland Pump Stations (see Figure 10A). Until urban development occurs, the area should be served as is.

The 2008 Park Place Concept Plan calls for a City distribution network starting south of Ogden Middle School and connecting north to existing City distribution mains along Holcomb Boulevard. A reservoir at Holly Lane and Morton Road is proposed to provide additional storage.

Given the limited number of existing services, it is recommended that the providers plan for future City service to the entire Park Place area. CRW will need to maintain transmission from the existing Anchor Way MM through Park Place to reach CRW's Holly Lane and Redland Road Pump Stations. Some existing CRW transmission infrastructure through this area is aging and will need to be replaced. It is suggested both providers fund a shared transmission main from the master meter to Holly Lane.

Existing CRW infrastructure is critical for CRW supply from the SFWB supply at Master Meter 02 to the CRW system. As such, the only water mains that may be eligible for withdrawal and remuneration are a portion of the CRW 12-inch diameter steel main in Holly Lane, extending south from CRW's Holly Lane Pump Station to the UGB, and a CRW 12-inch diameter ductile iron main in Donovan Road that serves the middle school. The possible shared improvement along Redland Ave would require relocating the Anchor Way Master Meter to Holly Lane (which would become a City to CRW master meter) and would replace aging infrastructure and serve the common needs of both utilities – water transmission backbone piping in Redland Road between Anchor Way and the UGB.

Figure 10B illustrates the proposed future service area and infrastructure withdrawals.

In order to accommodate the phased development of the Park Place area, the City should develop a detailed Park Place water service master plan to include:

- Confirmed siting, configuration, and capacity of future storage identified as the proposed Holly Lane Reservoir
- Confirmed water main sizing and backbone transmission facilities to serve the Lower Park Place pressure zone, including SFWB transmission main connections and pressure reduced supply from the Intermediate Park Place pressure zone

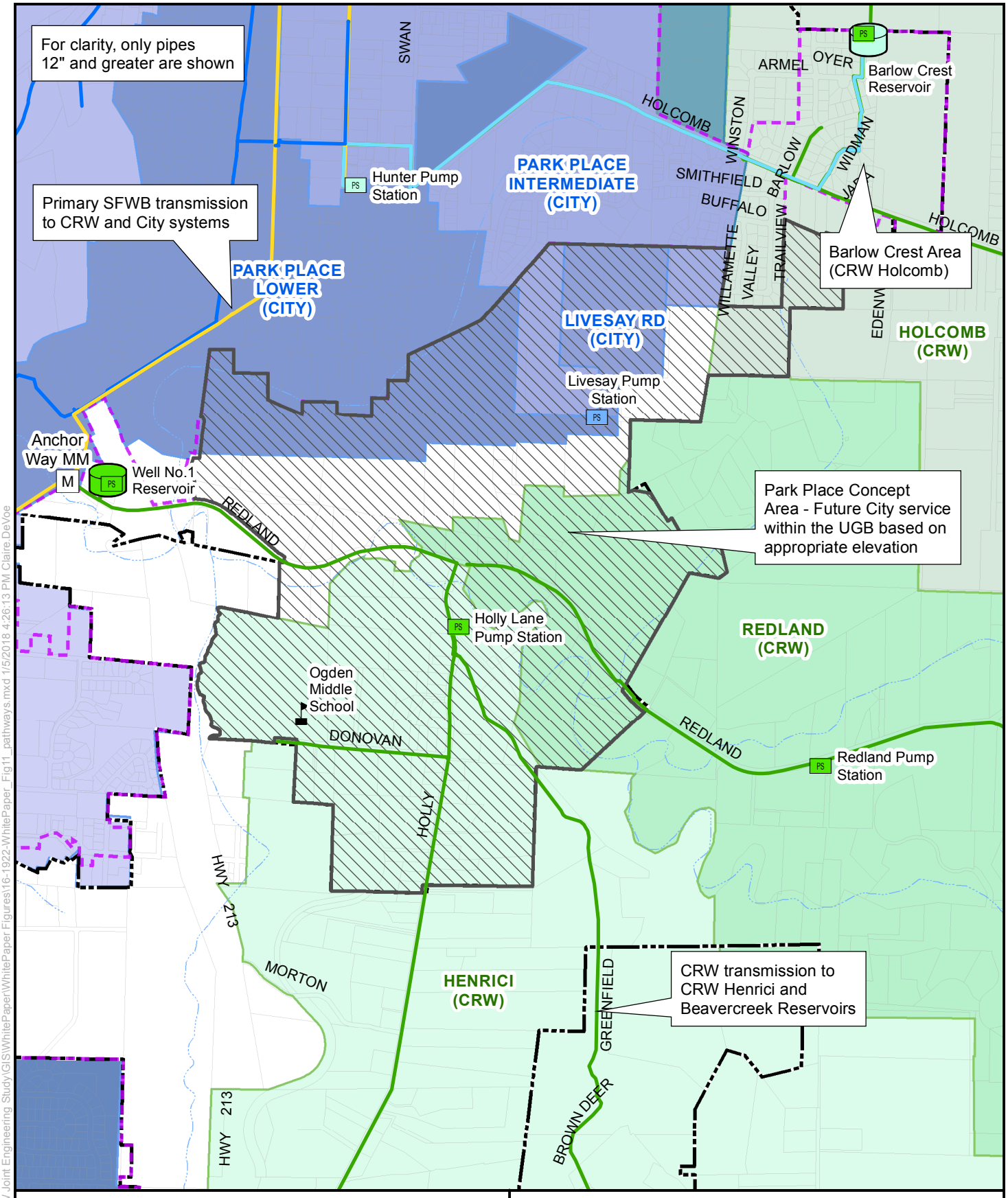


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FIGURE 10A - EXISTING PARK PLACE

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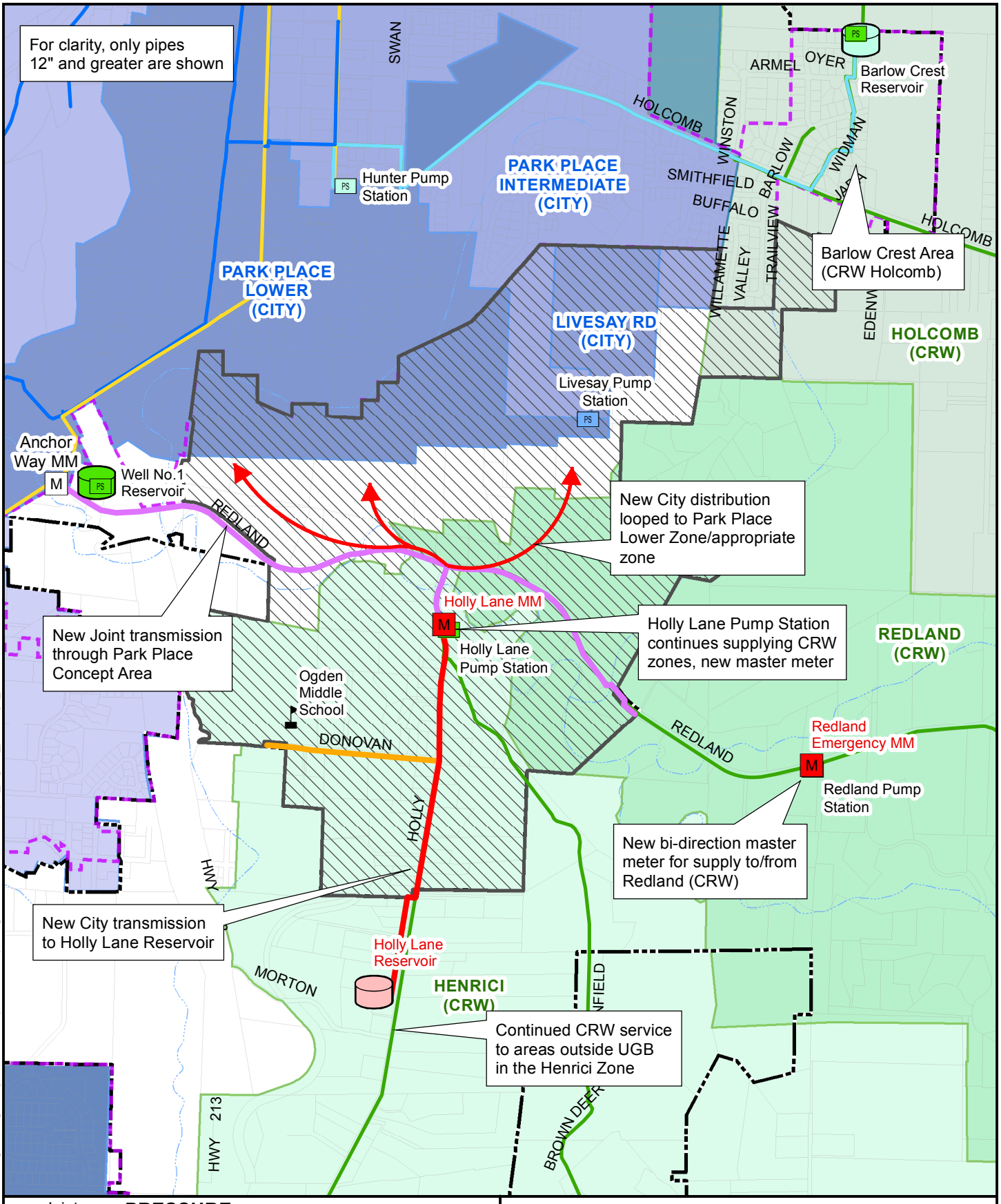

Oregon City - Clackamas River Water Joint Engineering Study

FIGURE 10B - FUTURE PARK PLACE

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Clackamas River Water

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- Coordination with CRW to determine if new shared transmission in Redland Road is feasible and to determine if potential withdrawal of mains between Holly Lane and the UGB is feasible and desirable.

These studies will inform how infrastructure develops in the near-term and will support CRW development of additional infrastructure to provide limited service until annexation and withdrawal occurs with the full development of the City water system facilities to provide service.

Resolution: Continued discussions regarding shared storage and transmission infrastructure in the Beavercreek and Park Place areas; Partial developer driven transfers and potential master meter relocation to the UGB

HOPP/Barlow Crest

The Holcomb-Outlook-Park Place focus area includes the CRW Holcomb-Barlow master metered zone, the CRW Holcomb pressure zone, and City service areas near Holcomb Road. Existing service to the HOPP area was set up under the 1998 HOPP Agreement which terminates in the year 2028, and includes jointly owned facilities and transmission mains. Presently, the SFWB WTP is the sole water supplier to the area. **Figure 11** illustrates the focus area, critical facilities, and customer designations.

North of the City, the CRW Holcomb-Barlow zone is served via multiple master meters from the City's Park Place Intermediate zone. This area is not expected to develop in the near future and should continue to be served as is via master metering.

Similarly, within the existing City service area, City customers should continue to be served without change.

The main point of dual interest in the HOPP area is the CRW/City interface at Barlow Crest. The CRW Holcomb pressure zone (797-ft HGL) is currently supplied with SFWB sourced water wheeled through jointly funded infrastructure from the SFWB WTP to the jointly owned Barlow Crest Reservoir (549-ft overflow). The CRW Barlow Crest Pump Station pumps from the jointly owned Barlow Crest Reservoir to the CRW Hunter Heights Reservoirs (797-ft overflow) which provide gravity supply to the CRW Holcomb pressure zone.

Much of the CRW Holcomb zone located within the UGB has been annexed into the city limits. However, the City does not have the existing infrastructure to provide service to this area as the Barlow Crest Pump Station is an essential facility for CRW's supply to the Hunter Heights Reservoir which serves CRW's Holcomb pressure zone both inside and outside the UGB.

Master Meter and transmission to Holcomb/Barlow (CRW)

MM11

Barlow Crest Pump Station

Barlow Crest Reservoir

Barlow Crest area (CRW Holcomb zone) at elevations greater than Clty service and within UGB

To/from CRW Hunter Heights Reservoirs

PARK PLACE INTERMEDIATE (CITY)

UMBER VIEW

OYER

ARMEL

TRAIL

WINSTON

BARLOW

WIDMAN

JADA

HOLCOMB

SMITHFIELD

BUFFALO

WILLAMETTE VALLEY

TRAILVIEW

EDENWILD

Clackamas River

Current Service

- Holcomb
- Barlow Crest Area

UGB
City Limits
Joint
CRW
City
SFWB

N

1 inch = 400 feet

January 2018

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Joint Engineering Study

Figure 11
HOPP/Barlow Crest

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Clackamas River Water

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Additionally, the CRW Backbone Project Phase 2 is proposed to include a new pump station and transmission facilities to boost water from the CRW Redland pressure zone to the Holcomb pressure zone/Hunter Heights Reservoir. This will provide a second supply route and water source to the Barlow Crest pressure zone. These improvements will allow CRW to supply the Holcomb zone from CRW's WTP.

Given the current understanding of the CRW Backbone Project, existing infrastructure, and the goals outlined in this white paper, there are two alternatives to consider:

A) Continued service as is, recognizing the City will continue to annex the land within the UGB but will not withdraw the territory from CRW. CRW would remain the service provider for the entire Holcomb pressure zone area inside and outside the UGB serving customers above an elevation of approximately 450 feet. The Phase 2 Backbone Project improvements would provide a second feed to the Holcomb pressure zone, allowing for a second source, the CRW WTP, to supply this area. The primary advantage of this option is that infrastructure and master meters are already in place to continue service as is for areas above an elevation of 450 feet. The primary disadvantage is that this alternative is not consistent with the goal of City service within the UGB, where feasible.

B) The City continues to annex and withdraw territory within the UGB and the associated distribution piping. An additional master meter would be installed at the UGB to deduct City supplied Holcomb pressure zone demand from the total supply from the CRW's Barlow Crest Pump Station. If improvements identified in the Phase 2 Backbone Project area constructed, future supply could be provided by CRW from either the CRW Barlow Crest Pump Station or the future CRW Bradley Road Pump Station with master metering to totalize the demand of the City area in the joint Holcomb pressure zone inside the UGB. This option would most effectively meet the goal of aligning service area boundaries with associated geo-political boundaries. However, it creates a complicated master metering and water wheeling arrangement.

Alternative A is recommended as it does not require the construction of additional master metering infrastructure, and minimizes disruption to existing rate payers. It is also compatible with the CRW Backbone Project as all water supply impacts are to CRW customers only.

In order to facilitate City management of sewer service, including the ability to take action in the event of non-payment by a customer, an agreement between the two agencies should be developed similar to the existing agreement between CRW and the City of Milwaukie.

Resolution: No change from the existing condition; development of a billing and customer shut off agreement

Typical Dual interests/Solutions

This section outlines proposed policy-level criteria for service area and infrastructure transfer.

Annexation and Withdrawal

Areas under consideration for withdrawal should meet the following criteria:

- Located within the UGB. Areas located within city limits should be given highest priority for withdrawal from the district, if possible.
- Adjacent to existing city limits. Priority should be given to CRW areas surrounded by City service area.
- Priority should be given to areas currently receiving additional City services such as sewer, etc.

The City and CRW will need to collaborate for the development of a plan and typical procedure for implementing service transfers once areas have been identified for withdrawal.

Infrastructure Remuneration

A remuneration policy should be developed to encourage proper maintenance and replacement of aging infrastructure and to encourage sizing to meet long-term needs regardless of the future water service provider ownership. The economic analysis was completed as part of this project and addresses the specific financial elements and further detail the parameters of the policy.

Master Meters and Joint Users

Master meters are required when water is supplied through wheeling and meets one or more of the following criteria:

- The service area crosses the UGB at which point a meter would be placed at the UGB
- The total length of pipe past the meter is greater than 1,000 lf
- The service area is not predicted to be withdrawn by the other provider in the near future.

Master meters are preferable to joint user customers when infrastructure reliability is questionable, proven through leak history and/or obsolete pipe material.

Joint User Customers should only be allowed where:

- The provider whose service boundary they reside within cannot supply the customer with water from their infrastructure
- AND the number of customers does not warrant the cost of a master meter

In these limited cases, Joint User is the only way to reasonably serve these customers. As an example, customers outside the UGB and served via private service lines off City mains (located within the UGB) must be Joint User because there is no justification for the City to extend service beyond the UGB.

In addition, a formal supply agreement between CRW and SFWB should be developed to address ongoing master metered supply to CRW.

Jointly Developed Infrastructure

Jointly developed infrastructure should continue to be encouraged where applicable to minimize redundant facilities and encourage future collaboration.

Summary of Customer and Infrastructure Withdrawal Potential

Table 4 illustrates the maximum number of the existing customers and length of water main infrastructure in each focus area, potentially eligible for withdrawal by the City from CRW if the recommendations and agreed strategies presented in the study area are executed. These areas are illustrated graphically in Figure 12. Table 5 summarizes the total number of customers and the share of CRW's south system demand that could be withdrawn through this process.

Additional Action Items

The following action items will require additional study and are recommended to conclude the dual interest resolution process. It is suggested that all action items will be completed within a year of this study, although certain items are dependent on the completion of others.

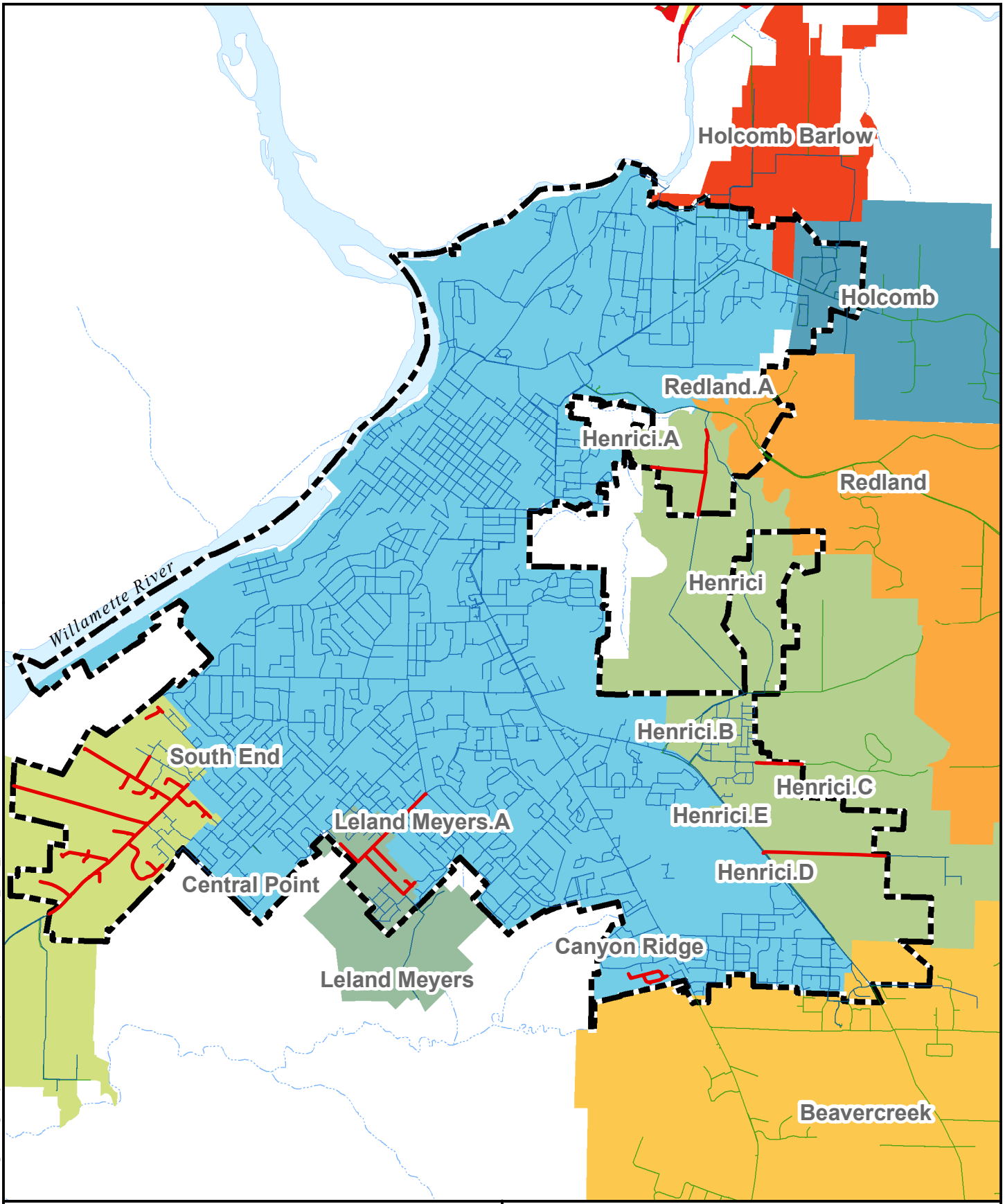
- Adopt a Remuneration Policy as outlines in the Remuneration Methodology TM (FCS Group, 2018).
- Adopt an updated, stand-alone Joint User Agreement
- Perform and adopt the findings of a Wheeling Charge Study to determine fair City and CRW rates for Joint User or Master Metered customers based on a defensible methodology such as cost of service
- Develop a water supply agreement for supply from SFWB to CRW
- Develop process for systematic transitions of service with communication to customers

Throughout this process, certain areas have been identified where mapping of service provider transition has not been completed. A common mapping convention and agreed schedule for updates should be coordinated, to include:

- Consistent and agreed upon Joint User properties
- Accurate service area boundaries
- Shared GIS data that avoids duplication by mapping of the other provider's infrastructure

Summary

As urban areas expand, boundary disputes as typified by the dual interests between Oregon City and Clackamas River Water become ever more common. The two water providers have a long history of working together to develop creative solutions to address the unique challenges they face. Formalizing this process in a common framework, rather than a rigid set of specific solutions, ensures common goals lead the process, and not individual opinions or short term changes in priorities. Developing methodologies and strategies that adapt to unique situations is more important for long-term cooperation and dual interest resolution. It is the goal of this study to provide a framework for Oregon City and Clackamas River Water to continue to efficiently provide high quality water to current and future customers for years to come, and minimizes conflict or misunderstanding.



Urban Growth Boundary (UGB)
City of Oregon City
Clackamas River Water District
Water Mains
Potential Transfers
River

N

1 inch = 4,000 feet

Oregon City - Clackamas River Water Joint Engineering Study

Figure 12 - Potential Customer & Infrastructure Transfers

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Clackamas River Water

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Table 4
Summary of Dual interest Areas by CRW Pressure Zone

Dual interest Area	HGL	Description	Potential Customer Transfers	CRW South Customer Count	CRW South Infrastructure Transfer (lf)
Holcomb-Barlow	549	Master metered from OC Park Place Intermediate Zone (Barlow Crest Res.)	No change	72	
Holcomb	797	Master metered from Barlow Crest Pump Station	No change	726	
Hunter Heights	910	Pumped up from CRW Holcomb	No change	70	
Redland	697	Master metered from Anchor Way and pumped via Redland PS		1082	
Redland.A			Development triggered transfers within Park Place Concept Area	8	
Henrici	590	Master metered from Anchor Way and pumped via Holly Lane PS		262	
Henrici.A			Development triggered transfers within Park Place Concept Area	46	2600’ 12" 1960 OD; 1650’ 12" 2004 DI
Henrici.B			Transfers within expanding development north of Thayer Road	14	
Henrici.C			Customer transfers along Thayer Road within UGB	7	1400’ 12" 2003 DI
Henrici.D			Customer transfers along Loder Road within UGB	21	3700’ 8" 1988 DI
Henrici.E			Additional Henrici Pressure Zone potential transfers	6	
Beavercreek	744	Pumped from CRW Henrici via Glen Oak PS	No change	1389	
Canyon Ridge	592	Joint Users supplied directly from OC Upper Zone		8	

Dual interest Area	HGL	Description	Potential Customer Transfers	CRW South Customer Count	CRW South Infrastructure Transfer (lf)
Canyon Ridge.A			Customer transfers within UGB	21	2200’ 6" 1980 DI
Leland Meyers	592	Master metered from OC Upper Zone		33	
Leland Meyers.A			Customer transfers within UGB	59	1650’ 6" 1960 OD; 3650’ 8" 1960 OD; 250’ 4" CI 1970; 1450’ 6" 1970 CI
Central Point	592	Joint Users supplied directly from OC Upper Zone		2	
Central Point.A			Joint User customer transfer within UGB	9	
South End	592	Master metered and Joint Users supplied directly from OC Upper Zone	TBD based on future development potential	334*	3500' 4-6'' 1960 AC; 5500' 4-6'' 1960 OD; 1000' 8'' 1966 DI; 4000' 4-6'' 1970's CI; 4050' 6'' 1980's DI; 650' 8'' 2000 DI; 6050' 12'' 2001 DI**

*Total CRW South End customer count within the UGB

**4100 lf of water main constructed as a joint project with a cost sharing agreement

Table 5
Summary of Potential Transfers

	Customer Count	Existing Water Mains (lf)	Existing Reimbursable Water Wains (lf)	2016 Demand (gpd)	Percent of Demand
Total CRW-South	4,170	679,000		1,212,250	100%
Possible Transfers Excluding South End	190	18,500	6,750	48,500	4%
South End Transfers	330	24,750	6,750	83,500	7%
Total Possible Transfers	530	43,250	13,500	131,750	11%
Remaining CRW within UGB	210	14,500		141,750	12%

APPENDIX E
TABLE 10.1B SOUTH STORAGE CAPACITY SUMMARY (1.5% GROWTH FORECAST), CRW

Table 101.A -Revised

Revised - 2/16/2017

North Storage Capacity Summary (1.5% growth forecast)

152nd Reservoir Storage Reduced from 5mg to 4mg

Site	Year	EDU's	ADD	MDD	Largest Fire Flow	Reservoir Storage Calculations			Required Storage	Available Storage	Existing Storage (Deficit) or Surplus
						Equalization	Fire storage	Emergency Storage			
Otty	2015		1.59	3.02	5,000	0.76	1.20	3.18	5.14	6.54	1.41
	2020		1.69	3.21	5,000	0.80	1.20	3.20	5.20	6.54	1.34
	2025		1.82	3.46	5,000	0.87	1.20	3.64	5.71	6.54	0.84
	2030		1.96	3.73	5,000	0.93	1.20	3.92	6.05	6.54	0.49
	2035		2.11	4.02	5,000	1.01	1.20	4.22	6.43	6.54	0.12
	2054		2.81	5.34	5,000	1.34	1.20	5.62	8.16	6.54	-1.62
Mather	2015		2.25	4.28	5,000	1.07	1.20	4.50	6.77	10	3.23
	2020		2.39	4.54	5,000	1.14	1.20	4.78	7.12	10	2.89
	2025		2.58	4.89	5,000	1.22	1.20	5.16	7.58	10	2.42
	2030		2.78	5.27	5,000	1.32	1.20	5.56	8.08	10	1.92
	2035		2.99	5.68	5,000	1.42	1.20	5.98	8.60	10	1.40
	2054		3.98	7.56	5,000	1.89	1.20	7.96	11.05	10	-1.05
152nd Windswept HWY 224/Carver	2016		0.13	0.25	5,000	0.06	0.00	0.26	0.32	4	3.68
	2019		0.15	0.29	5,000	0.07	0.00	0.3	0.37	4	3.63
	2024		0.17	0.32	5,000	0.08	0.00	0.34	0.42	4	3.58
	2029		0.19	0.36	5,000	0.09	0.00	0.38	0.47	4	3.53
	2034		0.21	0.39	5,000	0.10	0.00	0.42	0.52	4	3.48
	2054		0.21	0.39	5,000	0.10	0.00	0.42	0.52	4	3.48
Mather & 152nd Storage Combined	2015/16								7.09	14	6.91
	2019								7.49	14	6.51
	2024								8.00	14	6.00
	2029								8.55	14	5.45
	2034								9.12	14	4.88
	2054								11.57	14	2.43

Note 1. Equalization storage - 25 percent of maximum (peak) day demand (MDD)

Note 2. Fire Storage - Largest fire flow demand for each service level multiplied by the duration of that flow. See Table B105.2 Minimum Required Fire-flow and Flow Duration for Buildings

Note 3. Emergency Storage - volume allocated for providing water during periods when normal supply is interrupted is calculated to be twice the District's Average Day Demand (ADD)

Note 4. Demands based on 1.5% growth forecast

Note 5. 152nd Reservoir available storage (CRW) does not include SWA clearwell storage volume

Note 6. Fire storage for the Windswept HWY 224/Caver site (pressure zone) rely on Mather Reservoir for fire storage

Table 101.B

12/20/2016

South Storage Capacity Summary (1.5% growth forecast)

site	Year	EDU's	ADD	MDD	Largest Fire Flow	Reservoir Storage Calculations			Required Storage	Available Storage	Existing Storage (Deficit) or Surplus
						Equalization	Fire storage	Emergency Storage			
Holcomb & Hunter Heights	2014		0.25	0.69	1,500	0.17	0.18	0.50	0.85	1.20	0.35
	2019		0.27	0.74	1,500	0.19	0.18	0.54	0.91	1.20	0.30
	2024		0.29	0.80	1,500	0.20	0.18	0.58	0.96	1.20	0.24
	2029		0.31	0.86	1,500	0.22	0.18	0.62	1.02	1.20	0.19
	2034		0.33	0.93	1,500	0.23	0.18	0.66	1.07	1.20	0.13
	2054		0.45	1.26	1,500	0.32	0.18	0.90	1.40	1.20	(0.20)
Redland (.75MG / new 1.25 MG)	2014		0.41	1.15	1,500	0.28	0.18	0.82	1.28	1.05	(0.23)
	2019		0.44	1.24	1,500	0.31	0.18	0.88	1.37	2.00	0.63
	2024		0.48	1.33	1,500	0.33	0.18	0.96	1.47	2.00	0.53
	2029		0.51	1.44	1,500	0.36	0.18	1.02	1.56	2.00	0.44
	2034		0.55	1.55	1,500	0.39	0.18	1.10	1.67	2.00	0.33
	2054		0.75	2.09	1,500	0.52	0.18	1.50	2.20	2.00	(0.20)
Henrici	2014		0.19	0.53	1,500	0.13	0.18	0.38	0.69	1.55	0.86
	2019		0.20	0.57	1,500	0.14	0.18	0.40	0.72	1.55	0.83
	2024		0.22	0.62	1,500	0.16	0.18	0.44	0.78	1.55	0.78
	2029		0.24	0.67	1,500	0.17	0.18	0.48	0.83	1.55	0.72
	2034		0.26	0.72	1,500	0.18	0.18	0.52	0.88	1.55	0.67
	2054		0.35	0.97	1,500	0.24	0.18	0.70	1.12	1.55	0.43
Beavercreek	2014		0.61	1.72	1,500	0.43	0.18	1.22	1.83	1.20	(0.63)
	2019		0.66	1.86	1,500	0.47	0.18	1.32	1.97	1.20	(0.77)
	2024		0.71	2.00	1,500	0.50	0.18	1.42	2.10	1.20	(0.90)
	2029		0.77	2.16	1,500	0.54	0.18	1.54	2.26	1.20	(1.06)
	2034		0.83	2.32	1,500	0.58	0.18	1.66	2.42	1.20	(1.22)
	2054		1.12	3.14	1,500	0.79	0.18	2.24	3.21	1.20	(2.01)

Note 1. Equalization storage - 25 percent of maximum (peak) day demand (MDD)

Note 2. Fire Storage - Largest fire flow demand for each service level multiplied by the duration of that flow. See Table B105.2 Minimum Required Fire-flow and Flow Duration for Buildings

Note 3. Emergency Storage - volume allocated for providing water during periods when normal supply is interrupted is calculated to be twice the District's Average Day Demand (ADD)

Note 4. Demands based on 1.5% growth forecast

Note 5. Redland storage volumes changed to 2 mg in year 2019 to incorporate Backbone Redland Reservoir 1.25mg and demolition of Reservoir No. 1 (.3mg). Reservoir No.2 (.75mg).

APPENDIX F
MOLLALLA AVENUE STREETSCAPE CONCURRENT WATERLINE IMPROVEMENTS TECHNICAL MEMORANDUM, MURRAYSMITH

Technical Memorandum

Date:	February 25, 2019
Project:	Oregon City Water Distribution System Capital Improvement Program Update
To:	Aleta Froman-Goodrich, PE City of Oregon City
From:	Shad Roundy, PE Claire DeVoe, EIT Murraysmith
Re:	Molalla Ave Streetscape Concurrent Waterline Improvements

Introduction

The City of Oregon City (City) is currently working on an update of its water distribution system Capital Improvement Program (CIP). Simultaneously, the City is proceeding with design on the Molalla Avenue Streetscape Project which includes improvements along Molalla Avenue from Beavercreek Road to the intersection with Highway 213. This document is intended to document the purpose and cost of the Molalla Avenue project prior to completion of the updated CIP.

The Molalla Avenue project is intended to minimize existing Upper Zone over-pressurization and balance supply and demand between the Henrici Reservoir and the Boynton Standpipe. Additionally, the project is required to serve future growth within the City. The Molalla Avenue project is a portion of a larger set of capital projects to improve system capacity and operations. Other associated projects include the following:

- Parallel transmission line from the Mountainview Pump Station to Beavercreek Avenue
- Parallel transmission line from Beavercreek Ave to Glen Oak Road (along the Streetscape Project to Sebastian Way)
- Improved looping and upsized transmission between Highway 213 and Beavercreek Road, north of Glen Oak Road
- Upsized transmission between Glen Oak Road and the Henrici Reservoir

The Molalla Avenue project and other capital projects are presented in Figure 1.

Project Background and Summary

The South Fork Water Board (SFWB) supplies the City's Mountainview Reservoirs with treated water via a 30-inch supply main and the Division Street Pump Station. The City's Mountainview Pump Station in turn supplies Henrici Reservoir and the Boynton Standpipe. These tanks set the hydraulic Grade Line (HGL) in the Upper Zone. The tanks also act as suction supply for the Fairway Downs Pump Station, which supplies a small, closed zone near the Henrici Reservoir.

Growth is expected in the Upper and Fairway Downs Zones as described in the Beavercreek Concept Plan. This growth will require extension of Upper Zone distribution, and the construction of a new pump station and reservoir to replace the existing Fairway Downs Pump Station and extend the existing Fairway Downs Zone.

Under current conditions, the City has difficulties keeping the Henrici Reservoir filled and the Boynton Standpipe from overflowing. The Boynton Standpipe is centrally located while the Henrici Tank is located southeast of the system. When flow from the Mountainview Pump Station is increased to fill the Henrici Reservoir, high pressure issues are experienced by customers near the pump station. This is especially problematic in summer months when the pump station must operate at a higher flow rate to keep up with Upper Zone demands. This problem is expected to increase as the Mountainview Pump Station is expected to operate at higher flow rates to keep up with growth related demands.

An evaluation of the supply from the Henrici Reservoir and the Boynton Standpipe was performed with and without capital improvements as presented in Table 1. Prior to improvement, demands are distributed at a 67/33-percent split with the majority of demand supplied through the Boyton Standpipe. The improved system, which includes the Molalla Avenue project, results in an improved flow split of 50/50-percent between the reservoir and standpipe.

Table 1
Reservoir Filling Rates – Boyton Standpipe and Henrici Reservoir

Scenario	Boynton Standpipe (gpm)	Henrici Reservoir (gpm)
No Improvements	4,200	2,100
Only add Parallel Main on Molalla Ave	4,200	2,500
Only upsize Beavercreek Transmission from Glen Oak Road to Henrici Reservoir	3,600	2,900
Both improvements: Parallel Main on Molalla Ave and Upsize Beavercreek Transmission	3,500	3,500

1. 2015 ADD demands, 2 pumps on at Mountainview Pump Station, reservoirs at low set points.
2. Parallel main sizing evaluated between 12-inch and 24-inch. Improvements on Molalla Avenue between Beaver Creek Road and Glen Oak Road are recommended at 18-inch sizing.

Demands in the Upper Pressure Zone, Fairway Downs Pressure Zone, and CRW Master Meters 8&9 can be used to determine the ratio of the Molalla Avenue project serving existing and future

customers. These demands for existing and future time frames are summarized in Table 2. The ratio of existing to future services by 2035 is estimated at 68-percent existing and 32-percent future. The ratio of existing to future services by buildout is estimated at 42-percent existing and 58-percent future.

Table 2
Existing and Future Demand Summary and Ratios Associated with Molalla Avenue Project

Pressure Zone or Master Meter	Existing Average Day Demand	2035 Average Day Demand	Buildout Average Day Demand
Upper	1,600	2,370	3,860
Fairway Downs	20	20	40
CRW Master Meters 8 & 9	80	110	180
TOTAL	1,700	2,510	4,080

Demands in gallons per minute.

Preliminary costs were estimated for the Molalla Avenue project for the CIP update as summarized below. Cost estimates represent a Class 5 budget estimate in 2018 dollars, as established by the American Association of Cost Engineers. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +50 to +100 percent on the high end, meaning the actual cost should fall in the range of 50 percent below the estimate to 100 percent above the estimate.

- Project cost estimate for 18-inch pipeline on Molalla Avenue at approximately 4,200 linear feet
- Cost estimates include labor, materials, and markups
- Cost estimates exclude land or right-of-way acquisition
- Markups include 40-percent for engineering, overhead, and contractor profits
- Markups include 30-percent for construction contingency
- Total project cost is estimated at $1.7 million ($407 per linear foot)

City of Oregon City
Molalla Ave Streetscape
CIP Project Impacts

Mountainview Reservoirs and Pump Station

Existing Boynton Standpipe and Pump Station

Existing Fairway Downs Pump Station

Proposed Fairway Downs Pump Station

Existing Henrici Reservoir

Proposed Fairway Downs Reservoir

Text

CIP PROJECTS

- Parallel Transmission along Streetscape
- Mountainview to Henrici Transmission Projects
- Other CIP Projects
- Pump Station
- Reservoir

EXISTING WATER MAINS

- Oregon City
- SFWB
- West Linn
- UGB

PRESSURE ZONE

- Canemah
- Fairway Downs
- Intermediate
- Lower
- Paper mill
- Park Place Intermediate
- Park Place Livesay
- Park Place Lower
- Park Place View Manor
- Upper

FIGURE 1

0 1,250 2,500 Feet

N W E S

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October 2018 17-2119

murraysmith

APPENDIX G
SMALL WATERLINE REPLACEMENT PROJECTS & PRV PHOTO DOCUMENTATION, OREGON CITY

Updated 12/30/2018 for PW Ops Higher Priority List for Small Water Pipeline Replacement Project List For Projects Originally Listed in

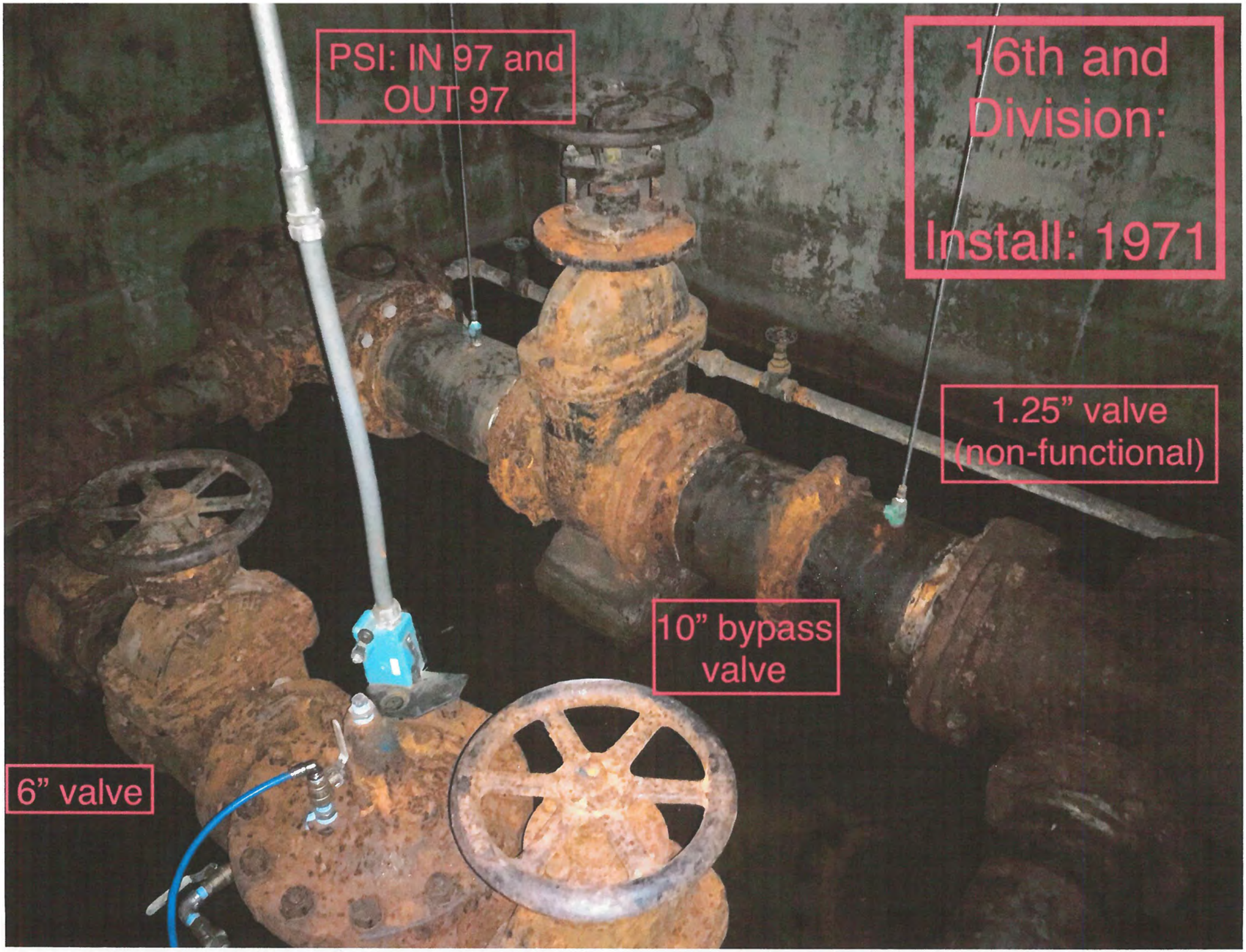
#	Project Location	Project Area Beginning	Project Area End	Existing Diameter	Proposed Diameter *[1]*	Length	Unit Construction Cost *[2]*	Total Construction Cost	CIP Cost (w/ Mark Up) [3]
	Street Name	*Street Name*	*Street Name*	*(in)*	*(in)*	*(ft)*	*($/ft)*	*($)*	*($)*
1	S. Center St	S. 2nd	1st St	6	8	700	$140	$98,000	**$150,500**
2	Barker Ave	South End Rd	Barker Rd	6	8	800	$140	$112,000	**$172,000**
3	Warner-Parrott Rd	King Rd	Boynton St	10	12	1100	$200	$220,000	**$337,900**
4	Belle Ct and Glenwood Ct	Holmes Ln	Linn Ave	6	8	1500	$140	$210,000	**$322,600**
5	Valley View Dr	Park Dr	McCarver Ave	4	8	1000	$140	$140,000	**$215,000**
6	Canemah Ct	Canemah Rd	Telford Rd	6	8	1700	$140	$238,000	**$365,600**
7	Randall St	Canemah Rd	Hartke Lp	6	8	700	$140	$98,000	**$150,500**
8	Hartke Lp and Alderwood Pl			6	8	3700	$140	$518,000	**$795,600**
9	Harrison St	7th St	Division St	6	8	600	$140	$84,000	**$129,000**
10	Division St	Harrison St	13th/14th St	6	8	4300	$140	$602,000	**$924,700**
11	Division St	Anchor Way PRV Station	Davis Rd	6	8	1300	$140	$182,000	**$279,600**
	Total					17400		$2,502,000	**$3,843,100**

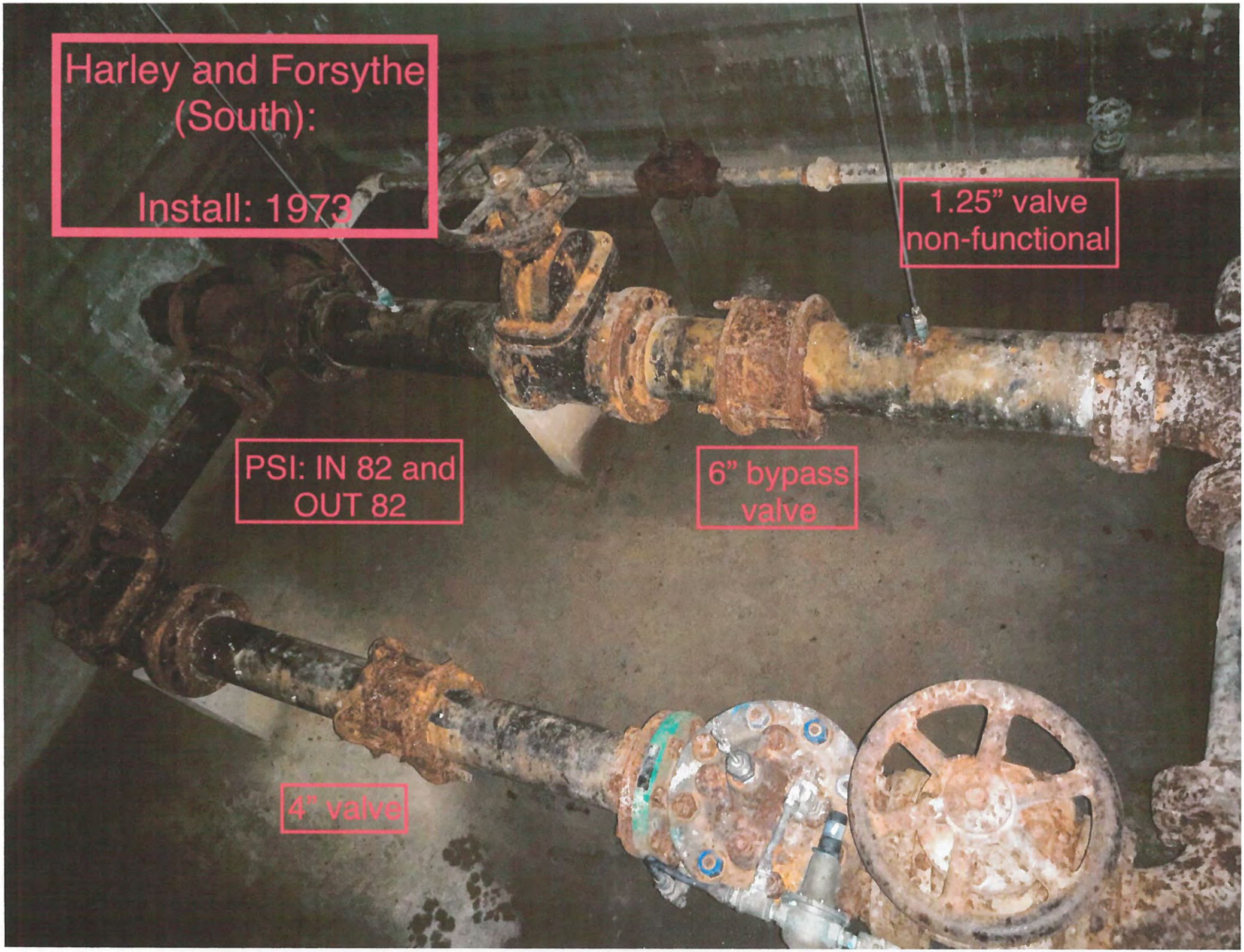
NOTES:

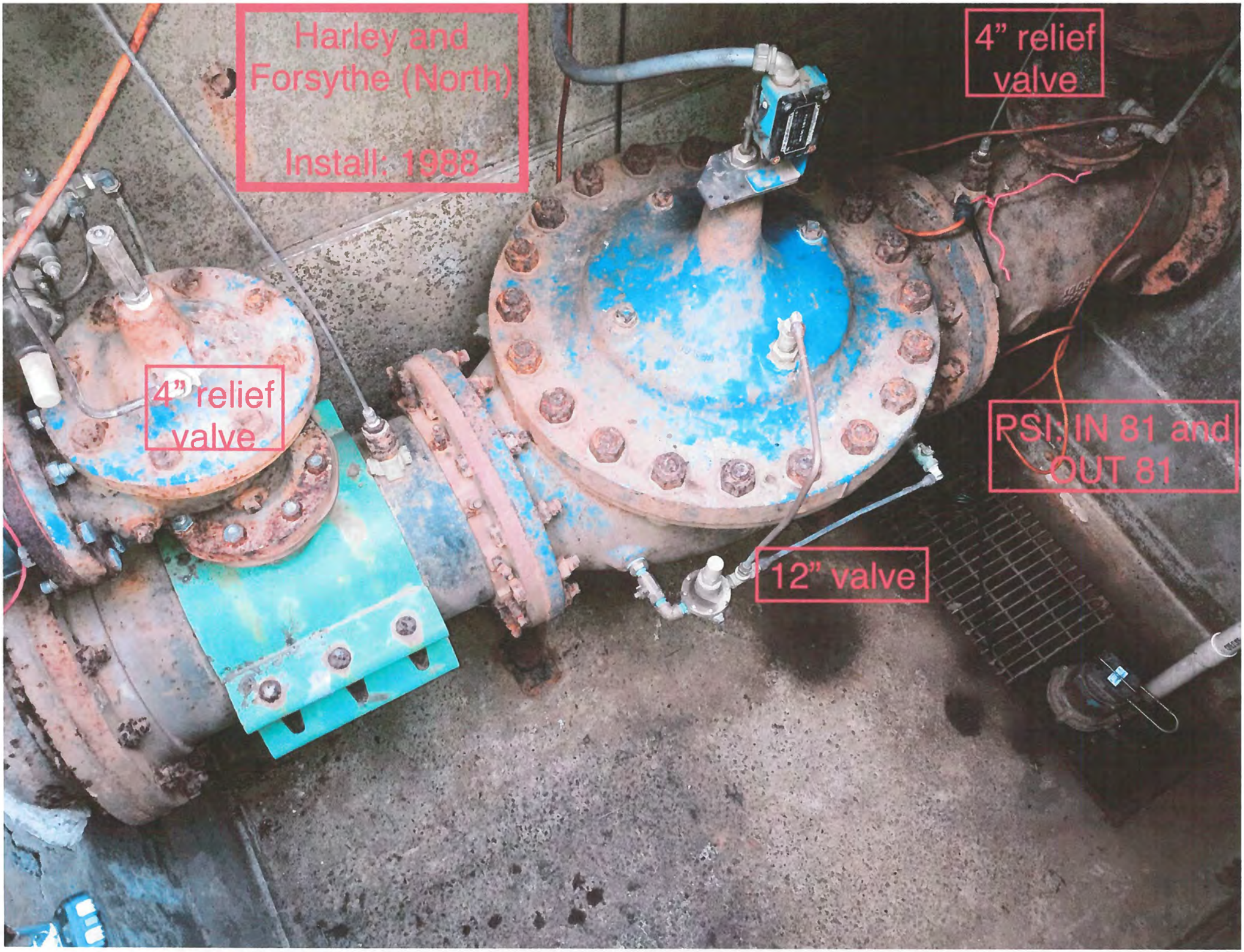
[1] Proposed pipe diameters are matching the existing diameter, 8-Inch Minimum.

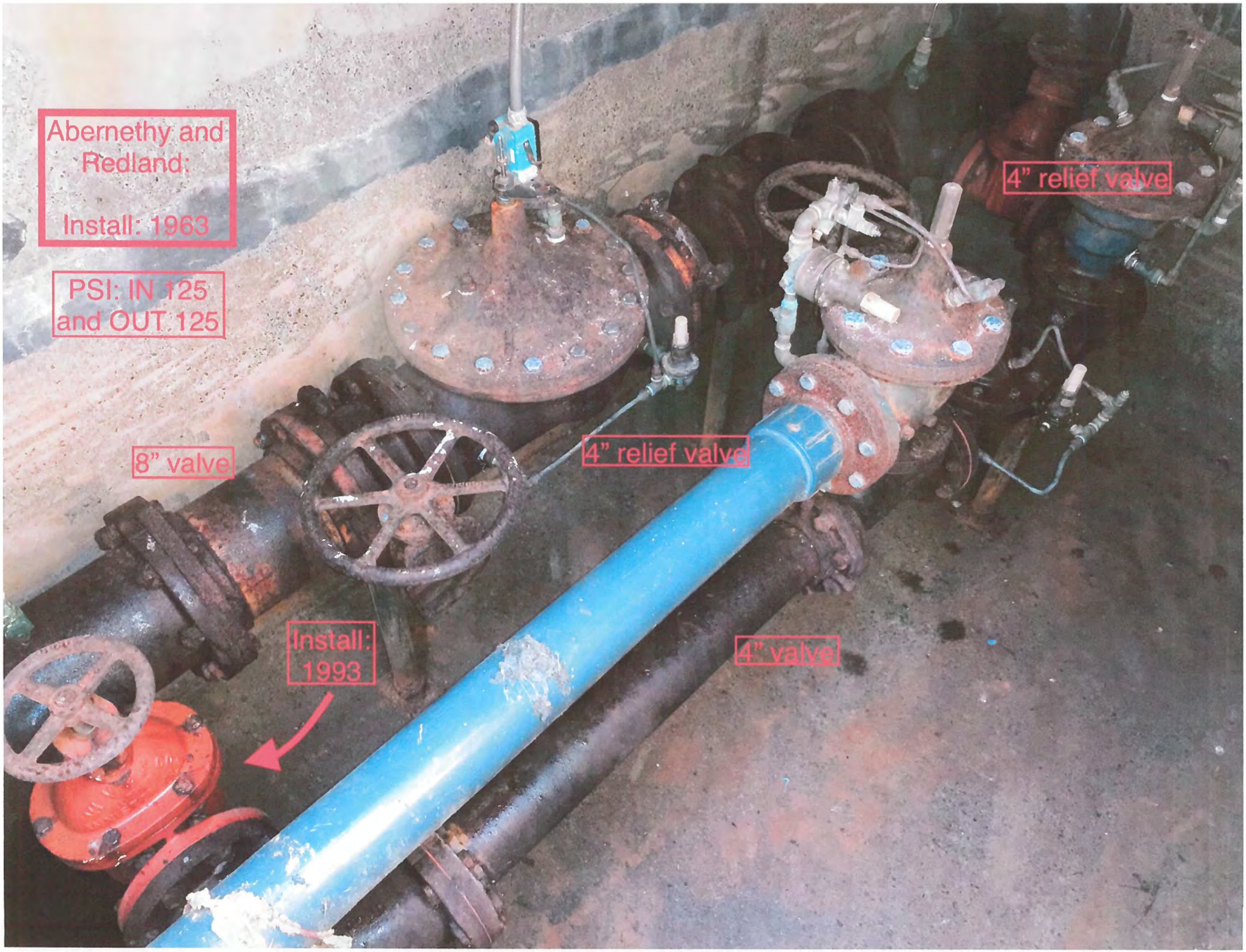
[2] Unit Construction Costs are based on units costs included in the 2012 Water Master Plan for developed areas.

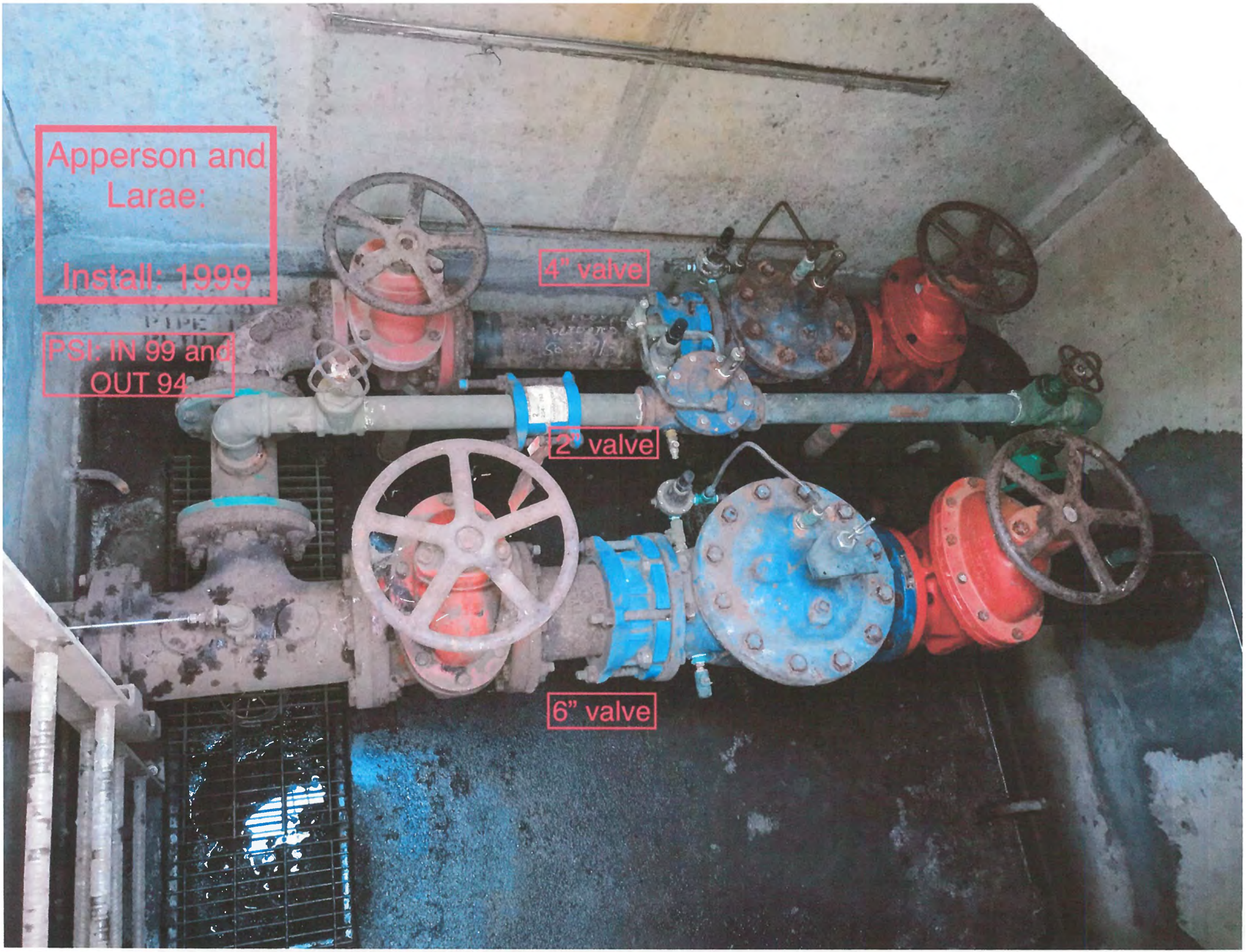
[3] CIP Cost includes a 20% contingency, 10% design engineering, 10% construction engineering, and 8% administration cost allowance in accordance with Appendix D and then rounded to the nearest $100.


PSI: IN 97 and OUT 97
16th and Division:
Install: 1971
1.25” valve (non-functional)
10” bypass valve
6” valve

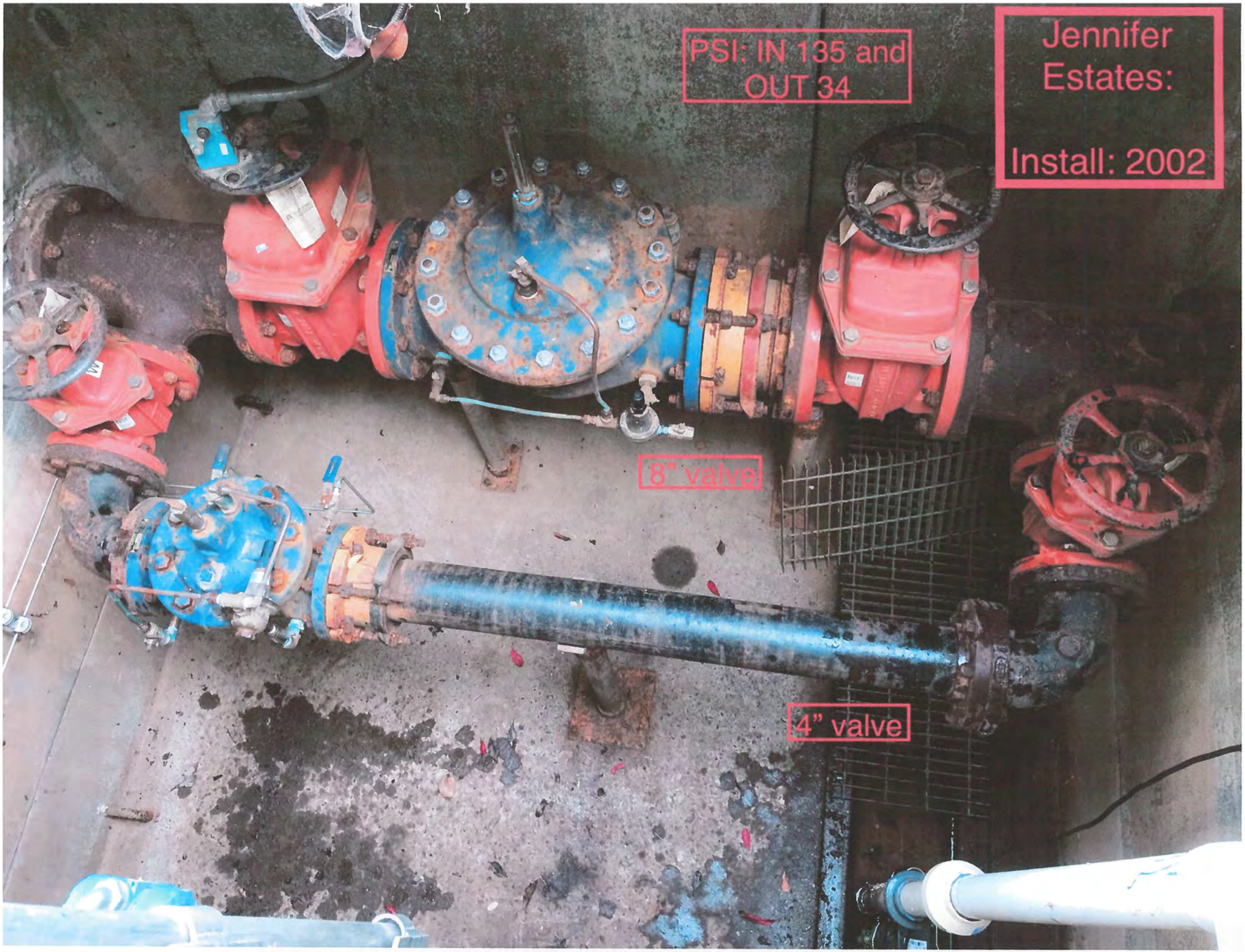

Harley and Forsythe (South):
Install: 1973
1.25” valve non-functional
PSI: IN 82 and OUT 82
6” bypass valve
4” valve

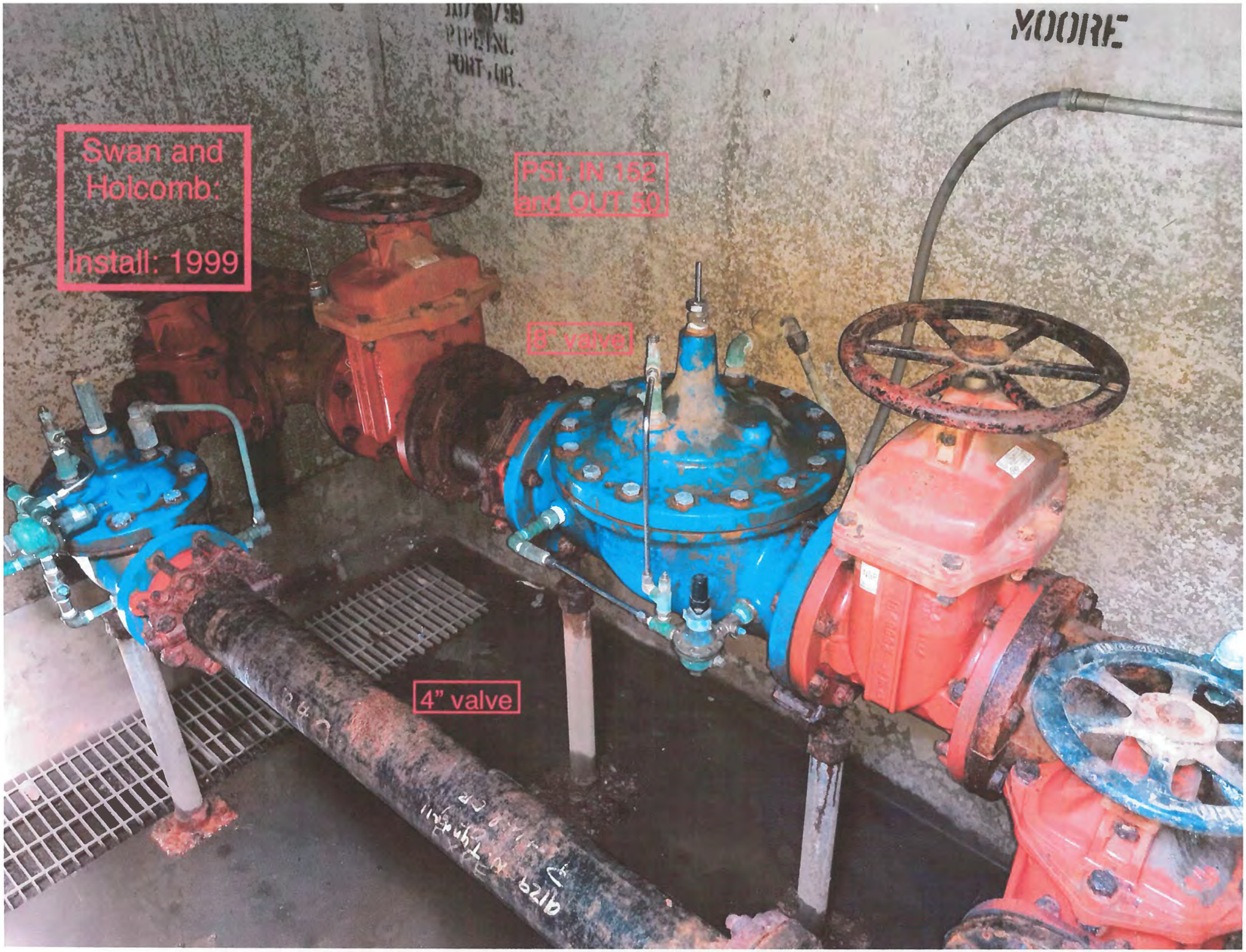

Harley and Forsythe (North)
Install: 1988
4" relief valve
4" relief valve
PSI: IN 81 and OUT 81
12" valve


Abernethy and Redland:
Install: 1963
PSI: IN 125 and OUT 125
4" relief valve
8" valve
4" relief valve
Install: 1993
4" valve

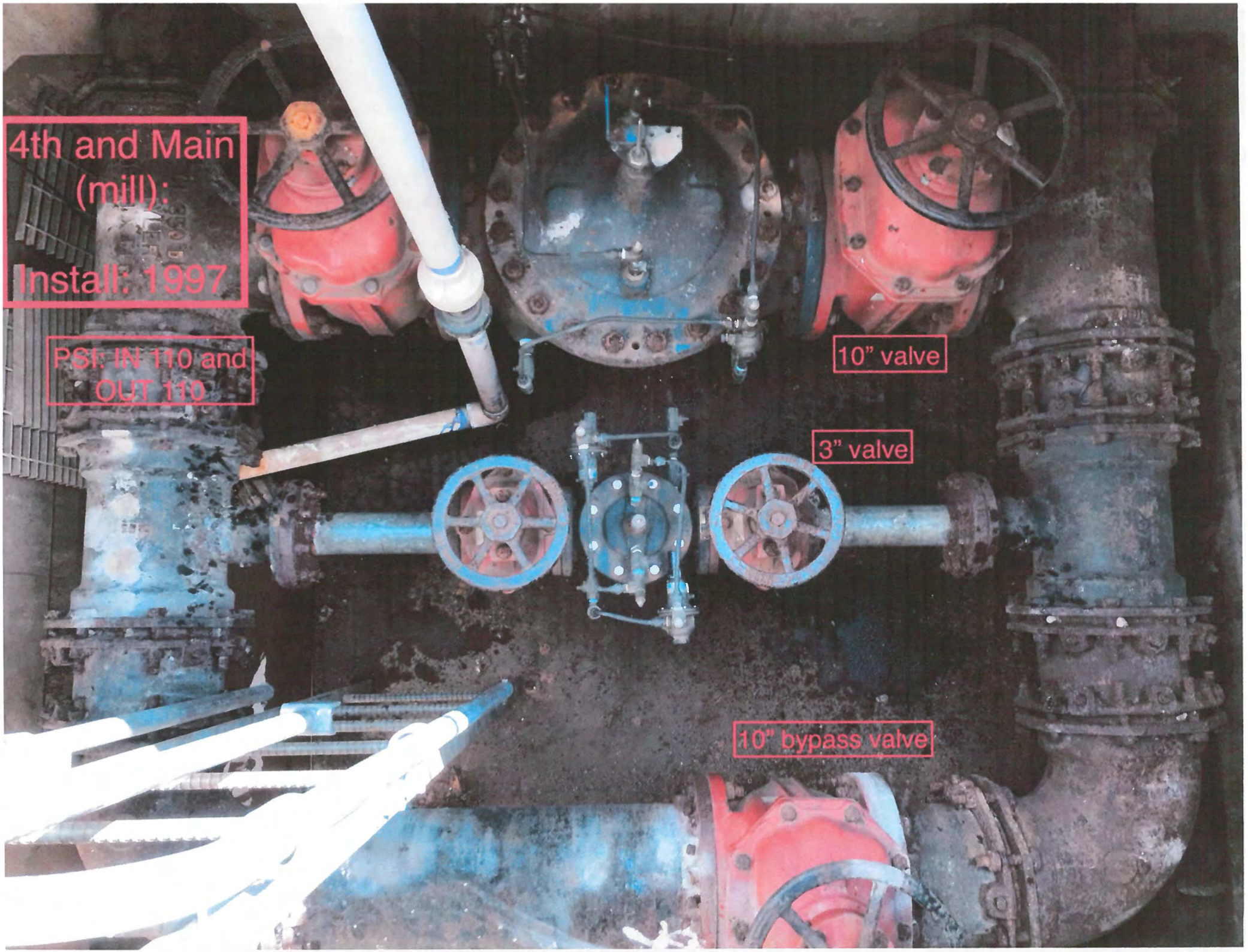

Apperson and Larae:
Install: 1999
PSI: IN 99 and OUT 94
4" valve
2" valve
6" valve

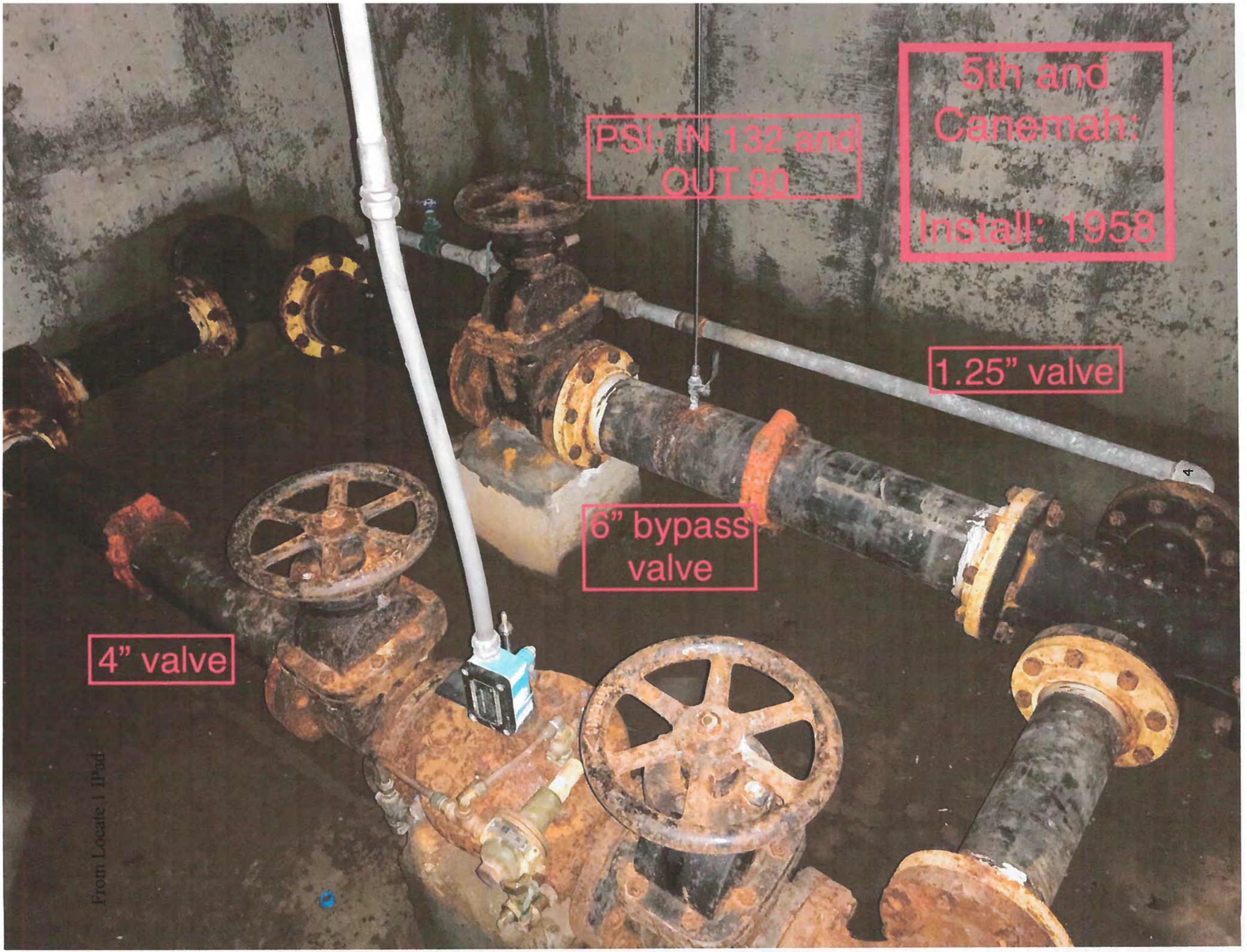

Hunter Pump Station:
Install: 1998
6" valve
PSI: IN 152 and OUT 52
3" valve

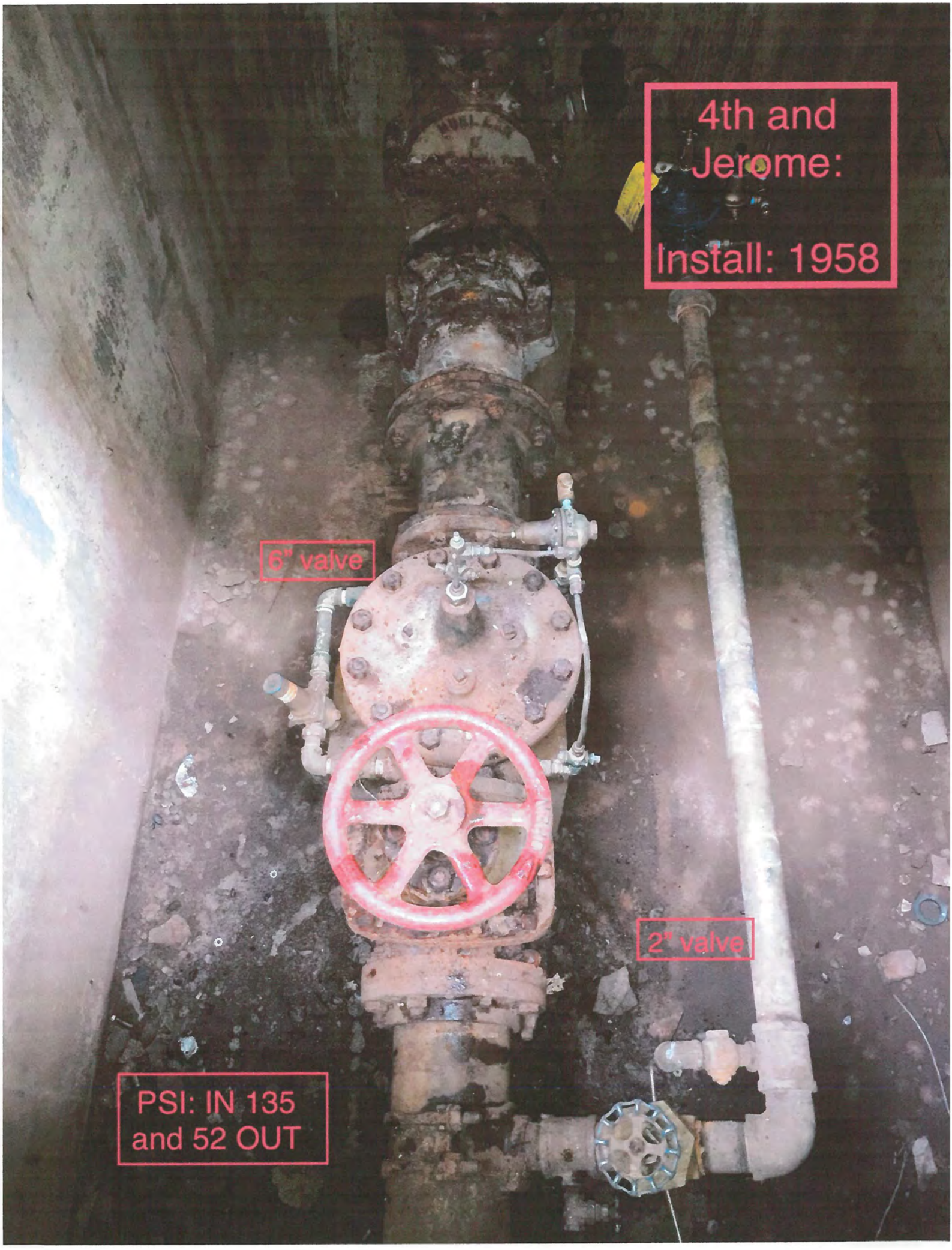

PSI: IN 135 and OUT 34
Jennifer Estates:
Install: 2002
8" valve
4" valve

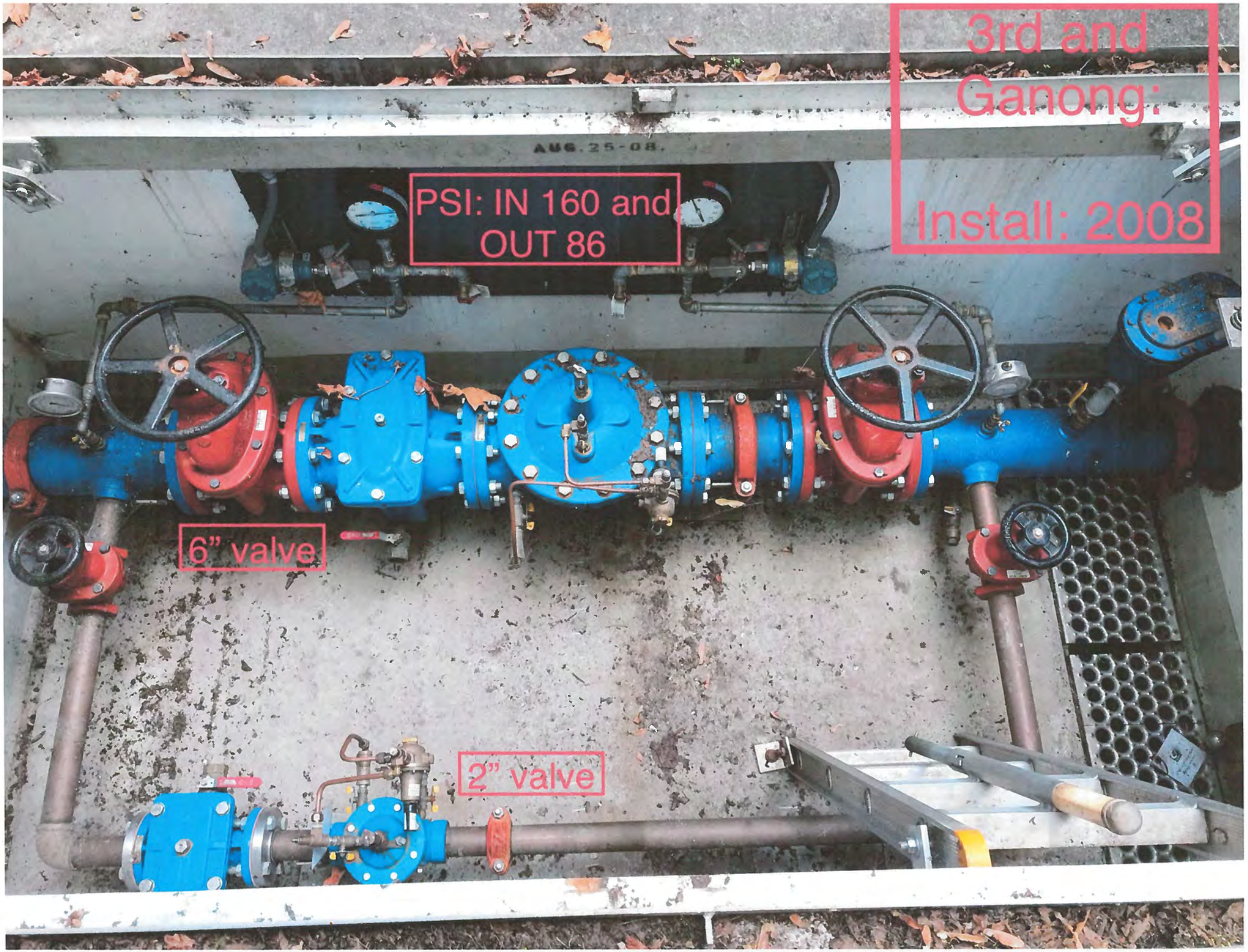

Swan and Holcomb:
Install: 1999
PSI: IN 152 and OUT 50
8" valve
4" valve
MOORE

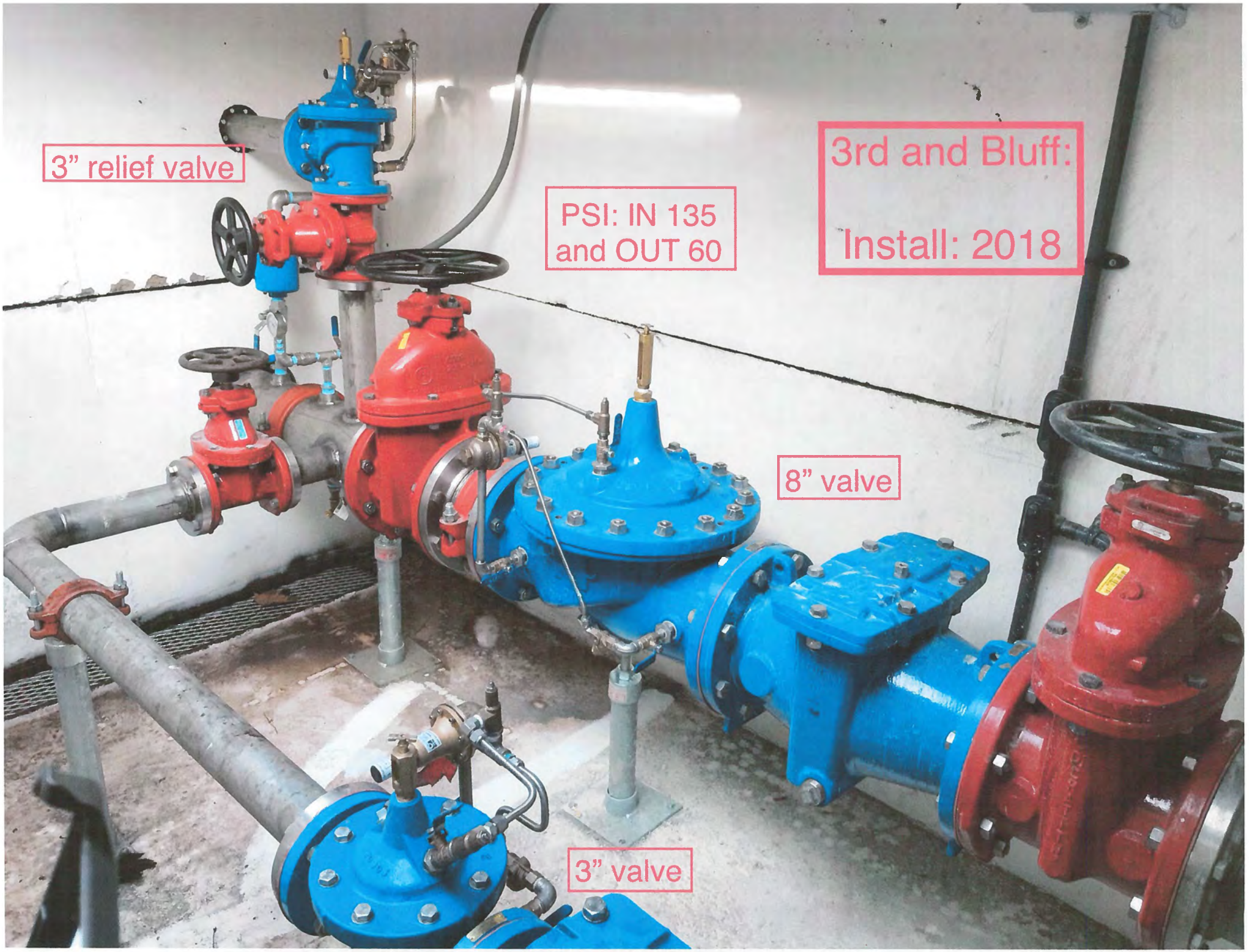

View Manor:
Install: 1999
PSI: IN 99
and OUT 32
8" valve
4" valve

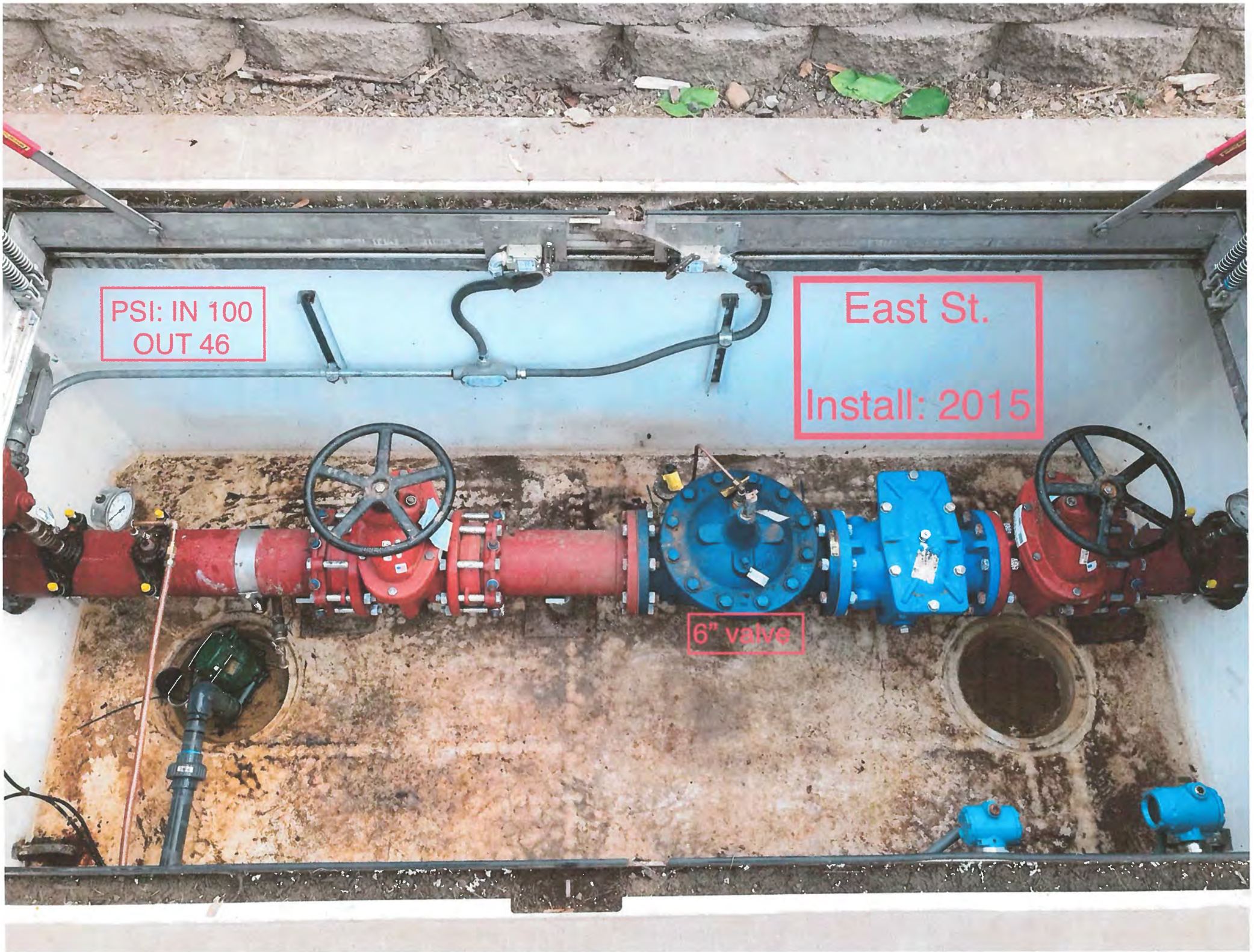

4th and Main (mill):
Install: 1997
PSI: IN 110 and OUT 110
10" valve
3" valve
10" bypass valve

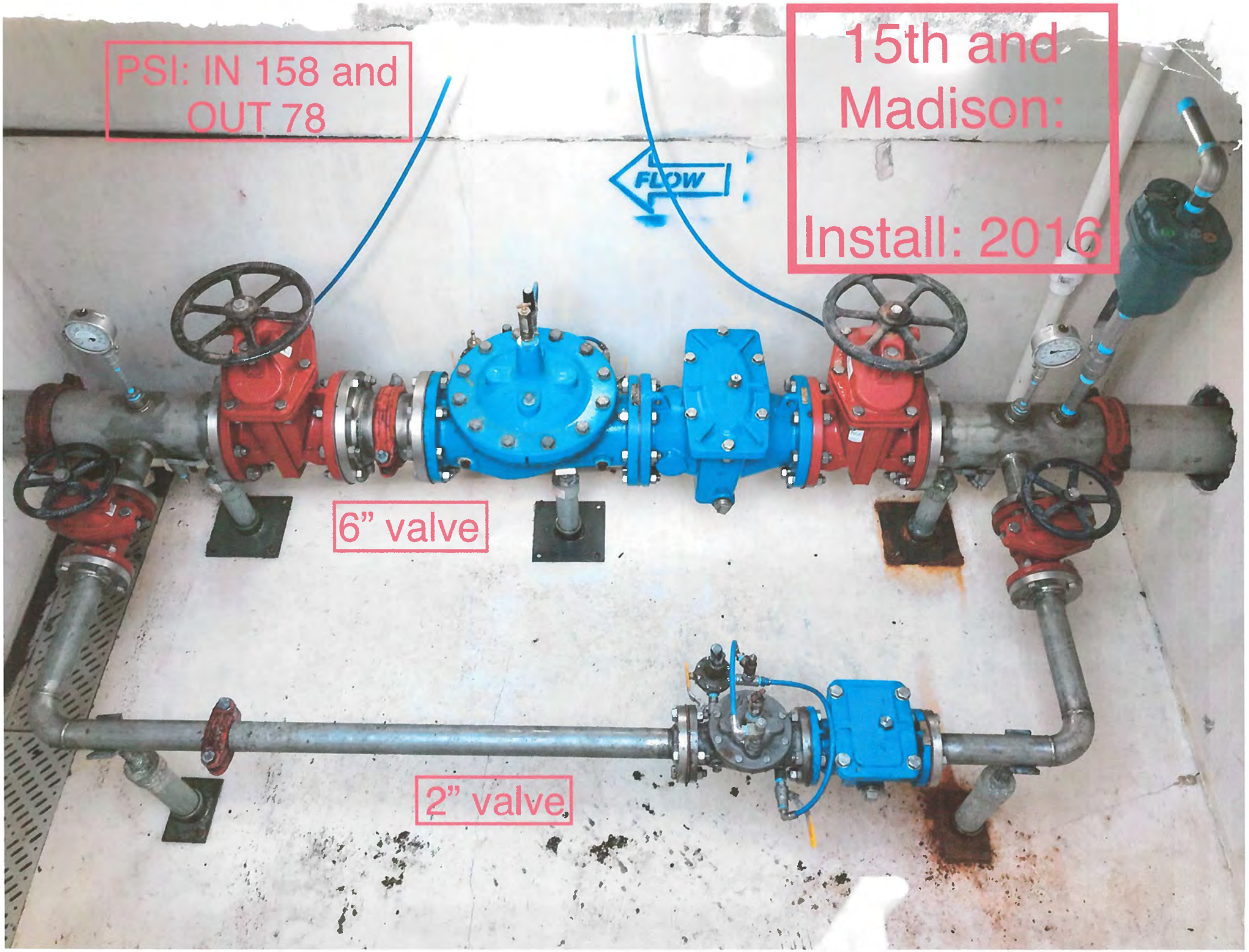

5th and Canemah:
Install: 1958
PSI: IN 132 and OUT 90
1.25" valve
6" bypass valve
4" valve
From Locate 1 IPad

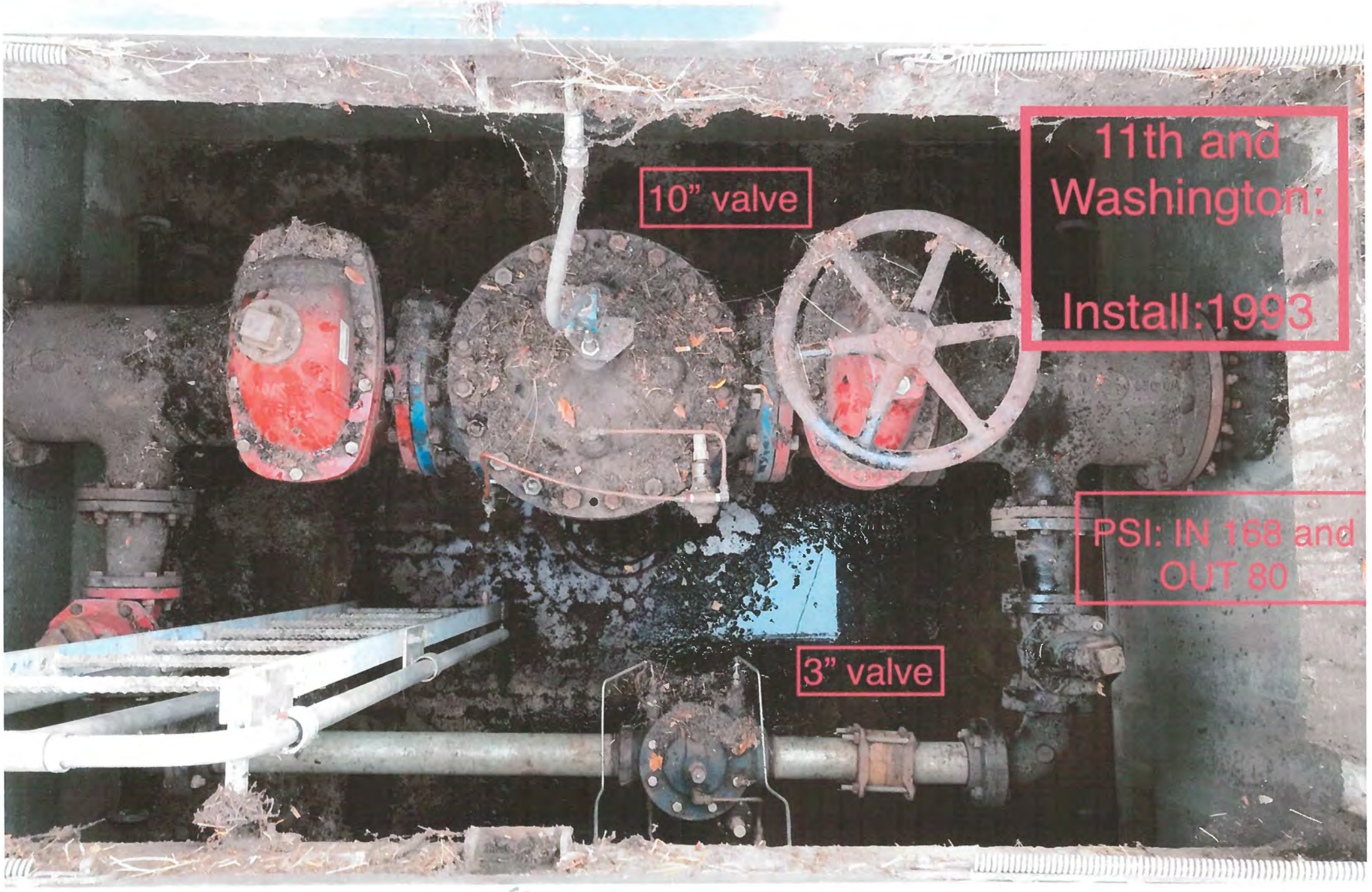

4th and Jerome:
Install: 1958
6" valve
2" valve
PSI: IN 135 and 52 OUT

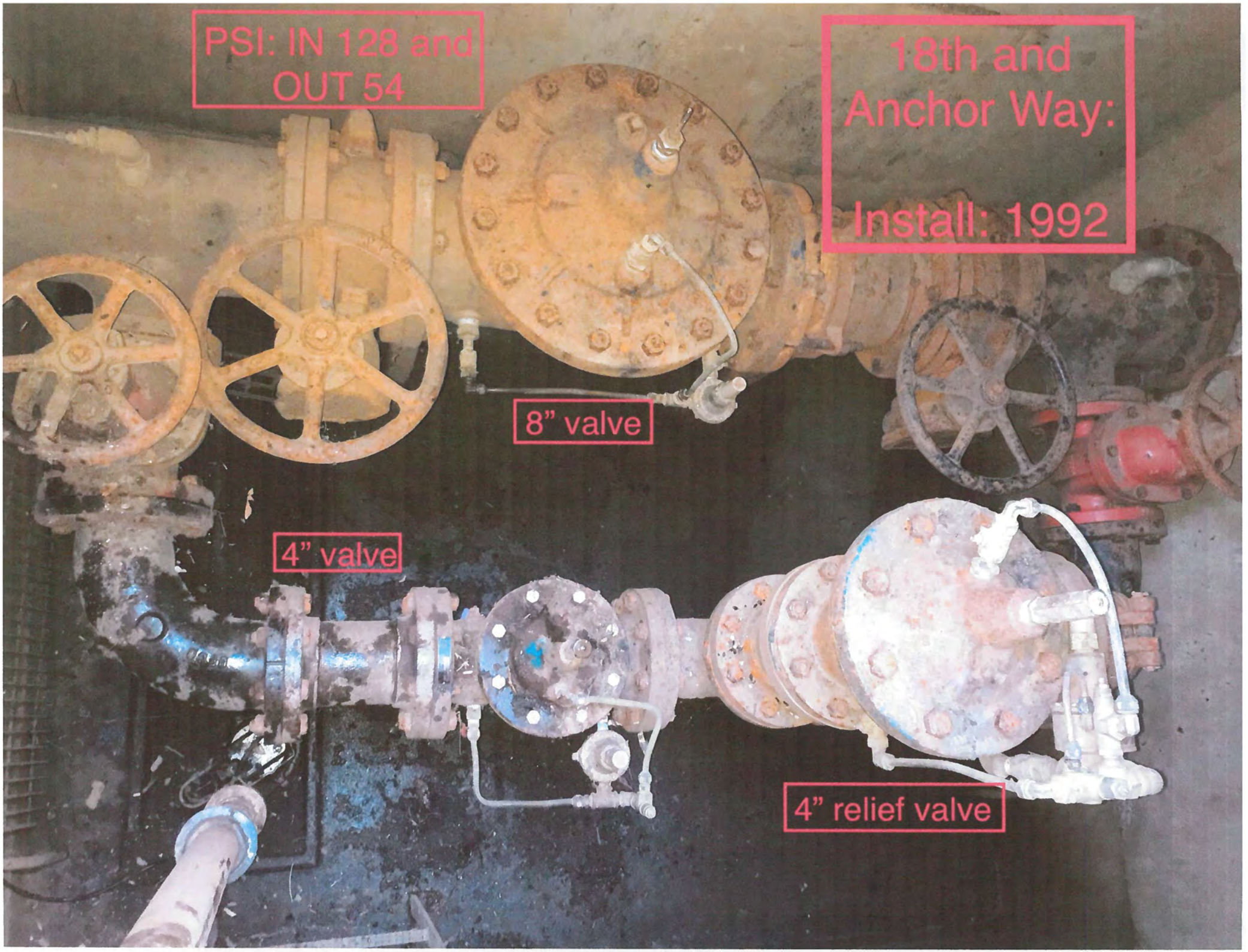

3rd and Ganong:
Install: 2008
PSI: IN 160 and OUT 86
6" valve
2" valve


3" relief valve
PSI: IN 135
and OUT 60
3rd and Bluff:
Install: 2018
8" valve
3" valve


PSI: IN 100
OUT 46
East St.
Install: 2015
6" valve


PSI: IN 158 and OUT 78
15th and Madison:
Install: 2016
FLOW
6” valve
2” valve


10" valve
11th and Washington:
Install:1993
PSI: IN 168 and OUT 80
3" valve


PSI: IN 128 and
OUT 54
18th and
Anchor Way:
Install: 1992
8" valve
4" valve
4" relief valve

APPENDIX H
MILL REDEVELOPMENT WATER DISTRIBUTION ANALYSIS TECHNICAL MEMORANDUM, MURRAYSMITH

Technical Memorandum

Date: January 18, 2018

Project: Oregon City Water Distribution System Capital Improvement Program Update

To: Aleta Froman-Goodrich, PE
City of Oregon City

From: Shad Roundy, PE
Natalie Jennings, PE
Murraysmith

Re: Mill Redevelopment Water Distribution Analysis

Background Information

The City of Oregon City (City) is evaluating expansion of the water distribution system to accommodate commercial redevelopment along the Willamette River, in the Paper Mill Zone. The development area and preliminary pipeline configuration are shown in Figure 1. The Paper Mill Zone is supplied through two pressure reducing valve (PRV) stations located at 3rd and Bluff and 99 E & Main. This technical memorandum documents recommended modifications to PRV stations to combine the Paper Mill Zone and the Lower Zone. Additionally, local pipeline sizing recommendations are provided to supply domestic and fire flow demands to the Mill Redevelopment Area.

Demand Summary

To evaluate the system capacity, domestic demand conditions were analyzed for average day demand (ADD), maximum day demand (MDD), and peak hour demand (PHD). Fire flow demands were evaluated during MDD including, 3,500 gallon-per-minute (gpm) and 5,000 gpm fire flow requirements.

The City's water demand data is summarized in the *Water Distribution System Master Plan* (West Yost, 2012) by service type and largest user for the full distribution system. Future demands in the Mill Redevelopment Area were developed by applying unit demands to number of dwelling units, square footage of office and retail space, or number of hotel rooms as shown in Table 1.

PARK PLACE - INTERMEDIATE

Harley & Foresythe (PRV12)

Harley & Foresythe (PRV11)

Apperson & La Rae (PRV10)

LOWER ZONE

Abernethy & Redland (PRV9)

PARK PLACE - LOWER

15th & Madison (PRV2)

11th and Washington(PRV1)

INTERMEDIATE ZONE

99E & Main - Paper Mill (PRV8)

PAPER MILL ZONE

3rd & Bluff (PRV5)

0 2,000 4,000 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN,

murraysmith

OREGON CITY

City of Oregon City
Water Distribution System

Legend

- PRVs
- Existing Pipes
- Mill Redevelopment Piping

N W E S

Mill Redevelopment Area
Proposed Piping and
New Combined Lower Zone

January 2018 17-2119

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Table 1
Water Demands by Type

Category	Unit	Number of Units, Rooms, or Square Feet	Unit Demand (gpm)	Total Demand (gpm)
Residential	dwelling unit	240	0.14	35
Office Space	1,000 Sq. Ft.	436	0.08	36
Retail Space	1,000 Sq. Ft.	119	0.08	10
Hotel	Rooms	115	0.07	9
			Total	90

Maximum day and peak hour demands for the Mill Redevelopment Area are estimated using the historical peaking factors from the master plan, established by the dividing max day by average day for MDD:ADD, and peak hour by average day for PHD:ADD, as shown in Table 2.

Table 2
Peaking Factors

Unit	Peaking Factor
MDD:ADD	2.3
PHD:ADD	4.5

Table 3 summarizes the demands in the proposed Mill Redevelopment Area, and the new, combined, Paper Mill/Lower Pressure zone.

Table 3
Water Demands by Zone

Demand	Mill Redevelopment Area[1]	Paper Mill and Lower Zones Combined
ADD	98 gpm	272 gpm
MDD	225 gpm	626 gpm
PHD	440gpm	1,225 gpm

[1] Includes existing demands in addition to the Mill Redevelopment demands.

Design Criteria

This section presents the planning and analysis criteria used to analyze performance of the City water distribution system. Criteria are presented in Table 4 for distribution system piping, service pressures, and recommended fire flow. Performance guidelines are based on a review of State requirements, American Water Works Association (AWWA) acceptable practice guidelines, and *Recommended Standards for Water Works, Ten States Standards (Great* Lakes – Upper Mississippi River Board of State and Provincial Public Heal and Environmental Managers, 2012).

Service Pressures

The desired service pressure range under ADD and normal operating conditions is 40 to 80 pounds per square inch (psi). The maximum 80 psi service pressure limit is required by the *Oregon Plumbing Specialty Code* (OPSC) 608.2. If mainline pressures exceed 80 psi, service connections should be equipped with individual PRVs.

Distribution Piping

In general, distribution flow velocities should not exceed 10 feet-per-second (fps) under the PHD conditions and drop below 3.5 fps under normal demand conditions. The minimum pipe size is 8-inch diameter for new permanently dead ended residential water mains and primary feeder mains in residential areas, however areas with large fire flow demands will require larger pipe diameters.

Fire Flow

The amount of water recommended for fire suppression purposes is typically associated with the local building type or land use of a specific location within the distribution system. Fire flow recommendations are typically much greater in magnitude than the MDD in any local area. Adequate hydraulic capacity for these potentially large fire flow demands controls pipe sizing and system operation.

During a fire flow event or emergency, the minimum service pressure is 20 psi as required by Oregon Health Authority, Drinking Water Services, and OAR 333-061-0025(7). The system should be capable of providing fire flow capacity while simultaneously delivering MDD and maintaining 20 psi throughout the distribution system. The system should meet this criterion with operational storage depleted and firm pumping capacity.

Two fire flow scenarios were requested by the City for evaluation in the Mill Redevelopment Area including 5,000 gpm and 3,500 gpm fire flow demands.

Table 4
Water System Performance Criteria

System Facility	Evaluation Criterion	Value	Design Standard/Guideline
Service Pressure	Normal Range (ADD Conditions)	40-80 psi	AWWA M32
	Maximum without individual PRV	80 psi	AWWA M32, Oregon Plumbing Specialty Code, Section 608.2
	Minimum, during MDD with Fire Flow	20 psi	AWWA M32, OAR 333-061
	Minimum, during PHD	75% of normal, not less than 40 psi	Murraysmith recommended, AWWA M32
	Velocity during PHD	Not to exceed 10 fps	AWWA M32

Distribution Piping	Minimum Pipe Diameter	8-inch recommended for fire flow, except in short mains without fire service	Industry Standard
Required Fire Flow and Duration	Single Family Residential	1,500 gpm for 2 hours	2014 Oregon Fire Code, Scenario 1: Requested by Oregon City
	Medium Density Residential, Commercial	3,000 gpm for 3 hours	
	Public, Industrial	3,500 gpm for 3 hours	
	Public, Industrial	5,000 gpm for 3 hours	Scenario 2: Requested by Oregon City

System Evaluation

Two types of infrastructure improvements are needed to service the proposed Mill Redevelopment Area including modifications to existing PRV stations, and new water lines.

Pressure Reducing Valve Stations

Current PRV settings in both the Paper Mill Zone and Lower Zone result in high pressures exceeding the 80-psi maximum requirement. Additionally, complete isolation of the Paper Mill Zone is unnecessary, as the elevations in this zone are similar to the adjacent Lower Zone. Recommendations to modify PRV stations include the following:

- A reduction in PRV settings for all PRV stations between the Intermediate Zone and the Paper Mill/Lower Zones to maintain maximum pressure below 120 psi and reduce risk of leakage. Recommended settings are provided in Table 5. Individual building PRVs are still required within the pressure zones.

- Combine the Paper Mill and Lower Zones by abandoning the 99E and Main PRV station. A pipe connection routing around the PRV station is required to maintain looped service.

Table 5
Recommended PRV Settings

Valve Name	Valve #	Valve 1 Size	Valve 2 Size	Valve 3 Size	Valve 1 Setting	Valve 2 Setting	Valve 3 Setting	Priority Opening
11th & Washington	1	3	10		67	58		1
15th & Madison	2	1.25	6	10	61	56	51	4
Abernathy & Redland	9	4	8		102	97		3
Apperson & La Rae	10	2	4	6	84	79	77	5
Harley & Forsythe (south)	11	1.5	4		71	66		2
Harley & Forsythe (north)	12	1.5	12		66	61		7
3rd & Bluff	5	3	10		42	39		6
99E & Main	8	3	10		abandon	abandon		n/a

Water Line Improvements

Water line improvements are required to serve the Mill Redevelopment Area. Improvements are focused on upsizing and extension of the pipeline on the proposed roadway running southwest to northeast through the center of the Mill Redevelopment Area. This improvement route eliminates pipeline improvements adjacent to the 3rd and Bluff PRV station and the associated 10-inch piping along the cliff face on Highway 99E that was recently replaced in the Hwy 99E Bluff Waterline Replacement Project. The existing section under the adjacent highway and railroad are also preserved.

To supply a 5,000 gpm fire flow, the pipe size on proposed roadway running southwest to northeast through the center of the Mill Redevelopment Area is recommended at 14-inch diameter with dead-end piping of 16-inches as shown in Figure 2. To supply a 3,500 gpm fire flow, the pipe size is recommended at 12-inch diameter with dead-end piping of 14-inches as shown in Figure 3.

The City's InfoWater hydraulic model was used to evaluate system capacity and size improvements. Figures showing pressure results for the pipe sizing and PRV analysis are provided in Appendix A.

Figure 2
Proposed Water Line Alignments in Mill Redevelopment Area 5,000 gpm Fire Flow

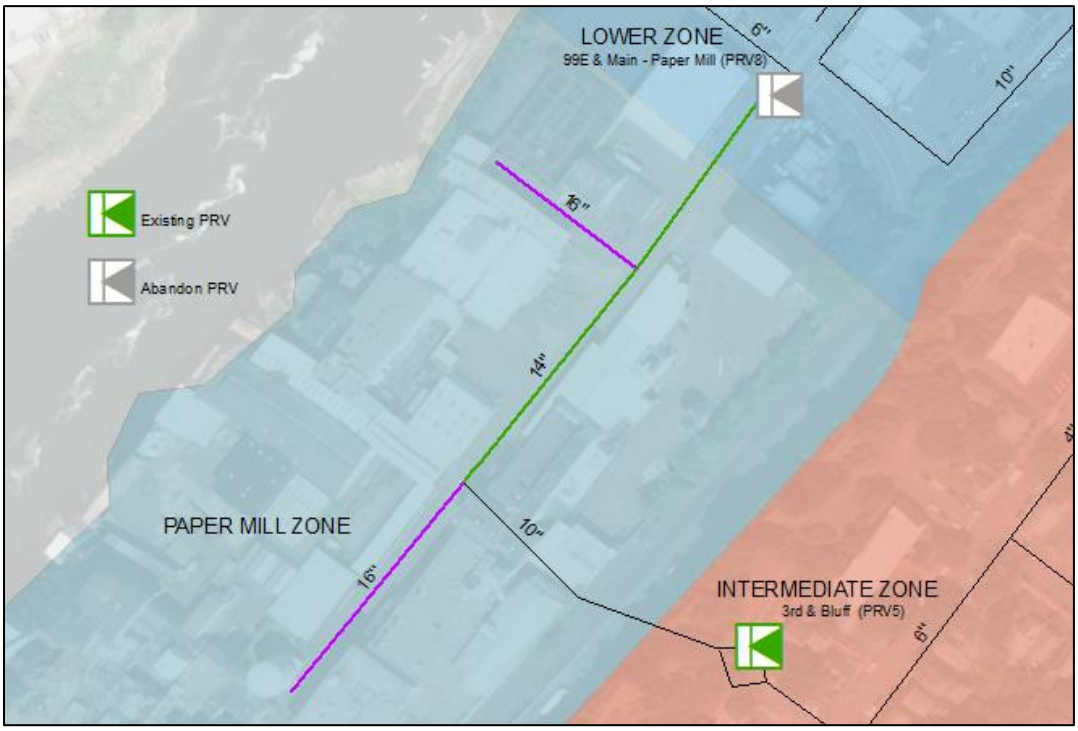
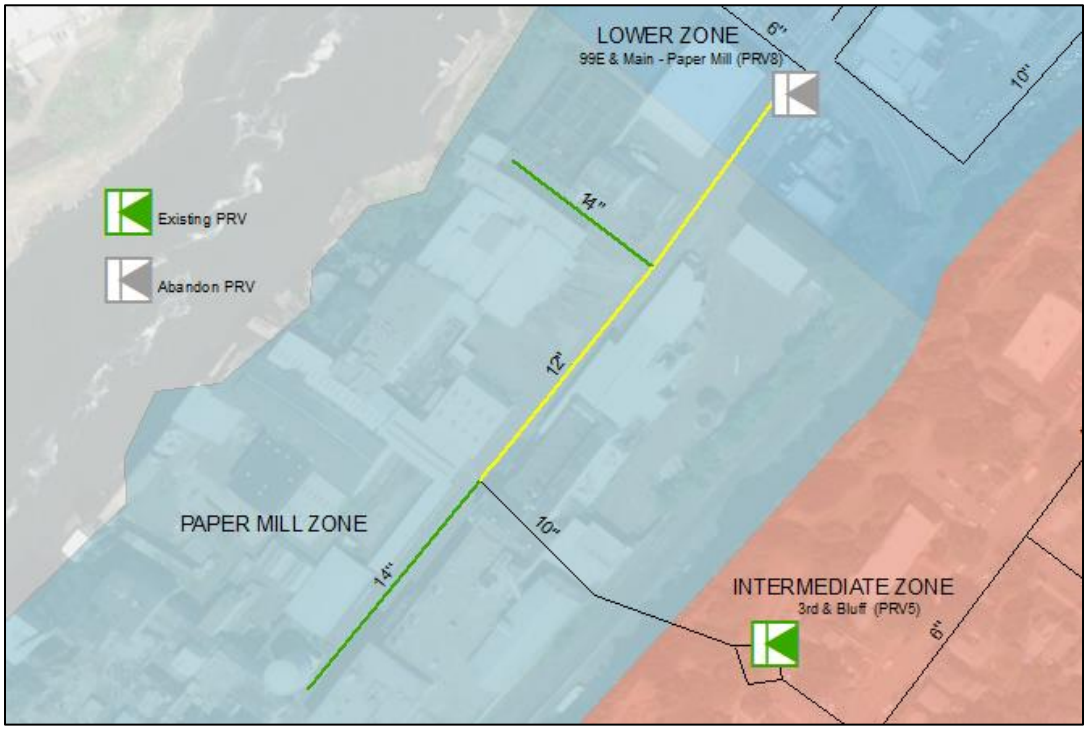


Figure 3
Proposed Water Line Alignments in Mill Redevelopment Area 3,500 gpm Fire Flow



Summary of Recommendations

Development can occur as desired by the City in the Mill Redevelopment Area. Several PRV and piping changes are needed to achieve design criteria specified herein, including combining two pressure zones. Specific changes within the zone include:

- Combination of the Paper Mill Zone and Lower Zone
- Abandonment of the PRV on 99E & Main
- Construction of new mains in the Mill Redevelopment Area
- Adjustments of PRV settings in PRV stations to the new Combined Paper Mill/Lower Zone

SJR:ncj

Appendix A

The City InfoWater hydraulic model was used to perform model simulations for domestic and fire flow demands and evaluate system pressures and velocities. The simulation results are summarized in the following figures.

Figure A1 – Average Day Demand

Figure A2 – Peak Hour Demand

Figure A3 – Maximum Day Demand + 3,500 gpm Fire Flow

Figure A4 – Maximum Day Demand + 5,000 gpm Fire Flow

Figure A1
Results: ADD

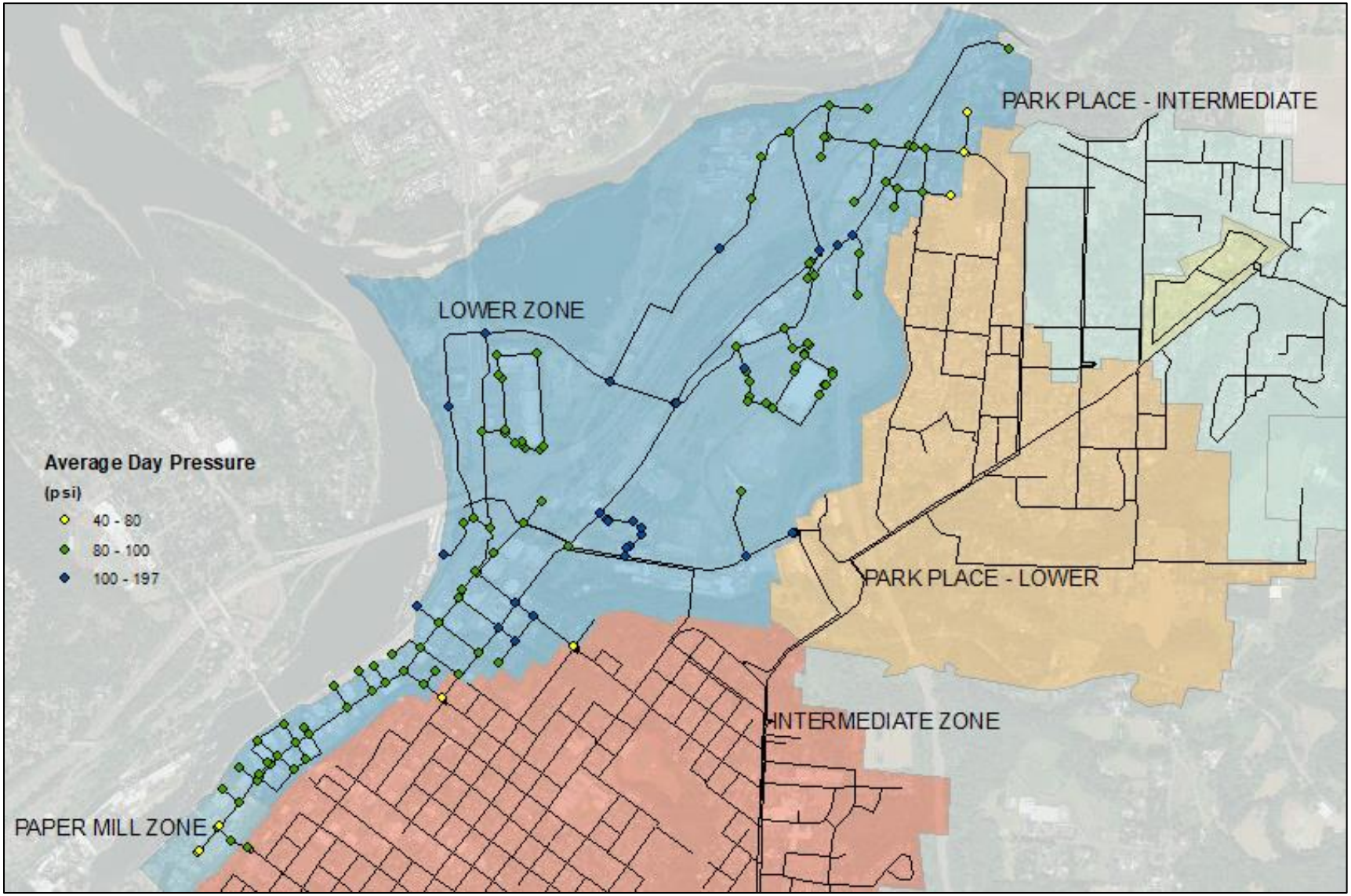


Figure A2
Results: PHD

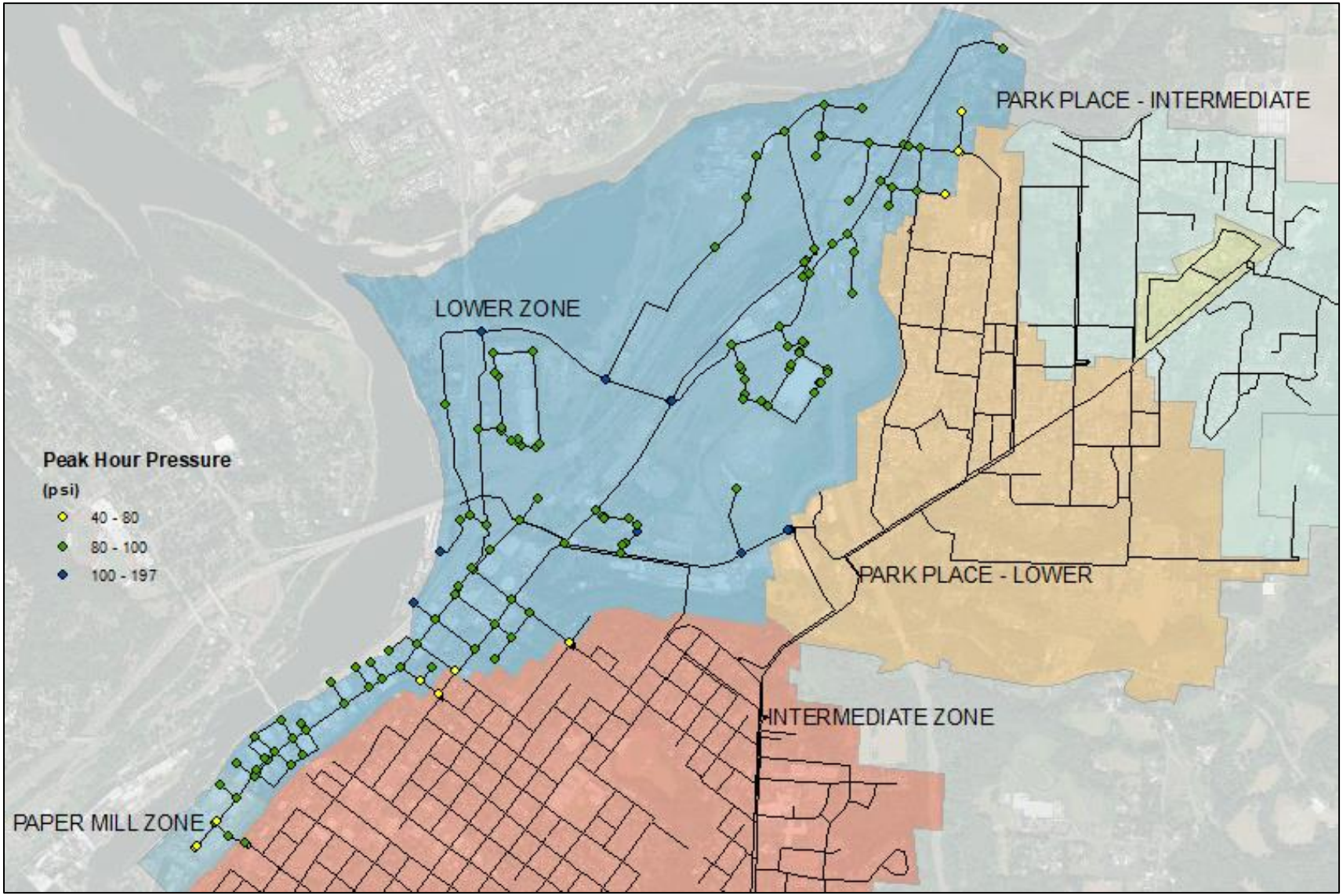


Figure A3
Results: MDD +3,500 gpm Fire Flow

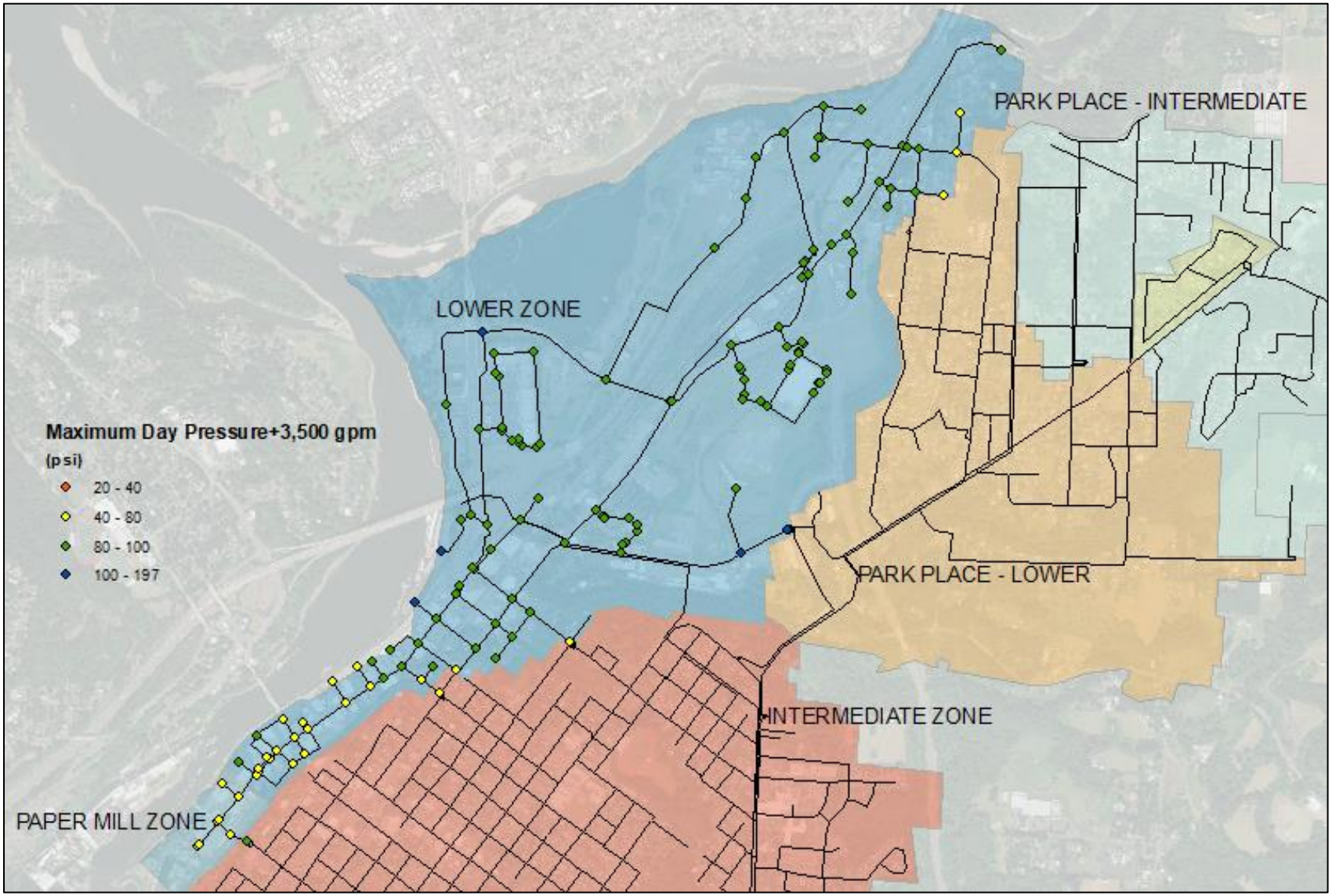


Figure A4
Results: MDD +5,000 gpm Fire Flow