EUGENE WATER & ELECTRIC BOARD

Rely on us.

M E M O R A N D U M

TO: Commissioners Mital, Simpson, Helgeson, Manning and Brown,

FROM: Mel Damewood, Engineering Manager; Wally McCullough, Water Engineering Supervisor; Laura Farthing, Senior Engineer-Water;

DATE: May 27, 2015

SUBJECT: Water Master Plan – Capital Improvement Plan

OBJECTIVE: Approval of 2015 Water System Master Plan: Resolution No. 1517

Issue

On June 2, 2015, staff will present the 2015 Water Master Plan Update to the board. Staff will prepare a series of four backgrounders to the Board for review prior to the June presentation. These backgrounders will cover the following information:

1. The need for a Master Plan, System Characteristics, and Demands
2. Resiliency Recommendations
3. Base and Upper Level Optimization
4. Capital Improvement Plan (CIP) and Summary

This is the fourth backgrounder in the series.

Background

EWEB's Water Master Plan serves as the road map for developing the ten year CIP. It is required by Oregon Administrative Rule (OAR) 333-061-0060 that community water systems serving more than 300 people maintain a master plan which is prepared by a licensed professional engineer. For a system serving more than 10,000 people, a master plan must be submitted and approved by the Oregon Health Authority every 10 years.

EWEB last completed an update to the Master Plan in 2004. In late 2013, plans were put in place to begin the update in 2014. Work has been ongoing since to update EWEB's hydraulic model, identify existing and future water system deficiencies, project future demands, update EWEB's service standards, evaluate the most cost effective way to develop a resilient spine in our system, and identify opportunities to simplify system operations.

The principal product resulting from the Master Plan is a recommended Capital Improvement Plan (CIP) which is the subject of this backgrounder.

Discussion

Projects on the CIP will be categorized as follows; many of the projects fall under more than one category:

- Existing Project – previously planned projects that were deemed to be consistent with the goals of the Master Plan remain on the CIP.
- Optimization Project – projects identified during the Master Plan that would optimize and/or simplify the operation of the system.
- Resiliency Project – projects identified that are required to create the "resilient spine" of the water system.
- Rehabilitation Project – projects necessary to repair or replace failing infrastructure.
- Growth Project – projects necessary to provide for growth in the system. These would normally be paid for, at least in part, by System Development Charges.

The following sections summarize the projects included in the CIP as recommended by the 2015 Water Master Plan. Unless otherwise noted, all costs shown are in 2015 dollars.

<u>Source Projects – Hayden Bridge and Willamette Plant (AWS)</u>

Projects related to our source of supply are shown in Table 1.

Table 1. Source Projects in CIP

Project/Description	**Category**	**Cost**
Hayden Bridge – Splitter Box Replacement and Drain Pipeline. *Replacement of antiquated solids diversion structure and completion of pipeline to divert basin solids to sludge pond.*	Existing, Rehab.	$650,000
Hayden Bridge – Filter S1-S6 Upgrade *Upgrade of the south 6 filters. The other 6 older filters have been upgraded previously.*	Existing, Rehab.	$2,100,000
Hayden Bridge – Disinfection System Replacement *Replacement of the gas chlorine system at the plant. On-site generation of sodium hypochlorite will be provided.*	Existing, Rehab.	$3,350,000
Hayden Bridge – Seismic Upgrades Phase 2 *Second phase of seismic upgrades. Work at Headhouse.*	Existing, Resiliency	$600,000
Hayden Bridge – Standby Power Improvements *Generating capacity for both Intakes and Filtration Plant.*	Existing, Resiliency	$1,650,000
Willamette Plant (AWS) *New second water treatment plant with intake on the Willamette River.*	Existing, Resiliency	$68,000,000*

*Costs for Willamette Plant are total over project life and include inflation.

The largest "Source" project in the CIP is the new Willamette Plant. This project first appeared in the CIP in 2009 with a cost of approximately $120M. This cost was based on an Engineering Study for a 30 million gallon per day (MGD) treatment plant located near the steam plant at our Headquarters site. The costs remained relatively constant until 2012 at which time it was acknowledged that it would not be feasible to locate a treatment plant at the Headquarters site. It was also acknowledged at that time that the long term financial plan could not support a $120M project and the costs were reduced to approximately $50M. This was a place holder amount estimated without knowing where the final site would be. This amount stayed in the CIP until 2014.

In 2014, after the proposed location of the plant became clearer, the original HQ site estimate was revised to account for the new location and a capacity of 10 MGD. With this change the estimate was increased to approximately $68M. Recent conceptual level studies for the plant indicate that this amount is appropriate for the plant as currently envisioned.

A summary of the cost changes which have occurred over time for this project is shown in Table 2.

Table 2. AWS Willamette Plant Cost History

	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total	Comment
2010-2019 CIP Presented to Board in September 2009				$ 1,470,000	$ 25,000,000	$ 50,000,000	$ 44,490,000			$ 120,960,000	Initial plan based on Consultant study of 30 MG plant at HQ site
2011-2020 CIP Presented to Board in September 2010				$ 1,470,000	$ 25,000,000	$ 50,000,000	$ 44,490,000			$ 120,960,000	
2012-2021 CIP Presented to Board in September 2011				$ 1,427,000	$ 24,300,000	$ 48,500,000	$ 43,200,000			$ 117,427,000	
2013-2022 CIP Presented to Board in August 2012	$ 26,000	$ 53,000	$ 109,000	$ 563,000	$ 3,478,000	$ 23,881,000	$ 24,597,000			$ 52,707,000	Amount reduced to $50M. Arbitrary, feeling was that this is all that would be acceptable.
2014-2023 CIP Presented to Board in July 2013		$ 52,000	$ 53,000	$ 109,000	$ 113,000	$ 3,478,000	$ 23,881,000	$ 24,597,000		$ 52,283,000	
2015-2024 CIP Presented to Board in July 2014			$ 52,000	$ 106,000	$ 109,000	$ 6,753,000	$ 19,321,000	$ 19,901,000	$ 20,498,000	$ 66,740,000	Selective Strategic option in CIP. Costs were refined to reflect estimated costs for 10MG plant on Willamette at current proposed location. Estimate increased due to revised estimate, shift of lab building from Hayden Bridge to new plant, and inflation for additional year of construction.
Proposed 2016-2025 CIP with 2015 Costs from True-Up.			$ 1,702,000	$ 515,000	$ 530,000	$ 5,791,000	$ 19,321,000	$ 19,901,000	$ 20,498,000	$ 68,258,000	Added funds for property purchase in 2015. Shifted engineering funds from 2018 to 2016 and 2017 to account for preliminary design activities.

Pump Stations and Reservoirs – Base Level

Projects related to our Base Level facilities are shown in Table 3.

Table 3. Base Level Facilities in CIP

Project/Description	Category	Cost
Hawkins Reservoir Improvements *Construction of dividing wall and seismic upgrades.*	Existing, Rehab., Resiliency	$1,930,000
Santa Clara Decommissioning and New 5 MG Reservoir *Demolition of Ex. Santa Clara Reservoir, replacement of pump station, and new 5 MG Reservoir*	Rehab., Resiliency	$12,300,000
New 5 MG Reservoir at Willamette Plant *New 5 MG reservoir at Willamette Plant Site. Not associated with Plant, just a site for distributed storage.*	Resiliency	$6,000,000
New 5 MG Reservoir at Elliot Site *New reservoir at existing EWEB property between 43rd and 46th streets in South Eugene.*	Resiliency	$9,370,000
College Hill Decommissioning and New 5 MG Reservoir *Construction of new reservoir at site of abandoned College Hill 603 Reservoir, then decommissioning of College Hill 607 reservoir.*	Resiliency	$$9,370,000

The first four of the above projects are anticipated within the next ten years to meet base level demand requirements. Additional base level storage will be provided in the future at either the Santa Clara Site or the Elliot Site.

Pump Stations and Reservoirs – Upper Level

Projects related to our Upper Level facilities are shown in Table 4.

Table 4. Upper Level Facilities in CIP

Project/Description	Category	Cost
Laurel Hill 850 Pump Station and Reservoir Improvements *Improvements to the Laurel Hill 850 Pump Station & Reservoir to allow decommissioning of the Fairmont 850 Pump Station*	Optimization	$300,000
Willamette 975 Pump Station *Pump station replacement.*	Existing, Rehab.	$800,000

Crenshaw Pump Station *New pump station near Gillespie Butte.*	Growth	$800,000
Hawkins 1150 Pump Station *New station to replace both the ex. Hawkins 1150 and the City View 1150 pump stations.*	Rehab., Optimization	$800,000
Crest 1150 Pump Station *Pump Station Replacement.*	Rehab.	$800,000
Shasta 975 Reservoir Improvements *Recoating existing steel reservoir.*	Rehab.	$300,000
Willamette 800 Reservoir Replacement *Replacement of Willamette 800 Reservoir #1.*	Existing, Rehab.	$1,000,000
Crest 800 Reservoir *New reservoir to serve areas in south west Eugene.*	Growth	$1,700,000
Shasta 800 Reservoir Improvements *Structural improvements to ex reservoir.*	Existing, Rehab.	$1,100,000
Pump Station Control System Improvements *Multi-year project to upgrade pump stations*	Existing, Rehab.	$1,900,000

Transmission

Projects related to our transmission pipelines are shown in Table 5.

Table 5. Transmission Pipelines in CIP

Project/Description	Category	Cost
Glenwood Transmission Main Improvements *Upsizing 2,000 feet of 16-inch pipe to allow for delivery of Willamette Plant supply into the system and for the future connection to the Russell Basin.*	Resiliency	$1,500,000
Transmission System River Crossing and Pipeline Rehabilitation *Improvements to correct identified issues with existing transmission mains and their elevated crossings.*	Resiliency, Rehab.	$2,000,000
23rd and Alder Street Transmission Improvements *Upsizing approximately 10,000 feet of pipeline in Alder and 23rd street.*	Optimization, Resiliency	$8,900,000
Expanded Willamette Plant Improvements *Upsizing Transmission main from Willamette Plant Site to Knickerbocker Bridge. Required when plant supply significantly exceeds 10 MGD.*	Resiliency	$8,400,000

Only the first two of the above projects are anticipated to be included in the 10-year CIP. The first is required prior to the completion of the Willamette Plant project. The second will be further defined in the next few years. The base level transmission system is part of our 'Resilient Spine' and preliminary studies have shown several of our exposed crossings require rehabilitation. Additional studies are planned to further define these projects and prepare for their implementation.

Distribution – Main Improvements

Main improvements are placed on the CIP based on one or more of the following factors:

- Adherence to Design Standards – main improvements required to adhere to standards such as number of customers on a dead end main, minimum pressure, fire flow capacity, etc.
- Optimization of the System – main improvements required to allow pump stations to work better together or to minimize the number of facilities.

There are dozens of main improvement projects included in the CIP to adhere to design standards. These are prioritized based on their benefit to the system.

The optimization projects that were identified as part of the Master Plan are shown in Table 6.

Table 6. Main Improvement Optimization Projects

Project/Description	Category	Cost
600 feet of 12-inch diameter pipeline to connect Willamette 800 PS to eastern Willamette 800 service area	Optimization	$214,000
4,300 feet of 12-inch diameter pipeline to connect Willamette 800 and Dillard 800 service areas	Optimization	$1,525,000
900 feet of 12-inch diameter pipeline to connect Shasta 800 and Willamette/Dillard 800 service areas	Optimization	$319,000
New PRV station to Connect Shasta 975 to Laurel Hill/Fairmount 850 service area	Optimization	$151,000

With respect to costs, $600K to $650K is included in the 10-year CIP for main improvements.

Distribution – Main Replacements

There are a little less than 800 miles of distribution pipeline in EWEB’s water system with an average age of approximately 40 years. EWEB’s water distribution system is relatively young and has a low leak rate in comparison to the national average. Therefore, EWEB historically has had a limited main replacement program focused primarily on replacing deteriorating pipes and lowering water services prior to city paving projects. In 2008, EWEB Water’s CIP showed significant increases in main replacement and main work. This was a vital step to bring reinvestment to appropriate levels and maintain them. In 2012, an adjustment to levelize these funds was implemented.

Over the last decade however, the number of main breaks in EWEB’s water distribution system has increased at approximately 8 percent per year. Meanwhile, the overall cost of repairing each leak has increased 14 percent per year. Because of an increasing concern with the number of water main leaks and escalating repair costs, EWEB developed a risk based tool for prioritizing main replacements as part of the Master Plan effort.

This model will be used to identify and prioritize main replacements in the future. With respect to the CIP, approximately $3.1M to $3.5M is allocated annually for this effort.

Distribution – Services

Service and meter replacements are included in the CIP with an annual expenditure of approximately $600,000.

Other Items in CIP

In addition to the above projects, there are numerous other items in the CIP. These include:

- Allowances for emergent and misc work – Each of our project areas have minor amounts in the CIP to account for emergent and miscellaneous work that is not planned but likely to arise during any given year. These include items such as:
    - Equipment repairs that extend the useful life of the facility and can be capitalized.
    - Items requiring repair or replacement discovered during normal maintenance activities (such as a corroded ladder in a reservoir discovered during a reservoir inspection).
    - Replacement of items which have failed unexpectedly.
- Shared Services – The water utilities' portion of the projects which affect both the water and electric utility are also included in the CIP. These improvements are associated with information technology, fleet, and buildings/lands and are as recommended in the planning documents for the respective area.

Capital Improvement Program

The first ten years of the Master Plan CIP is included as Attachment 1. This is essentially an early draft of what the Board will be asked to approve at the July board meeting. Costs presented are increased for inflation based on the year that they occur.

For the CIP, the projects and work described above have been identified along with their schedule for completion. This schedule considered the following:

- Demand, including water production, storage, and distribution
- Preventing lost investment – trying to avoid improvements to projects which are going to be decommissioned.
- Resiliency – those projects contributing to the Resilient Spine are constructed first.
- Financial and staff resources.
- Logical or required orders of construction.

Summary

Over the last four Board backgrounders on the Water System Master Plan, Staff has the major shifts in planning philosophy and the impacts that these shifts will bring to planning, design, standardization and implementation to the Water CIP. In essence, the following are the shifts that the 2015 WSMP has brought:

1) An emphasis to focus on water system optimization, making the water system more efficient and effective to deliver and maintain water quality. This is a shift from previous master plans that focused on growth and major rehabilitation projects.
2) The recommendation following the Oregon Resiliency Plan's time of recovery for water systems and expected to work towards those goals in a 50 year period.
3) The development of a "resilient spine" and resiliency plan that focuses on key infrastructure hardening. This will result in "service level" differences of our customers following a major disaster.
4) Continue developing a new philosophy of building smaller reservoirs that are distributed across the system, built for resiliency and long life, recognizing this may be more costly in the out-years of the Water 10-year CIP but less costly in the long term.
5) Simplification of the upper level system which will reduce overall Operations and Maintenance costs in the long run, and prevent the necessity of future new facilities being constructed. This may require some pipeline improvements in the South Hills in order to implement this strategy and save money in the long run.

There may be more policy level discussions that need to be discussed that are important to the Board as well. At the June 2nd meeting, staff will give a short summary presentation of the Master Plan and then allow the Board to ask questions and have a discussion on these important matters.

Recommendation

It is staff's recommendation that the Board approve the 2015 Water System Master Plan and Resolution #1517. Although the Master Plan has not yet been fully assembled (compiled)and bound into a single document, approval will include the attachments produced in the backgrounder information, and detailed planning analysis to back up the document.

Requested Board Action

On June 2nd 2015, EWEB staff will be asking the Board to approve the 2015 Water System Master Plan and Resolution #1517.

Approval by the Board sets forth staff to begin crafting future Capital Improvement Plans, Studies, and Programs to support the goals and recommendations of the Master Plan. Funds needed to implement the Master Plan will be conducted through Board approvals of the 10-Year CIP, Water's Long Term Financial Plan, and through annual Capital and O&M Budgets.

Staff will be available to answer questions at the June 2, 2015 Board meeting. Staff is also available throughout the month of May as these backgrounders get distributed to answer questions. If you have any questions, please call Mel Damewood at 541-685-7145 or email mel.damewood@eweb.org.

Attachment 1: Water Division - 10 Year Capital Plan 2016 to 2025

Project	SubProject	Work Order	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
		Inflation Multiplier	1.030	1.061	1.093	1.126	1.159	1.194	1.230	1.267	1.305	1.344
Type 1 Projects												
Source	Intake Type 1	Emergent and Misc. Intake Equipment and Work	-	53,045	54,636	56,275	57,964	59,703	61,494	63,339	65,239	67,196
		Emergency Water Supply - treatment trailer	103,000									
	Subtotal		103,000	53,045	54,636	56,275	57,964	59,703	61,494	63,339	65,239	67,196
	Filtration Plant Type 1	Emergent and Misc. Plant Equipment and Work	51,500	106,090	109,273	281,377	289,819	298,513	307,468	316,693	326,193	335,979
		Solids "Splitter Box Rebuild"	51,500	636,540	-	-	-	-	-	-	-	-
	Subtotal		103,000	742,630	109,273	281,377	289,819	298,513	307,468	316,693	326,193	335,979
	Source Type 1 Total		206,000	795,675	163,909	337,653	347,782	358,216	368,962	380,031	391,432	403,175
Distribution Pipe and Services	Main Replacements Type 1	Dozens of Work Orders	3,193,000	3,394,880	3,605,999	3,826,730	4,057,459	4,179,183	4,304,559	4,433,695	4,566,706	4,703,707
	Subtotal		3,193,000	3,394,880	3,605,999	3,826,730	4,057,459	4,179,183	4,304,559	4,433,695	4,566,706	4,703,707
	Main Improvements Type 1	Developer Driven Substructure Improvements - Reimbursable	360,500	371,315	382,454	393,928	405,746	417,918	430,456	443,370	456,671	470,371
		General Plant - Water Operations Annual Allowance	41,200	42,436	43,709	67,531	69,556	71,643	73,792	76,006	78,286	80,635
		Misc Improvements, fire & looping improvements	618,000	636,540	710,273	731,581	753,528	776,134	799,418	823,401	848,103	873,546
	Subtotal		1,019,700	1,050,291	1,136,436	1,193,039	1,228,831	1,265,695	1,303,666	1,342,776	1,383,060	1,424,551
	Transmission Type 1	Misc. Improvements	61,800	63,654	65,564	67,531	69,556	71,643	73,792	76,006	78,286	80,635
	Subtotal		61,800	63,654	65,564	67,531	69,556	71,643	73,792	76,006	78,286	80,635
	Services and Meters Type 1	Customer Driven Meter Installations - Reimbursable	772,500	795,675	819,545	844,132	869,456	895,539	922,405	950,078	978,580	1,007,937
		Replacement of Water Meters	515,000	530,450	546,364	562,754	579,637	597,026	614,937	633,385	652,387	671,958
		Replacement of Large Water Services and Meters	61,800	63,654	65,564	67,531	69,556	71,643	73,792	76,006	78,286	80,635
		Backflow & Other Upgrades on Fire Services	30,900	31,827	32,782	33,765	34,778	35,822	36,896	38,003	39,143	40,317
	Subtotal		1,380,200	1,421,606	1,464,254	1,508,182	1,553,427	1,600,030	1,648,031	1,697,472	1,748,396	1,800,848
	Dist. Pipe and Services Type 1 Total		5,654,700	5,930,431	6,272,253	6,595,482	6,909,273	7,116,552	7,330,048	7,549,950	7,776,448	8,009,742
Distribution Facilities	Pump Stations Type 1	Emergent and Misc. Pump Station Equipment and Work	103,000	159,135	163,909	168,826	173,891	179,108	184,481	190,016	195,716	201,587
		Future Pump Station Improvements/Replacements	-	-	-	-	-	477,621	491,950	506,708	521,909	537,567
		Laurel Hill 850 Improvements	257,500									
		Willamette 975	61,800	795,675	-	-	-	-	-	-	-	-
		Crenshaw Pump Station	-	106,090	819,545	-	-	-	-	-	-	-
		Hawkins 1150	-	-	109,273	844,132	-	-	-	-	-	-
		Crest 1150	-	-	-	112,551	869,456	-	-	-	-	-
	Subtotal		422,300	1,060,900	1,092,727	1,125,509	1,043,347	656,729	676,431	696,724	717,625	739,154
	Reservoirs Type 1	Emergent and Misc. Reservoir Equipment and Work	103,000	106,090	109,273	112,551	115,927	119,405	122,987	126,677	130,477	134,392
		Recoat Shasta 975					347,782					
	Subtotal		103,000	106,090	109,273	112,551	463,710	119,405	122,987	126,677	130,477	134,392
	Dist. Facilities Type 1 Total		525,300	1,166,990	1,202,000	1,238,060	1,507,056	776,134	799,418	823,401	848,103	873,546
Type 2 Projects												
Source	Filter S1 to S6 Upgrades		2,163,000	-	-	-	-	-	-	-	-	-
	HB Seismic Upgrades - Headhouse		-	530,450	109,273	-	-	-	-	-	-	-
	Disinfection System Replacement		51,500	1,591,350	1,966,909	-	-	-	-	-	-	-
	Hayden Bridge Standby Power Improvements (Intake and Plant)		772,500	954,810								
	Subtotal		2,987,000	3,076,610	2,076,181	-	-	-	-	-	-	-
Distribution Pipe and Services	Alder & 23rd Upsize to 36-Inch (needed before 2nd Phase Elliot Res) - After 10 years		-	-	-	-	-	-	-	-	-	-
	Upsize 2,000 ft of 16-inch to 36-inch for AWS (prior to startup)		-	-	-	-	579,637	1,194,052	-	-	-	-
	Transmission Improvements per studies yet to be completed		-	-	1,092,727	1,125,509	-	-	-	-	-	-
	Subtotal		-	-	1,092,727	1,125,509	579,637	1,194,052	-	-	-	-
Distribution Facilities	Pump Station Distribution SCADA/PLCs Upgrades		412,000	530,450	546,364	562,754						
Base Level	Divide and Upgrade Hawkins Hill		257,500	891,156	917,891	-	-	-	-	-	-	-
	Decommision Santa Clara Res & PS, New 5 MG Reservoir & PS		-	-	-	-	-	358,216	7,379,243	7,600,620	-	-
	New 5 MG Reservoir at Willamette Plant		-	-	-	562,754	3,477,822	3,582,157	-	-	-	-
	New 5 MG Reservoir at Elliot Site		-	-	-	-	-	-	-	633,385	5,786,669	5,960,269
	New 5 MG Reservoir at College Hill (Construction 2026-2027)		-	-	-	-	-	-	-	-	-	671,958
Upper Level	Willamette 800 Reservoir Replacement		1,030,000	-	-	-	-	-	-	-	-	-
	New Crest 800		-	-	-	337,653	1,622,984	-	-	-	-	-
	Shasta 800 Rehab		-	-	327,818	900,407	-	-	-	-	-	-
	Subtotal		1,699,500	1,421,606	1,792,072	2,363,569	5,100,806	3,940,373	7,379,243	8,234,006	5,786,669	6,632,227

Attachment 1: Water Division - 10 Year Capital Plan 2016 to 2025

Project	SubProject	Work Order	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Shared Services	AMI Network and IT work		270,360	133,200	38,700	16,200	16,200	38,700	-	-	-	-
(uninflated)	Replace Customer Info. System (CIS)		450,000	450,000	-	-	-	-	-	-	-	-
	Add new online services (prepay, usage)		180,000	90,000	90,000	-	-	-	-	-	-	-
	Add Mobile Work Mgmt (MWM)		-	-	180,000	-	-	-	-	-	-	-
	Replace Financial Systems (FMS)		-	-	-	288,000	22,500	-	-	-	630,000	-
	Compute (VM) and Storage (SAN) Replacement		-	-	225,000	-	-	-	-	225,000	-	-
	Subtotal		900,360	673,200	533,700	304,200	38,700	38,700	-	225,000	630,000	-
	Type 2 Total		5,586,860	5,171,416	5,494,681	3,793,277	5,719,143	5,173,125	7,379,243	8,459,006	6,416,669	6,632,227
Type 3 Projects												
Source	Alternative Water Supply		515,000	530,450	5,791,453	19,321,235	19,900,872	20,497,898	-	-	-	-
	Type 3 Total		515,000	530,450	5,791,453	19,321,235	19,900,872	20,497,898	-	-	-	-
Program Total			13,230,561	14,485,232	20,108,462	32,263,290	35,591,400	34,797,147	17,044,236	18,273,452	16,509,790	17,203,315

RESOLUTION NO. 1517
JUNE 2015

EUGENE WATER & ELECTRIC BOARD
RESOLUTION CONCERNING ADOPTION OF THE
2015 WATER MASTER PLAN

WHEREAS, the Eugene Water & Electric Board (EWEB) owns and operates a municipal water system which provides water service to customers located within the City of Eugene and adjacent areas; and,

WHEREAS, EWEB is charged with planning responsibly for a safe and reliable water supply system to meet the current and projected future demands of its customers, including sufficient reserves for municipal fire protection and emergency use; and,

WHEREAS, the EWEB 2015 Water System Master Plan updates EWEB's last Water System Master Plan, prepared in 2004; and,

WHEREAS, the EWEB 2015 Water System Master Plan includes a capital improvements plan that identified specific project needs over a twenty-year period, but also provides EWEB with a living document that extends beyond the capital plan; and,

WHEREAS, the EWEB 2015 Water System Master Plan provides a comprehensive analysis of the system, including, demand forecasts, regulatory compliance, optimization and resiliency plans; and,

WHEREAS, the EWEB 2015 Water System Master Plan develops policies and criteria that guide the planning, design and construction of the system; and,

NOW, THEREFORE, IT IS HEREBY RESOLVED that EWEB shall utilize the 2015 Water System Master Plan as a planning document for determining the ten-year capital plans submitted annually to the Board for approval; and,

BE IT FURTHER RESOLVED that the EWEB General Manager and staff are directed to take the necessary steps, including development of a funding plan, periodic updates or further development to elements of the Water System Master Plan, 10-year formulized update to the Water System Master Plan and other actions as required to accomplish these objectives.

DATED this 2nd day of June 2015.

THE CITY OF EUGENE, OREGON
Acting by and through the
EUGENE WATER & ELECTRIC BOARD

____
Vice President

I, TARYN M. JOHNSON, the duly appointed, qualified and acting Assistant Secretary of the Eugene Water & Electric Board, do hereby certify that the above is a true and exact copy of the Resolution adopted by the Board at its June 2, 2015 Regular Board Meeting.

____
Assistant Secretary

MEMORANDUM

EUGENE WATER & ELECTRIC BOARD

Rely on us.

TO: Commissioners Mital, Simpson, Helgeson, Manning and Brown,

FROM: Mel Damewood, Engineering Manager; Wally McCullough, Water Engineering Supervisor; Laura Farthing, Senior Engineer-Water;

DATE: May 8, 2015

SUBJECT: Water Master Plan

OBJECTIVE: Information Only

Issue

On June 2, 2015, staff will present the 2015 Water Master Plan Update to the board. Staff will prepare a series of four backgrounders for the Board to review prior to the June presentation. These backgrounders will cover the following information:

1. The need for a Master Plan, System Characteristics, and Demands
2. Resiliency Recommendations and Distribution System Pipeline Characteristics and Improvements
3. Base and Upper Level Optimization
4. Capital Improvements Plan (CIP)

This is the first backgrounder in the series.

Background

EWEB's Water Master Plan serves as the road map for developing the ten year CIP. It is required by Oregon Administrative Rule (OAR) 333-061-0060 that community water systems serving more than 300 people maintain a master plan which is prepared by a licensed professional engineer. For a system serving more than 10,000 people, a master plan must be submitted and approved by the Oregon Health Authority every 10 years.

The OAR requires that the Master Plan evaluate the needs of the water system for a minimum of a 20 year period and include at a minimum the following elements;

- Summary of a plan to address water system deficiencies.
- Description of the existing water system, water quality, and level of service goals.
- An estimate of projected demands and growth within the system.
- An engineering evaluation of the existing facilities to meet water quality and service level goals.
- Identification of alternative engineering solutions and associated capital and operation and maintenance costs to correct deficiencies and meet anticipated growth.
- A description of alternatives to finance the water system improvements.
- A recommended water system improvement program (CIP).

EWEB last completed an update to the Master Plan in 2004. In late 2013, plans were put in place to begin the update in 2014. Work has been ongoing since to update EWEB's hydraulic model, identify existing and future water system deficiencies, project future demands, update EWEB's service standards, evaluate the most cost effective way to develop a resilient spine in our system, and identify opportunities to simplify system operations.

Discussion

The following sections summarize the work that was done characterizing the water system and developing demand projections to be used for planning purposes throughout the Master Plan.

<u>Service Area Characteristics and the Existing System</u>

EWEB serves the area within the City of Eugene's (City) Urban Growth Boundary (UGB), Lane Community College, the airport, and four wholesale customers; River Road Water District, Santa Clara Water District, the City of Veneta, and the Willamette Water Company. The total population of the service area is approximately 183,000.

Water Sources

EWEB holds three municipal water right permits on the McKenzie River. The water right permits authorize the municipal use of up to approximately 300 cubic feet per second (cfs) (approximately 194 million gallons per day (mgd)). The water right permits and their priority dates are summarized in Table 1 below.

Table 1. EWEB McKenzie River Water Rights

Permit No.	Priority Date	Quantity (cfs/mgd)	Status
8602	05/16/1925	27.08/17.5	Certificate No. 15180
17358	10/15/1976	90.0/58.2	Certificate No. 68537
27441	06/14/1961	183.0/118.3	Extension Application File #S-35037

In addition EWEB has a pre-1909 Surface Water Registration Claim on the Willamette River. EWEB registered its Willamette River claim (Surface Water Registration 354) for 30.9 cfs (approximately 20 mgd) under this mandate.

Water Treatment

EWEB exclusively uses the McKenzie River source to provide water to the two intakes located in Springfield, OR near the intersection of Marcola Rd and Hayden Bridge Rd. Water is pumped from the raw water intakes to the Hayden Bridge Water Filtration Plant (HBFTP) which has a capacity of 88 MGD.

Service Levels
Water from the HBFTP is pumped through 45-inch and 60-inch parallel transmission mains to the intertie location near the intersection of I-105 and I-5 in Springfield, Oregon. At the intertie the pipelines split into three pipes that serve the base level system; a 45-inch transmission line to the south, a 45-inch transmission line to the west, and a 36-inch transmission line to the north.

The majority of EWEB's customers are located in the base level system at an elevation at or below 500 feet. The base level system has a total of 55 million gallons (MG) of storage from three base level reservoirs; Santa Clara Reservoir (20 MG), College Hill Reservoir (15 MG), and the Hawkins Hill Reservoir (20 MG). These reservoirs serve the base level and are the source of supply for the upper level system.

The customers located in areas above 500 feet are served by the upper level system which consists of five service levels summarized in Table 1 below. These services levels are further broken down into 22 upper level service areas. Both the service levels and service areas are summarized in Table 1 below. Water to the service areas is provided by a combination of pump stations and small reservoirs that range in size from 0.30 MG to 1.75 MG. EWEB currently operates and maintains 25 pump stations and 19 distribution system reservoirs.

Table 1. Service Levels and Service Area Summary

Service Level	Lower Customer Elevation	Upper Customer Elevation	Existing Service Areas (overflow elevation)
Base Level	375	500	Base (607)
700 Level	400	600	Bloomberg 700, College Hill 703, and Crest 703
800 Level	500	700	Shasta 800, Dillard 800, Willamette 800, Crest 800, City View 800, South Louis Lane, and Gillespie Butte 800.
850 Level	550	750	Fairmount/Laurel Hill 850
975 Level	700	875	Shasta 975, Dillard 975, Willamette 975, Crest 975, and City View 975

1150 Level	875	1050	Shasta 1150, Willamette 1150, Crest 1150, and City View 1150
1250 Level	1050	1150	Summit Terrace 1250
1325 Level	1050	1225	Willamette 1325 and Crest 1325

Water is delivered through the distribution system by approximately 800 miles of mains. The distribution system will be covered in the next backgrounder in detail. A system map is provided as Figure 1.

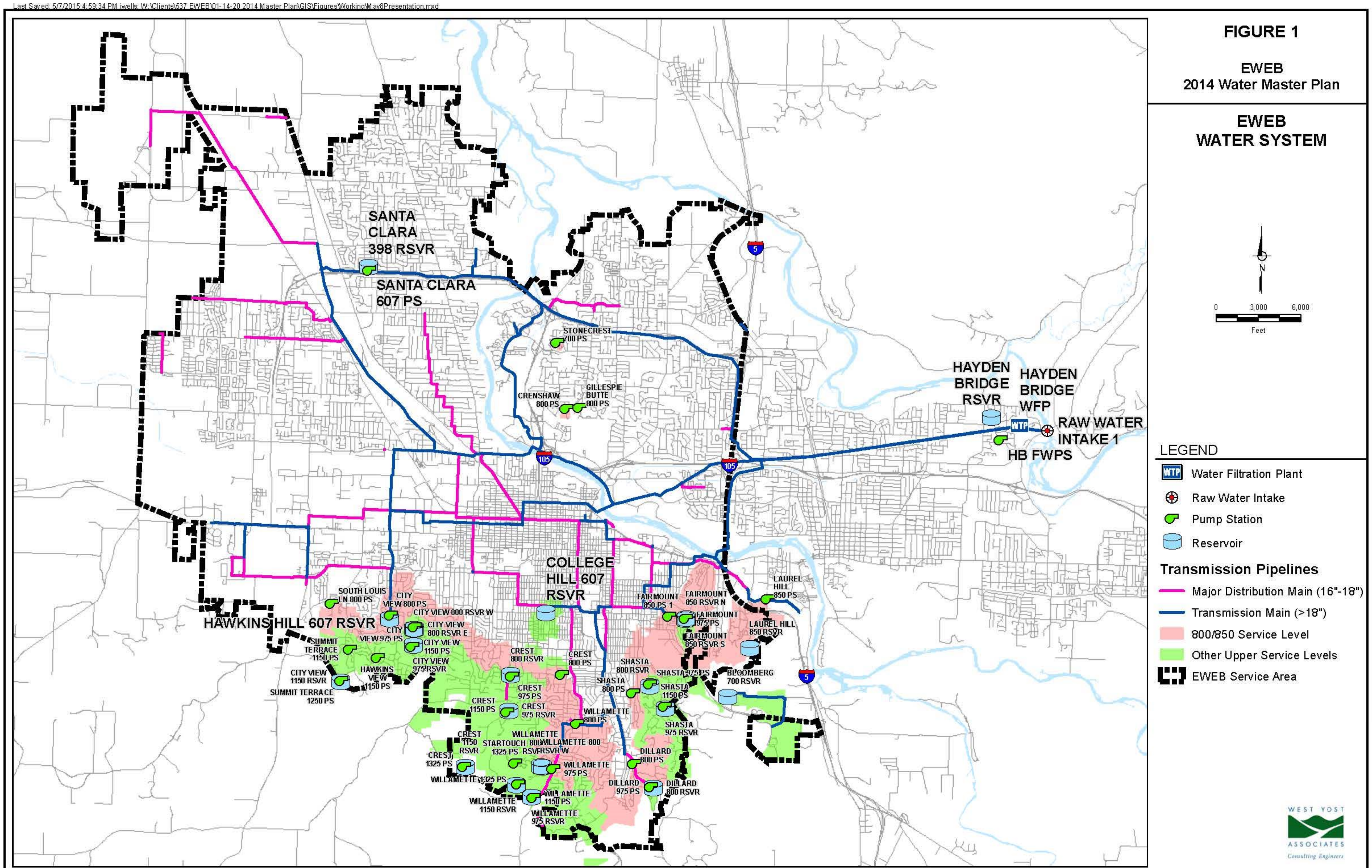
FIGURE 1
EWEB
2014 Water Master Plan
EWEB
WATER SYSTEM
0
3,000
6,000
Feet
LEGEND
Water Filtration Plant
Raw Water Intake
Pump Station
Reservoir
Transmission Pipelines
Major Distribution Main (16"-18")
Transmission Main (>18")
800/850 Service Level
Other Upper Service Levels
EWEB Service Area
SANTA CLARA 398 RSVR
SANTA CLARA 607 PS
HAYDEN BRIDGE RSVR
HAYDEN BRIDGE WFP
RAW WATER INTAKE 1
HB FWPS
COLLEGE HILL 607 RSVR
HAWKINS HILL 607 RSVR
STONECREST 700 PS
CRENSHAW 800 PS
GILLESPIE BUTTE 800 PS
LAUREL HILL 850 PS
LAUREL HILL 850 RSVR
BLOOMBERG 700 RSVR
SOUTH LOUIS LN 800 PS
CITY VIEW 800 PS
CITY VIEW 800 RSVR W
CITY VIEW 800 RSVR E
CITY VIEW 975 PS
CITY VIEW 1150 PS
CITY VIEW 975 RSVR
CITY VIEW 1150 RSVR
SUMMIT TERRACE 1150 PS
SUMMIT TERRACE 1250 PS
HAWKINS VIEW 1150 PS
CREST 800 RSVR
CREST 800 PS
CREST 975 PS
CREST 975 RSVR
CREST 1150 PS
CREST 1150 RSVR
CREST 1325 PS
STARTOUCH 1325 PS
FAIRMOUNT 850 PS 1
FAIRMOUNT 850 RSVR N
FAIRMOUNT 975 PS
FAIRMOUNT 850 RSVR S
SHASTA 800 RSVR
SHASTA 800 PS
SHASTA 975 PS
SHASTA 1150 PS
SHASTA 975 RSVR
WILLAMETTE 800 PS
WILLAMETTE 800 RSVR E
WILLAMETTE 800 RSVR W
WILLAMETTE 975 PS
WILLAMETTE 1150 PS
WILLAMETTE 1150 RSVR
WILLAMETTE 975 RSVR
DILLARD 800 PS
DILLARD 975 PS
DILLARD 800 RSVR
WEST YOST ASSOCIATES
Consulting Engineers

Demand Projections

The Master Plan involves taking a comprehensive look at existing facilities and future needs to provide water service. The first step in this comprehensive analysis is to determine what the future water demands will be. The following section covers the water demand project done for this Master Plan Update, the following backgrounders will summarize the analysis that was done to plan for the future.

Since the 2004 Master Plan was completed, EWEB, similar to the rest of the nation, has seen a drastic decline in water demands. The maximum day demands for the system have dropped from 64.5 million gallons per day (mgd) in 2004 to approximately 50 mgd in 2013. As a result of this decline this master plan update is not focused on growth but instead on improving system reliability and rehabilitating our existing infrastructure.

Demand projections are a critical part of the Master Plan Update. These projections are used to identify the required water supply and distribution system upgrades needed to provide efficient service in the future and to develop and calibrate the water system model. The hydraulic model is used to identify potential deficiencies in the existing water system and to assist in the assessment of future water system requirements. The demand projections for this Master Plan were done for a 20 year planning horizon which includes demands within the UGB and demands for an expanded UGB to accommodate possible growth from the Envision Eugene process.

Demand projections are typically done with a high level of conservatism to provide for the highest demands possible. Figure 2 shows previous and the current master plan projections compared with actual demands in the system. This graph shows that demand projections are more of an art than a science and are based on the best information available at the time.

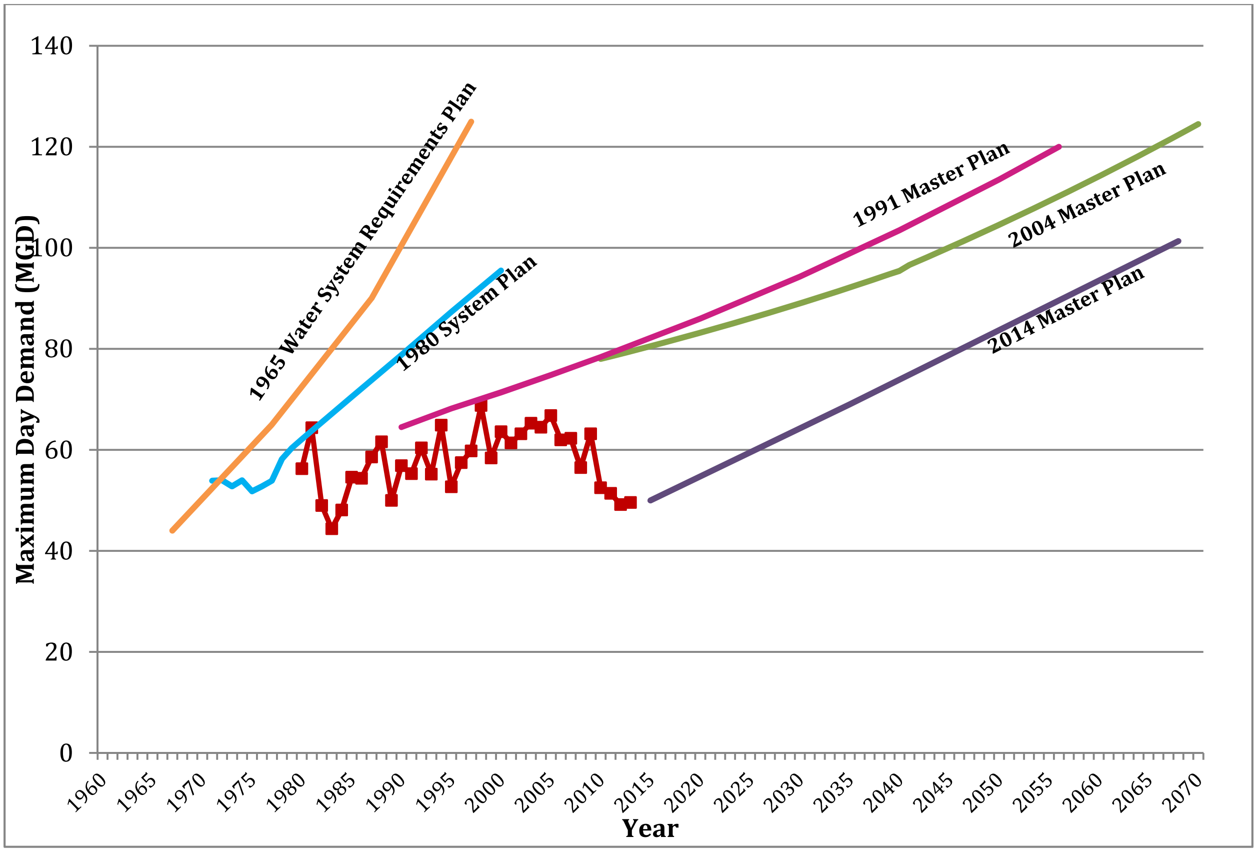

Figure 2. Master Plan Projections Versus Actual Demands

The first step in developing demand projections is to determine past and existing demand patterns and compare them to the population in the system. The average day demand (ADD) for the system was obtained from EWEB's SCADA system. The population forecasts (for areas within the UGB and the potential areas as part of an expanded UGB) were obtained from the Lane Council of Governments. From this data the average per capita water demands for the years 2009 through 2013 were calculated. The data used for this analysis is summarized in Table 2 below. As the table shows the system has an existing average per capita demand in gallons per capita per day (gpcd) of 130 gpcd and shows a trend of decreasing water use, which is attributed to water conservation by customers. To account for any potential rebound in water usage that could occur as the economy improves it was recommended that a per capita water demand of 135 gpcd be used for all the projections.

Table 2. Historical Per Capita Water Demands

Year	ADD, mgd	Estimated Water Delivery Population	Average Day per capita Water Demand, gpcd
2009	26.0	173,438	150
2010	23.0	175,003	131
2011	22.2	175,828	126
2012	23.1	177,153	130
2013	23.8	183,055	133
		Average (2010-2013)	130

The per capita water demand is used to project demands into the future by assuming that it stays constant until the end of the planning period, in this case to 2035. To determine the 2035 potential ADD, the per capita water demand of 135 was multiplied by the projected population from the Lane Council of Governments (LCOG). To determine the potential 2035 Maximum Day Demand (MDD), the ratio of the existing ADD to the existing MDD (called a peaking factor) was multiplied by the 2035 potential ADD. These demands were then used to calculate the demand per service area. This analysis showed that the base level system accounts for approximately 88 percent of the system demand. Table 3 summarizes the system wide demands that were used for this Master Plan Update. A full description of the methodology and data used to project demands and the demands by service area can be found in *Chapter 4: Water Demand* included as Attachment 1.

Table 3. Existing and Future System Water Demands

	Existing Water Demand, mgd	**2035 Potential Water Demand, mgd***
ADD	24.0	50.0
MDD	33.0	69.0

*These demands include potential Envision Eugene sites.

Recommendation
None. This is an information item only. This memo is the first of four backgrounders. A final recommendation will be made in the last backgrounder.

Requested Board Action
On June 2, 2015, EWEB staff will be asking the Board to approve the 2015 Water System Master Plan.

Approval by the Board sets forth staff to begin crafting future Capital Improvement Plans, Studies, and Programs to support the goals and recommendations of the Master Plan. Funds needed to implement the Master Plan will be conducted through Board approvals of the 10-Year CIP, Water's Long Term Financial Plan, and through annual Capital and O&M Budgets.

Staff will be available to answer questions at the June 2, 2015 Board meeting. Staff is also available throughout the month of May as these backgrounders get distributed to answer questions. If you have any questions, please call Mel Damewood at 541-685-7145 or email mel.damewood@eweb.org.

Attachment 1: Chapter 4 – Water Demand

4.1 OVERVIEW

This chapter presents the existing and estimated future water demands for the EWEB service area. Two future water demand scenarios have been developed for this 2014 Water Master Plan: a 20-year planning period which includes growth inside the existing Urban Growth Boundary and a scenario where the Urban Growth Boundary is expanded as anticipated as part of Envision Eugene. These future water demand estimates are used to identify the required water supply and distribution system upgrades needed to provide efficient service and to develop and calibrate the potable water system hydraulic model. The model is used to identify potential deficiencies in the existing water system, to assist in the assessment of the future water system requirements and to define the future capital improvement program based on anticipated future development. Water demand projections also play a key role in helping EWEB identify and secure sufficient water supplies to serve their future customers under various hydrologic conditions.

The following sections of this chapter describe the data and methodology used to determine EWEB's existing and future water system demands:

- Historical Water Production, Consumption and Non-Revenue Water
- Water Use Factors
- Water Conservation Program
- Projected Water Demand

4.2 HISTORICAL WATER PRODUCTION, CONSUMPTION AND NON-REVENUE WATER

Water production, the total quantity of water treated and delivered into the distribution system by the Hayden Bridge Water Treatment Plant (HBWTP), water consumption, the quantity of water actually used by its customers, and non-revenue water, the amount of water lost in the system, are discussed in this section for the years 2000 through 2013.

4.2.1 Annual Water Production

Water production data between 2000 and 2013 was obtained from the HBWTP operations staff. As shown in Table 4-1, annual water production has been decreasing in recent years to an average of approximately 24 million gallons per day (mgd). This reduction is due to increased water conservation through more efficient fixtures and by cutbacks by customers to save money.

Table 4-1. Annual Volume Produced and Average Day Demand, 2000-2013

Year	Annual Volume Produced, MG[(a)]	ADD, mgd
2000	11,091	30.3
2001	10,296	28.2
2002	10,622	29.1
2003	10,991	30.1
2004	10,537	28.8
2005	10,050	27.5
2006	10,720	29.4
2007	10,394	28.5
2008	9,876	27.0
2009	9,488	26.0
2010	8,381	23.0
2011	8,093	22.2
2012	8,439	23.1
2013	8,683	23.8
Average (2010 - 2013)	8,399	23.0
Maximum (2010-2013)	8,683	23.8

(a) Sources: Water Management and Conservation Plan for years 2000-2009; "Flow Data Form 2013.xlsx" provided by EWEB for 2013.

ADD = Average Day Demand. Annual Volume divided by the number of days in that year.

4.2.2 Annual Water Consumption

Historical water consumption by customer type is presented in Table 4-2. Metered consumption has been decreasing somewhat over the past few years. EWEB's average day demands for the period of 2000 through 2013 have ranged from 30.3 mgd in 2000 to 23.8 mgd in 2013. The trend over this period for average day demands has been a decrease of 6.5 mgd or about 20 percent. The percentage of total consumption by each customer type in 2013 is also shown in Table 4-2. As shown, single family residential customers consumed 57 percent of EWEB's water in 2013. Multi-family residential water users were the next largest consumer at 12 percent, followed by Institutional users at 7.9 percent. The City of Veneta connected to the system as a contract user in late 2013 and uses approximately 72 million gallons per year.

Table 4-2. Historical Water Consumption by Customer Type[a]

Customer Type	Annual Water Consumption, MG/yr					Percent of Total Consumption (2013)
	2009	2010	2011	2012	2013	
Single Family Residential	4,493	3,933	3,802	3,952	3,988	51.1%
High Density Single Family Residential	521	486	480	487	481	6.2%
Multi-Family Residential	997	909	896	917	941	12.0%
Commercial	442	466	416	430	430	5.5%
Industrial	300	181	173	192	193	2.5%
Institutional	689	747	605	599	615	7.9%
Landscape Irrigation	128	113	81	95	82	1.0%
City of Veneta	-	-	-	-	15	0.2%
Other[b]	2,547	1,107	1,099	1,105	1,066	13.6%
Total	10,117	7,943	7,551	7,778	7,811	100.0%

[a] Source: Account meter data 2009-2013 provided by EWEB.
[b] See section 4.3.1 for discussion.

4.2.3 Non-Revenue Water

Non-revenue water (NRW) refers to the difference between the recorded water production and metered water consumption. NRW includes unmetered hydrant use, other unmetered uses, meter inaccuracies (both production and customer), and water lost to reservoir overflow or leakage. The American Water Works Association (AWWA) has adopted a water audit methodology developed initially by the International Water Association. This methodology is documented in the AWWA Manual of Water Supply Practices M36 (Water Audits and Loss Control Programs, Third Edition, 2009) and is summarized in Table 4-3.

Table 4-3. Water Balance Factors

Water from all sources (EWEB-owned and Imported from emergency inter-ties)	Authorized Consumption	Billed Authorized Consumption	Billed metered consumption (including water exported to another system). Billed unmetered consumption.	Revenue Water
		Unbilled Authorized Consumption	Unbilled metered consumption. Unbilled unmetered consumption.	Non- Revenue Water
	Water Losses	Apparent Losses	Unauthorized consumption. Metering inaccuracies. Data handling error.	
		Real Losses	Leakage from transmission and/or distribution mains. Leakage and overflows at storage tanks. Leakage from water delivery connections up to point of customer metering.	

Source: AWWA. Manual of Water Supply Practices M36. Water Audits and Loss Control Programs, Third Edition, 2009

The water production and metered consumption for 2000 through 2013, along with the calculated NRW for each year, are shown in Table 4-4. As shown in Table 4-4, the average NRW for that period was 7.1 percent.

The 2004 Water Master Plan indicates that during the period of 1998-2002, the NRW value ranged from 6.1 percent to 10 percent of total water production, with an average of 7.7 percent of total water production. The NRW rate in many water systems ranges from 7 percent to well over 15 percent of total water produced. The NRW experienced by EWEB is low compared to many water systems. This low rate of NRW is indicative of a well-run and maintained water system.

Two factors significantly affect NRW over time. First, as transmission and distribution systems age, leaks tend to develop and meters lose efficiency which will tend to increase NRW over time. Second, leak detection programs and scheduled pipeline renewal and replacement projects will tend to decrease the NRW over time. Balancing these two factors, West Yost recommends using a NRW value of 7 percent in the water demand projections. This value for the EWEB water system is recommended to allow for some system deterioration over time, but anticipates continued leak detection and repair on the part of EWEB.

Table 4-4. Non-Revenue Water (NRW) (2000-2013)

Year	Water Production, MG[(a)]	Water Consumption, MG[(b)]	NRW, MG/yr	NRW, % of Water Production
2000	11,091	10,341	750	6.8%
2001	10,296	9,393	903	8.8%
2002	10,622	9,972	650	6.1%
2003	10,991	10,136	855	7.8%
2004	10,537	9,605	933	8.8%
2005	10,050	9,386	665	6.6%
2006	10,720	10,030	690	6.4%
2007	10,394	9,601	794	7.6%
2008	9,876	9,299	577	5.8%
2009	9,488	8,782	706	7.4%
2010	8,381	7,810	572	6.8%
2011	8,093	7,565	527	6.5%
2012	8,439	7,828	611	7.2%
2013	8,683	8,021	662	7.6%
			Average (2010-2013)	7.1%

(a) See Table 4-1.
(b) Sources: Water Management and Conservation Plan for years 2000-2009; Meter data for years 2010-2013.

4.3 WATER USE FACTORS

Historically, EWEB has based future water demand projections on the historical per capita water demands and water service area population projections. This method provides an adequate approximation of future water demands providing per capita water demands do not change significantly over time, and total demand increases proportional to the population. If future development plans emphasize growth of non-residential land-use types, the overall per capita water demand could increase over time, and the water demand could increase at a greater rate than the population growth. To account for changing development and land use patterns, water demand projections have been prepared using both land use based water demand factors and per capita demand factors. The purpose of this section is to describe the land use based water demand factors, the per capita water use factors, and the water demand peaking factors.

4.3.1 Land Use Based Water Use Factors

A land use based methodology for demand projections has been developed. Demand projections have been developed by evaluating the per capita water demand and assigning demand to each dwelling unit. This section describes the historical EWEB demand by land use type as the first step towards development of land use based water demand projections.

Metered customer water demand data for 2009 through 2013 was provided by EWEB, along with two Geographical Information System (GIS) shapefiles. The first GIS shapefile database contained the meter identification numbers and spatial locations. The second GIS shapefile database contained the spatial designations of land uses throughout the EWEB service area. The number of dwelling units for each for each pressure zone was provided by the Lane Council of Governments. This information formed the basis for the historical demand by land use analysis.

With both the meter identification numbers and the land use designations spatially located in GIS, the two GIS databases were cross-referenced to assign a land use to each meter identification number. After assigning a land use to the meter identification numbers, the water consumption data was correlated to the land use. The resulting correlation contained the individual meter identification numbers' consumption data by land use, which was then tabulated to determine the total consumption by each land use type, as shown in Table 4-2. For residential land use types, the total consumption was divided by the number of dwelling units within that land use type. The total consumption of each non-residential land use type was divided by the corresponding total area of that land use type in the EWEB service area. The total number of dwelling units for the residential land use types and the total area of the non-residential land use types are shown in Table 4-5.

Table 4-5. Summary of Land Use Types with Active Meters[(a)]

Land Use Type	Total Area, acres	Dwelling Units, DU
Single Family Residential		46,612
High Density Single Family Residential		9,133
Multi-Family Residential		24,119
Commercial	1,208	
Industrial	1,272	
Institutional	2,005	
Landscape Irrigation	3,872	
Other[(b)]	14,731	

(a) Source: Account meter data 2009-2013.
(b) Other classification currently includes "Transportation" parcels that contain some irrigation as well as airport demand.

The resulting land use based water demand factors are shown in Table 4-6. Both the dwelling unit based factors for the residential customer types and the land use based factors for the non-residential customer types are consistent with industry standards and other water utilities. As noted in both Table 4-5 and Table 4-6, the Other customer type contains transportation parcels that contain both irrigation and airport water demands. These parcels would require segregation or re-classification in order to develop accurate land use based water demand factors.

Table 4-6. Average Annual Water Demand Factors by Land Use Type, 2009-2013[(a)]		
Customer Type	Average Annual Water Demand Factors	
	gpd/ac	gpd/DU
Single Family Residential	-	237
High Density Single Family Residential	-	147
Multi-Family Residential	-	106
Commercial	991	-
Industrial	447	-
Institutional	890	-
Landscape Irrigation	71	-
Other[(b)]	253	-

(a) Source: Account meter data 2009-2013.
(b) Other classification currently includes "Transportation" parcels that contain some irrigation as well as airport demand.
gpd/ac = Gallon per day per acre
gpd/DU = Gallon per day per dwelling unit

Furthermore, the Landscape Irrigation customer type unit use factor is lower than would be expected. The method to determine this land use relied on the total land use designated as irrigation. While investigating these classifications, it was determined that there are large areas of land designated as irrigation that do not actually receive irrigation water. The amount of land designated as irrigation but received no flows was large enough to significantly skew this land use factors. Irrigation demand in the Willamette Valley depend on the vegetation, soil type and irrigation equipment. Given the cost of water, large scale irrigation using municipal water is not anticipated.

4.3.2 Per Capita Water Use Factors

Per capita water demands for the years 2009 through 2013 are shown in Table 4-7. As water demand has generally been decreasing during the last decade, the average per capita water demand for the entire period has also decreased. Between 2000 and 2008, the average water demand in gallons per capita per day (gpcd) was 170 gpcd. As shown in Table 4-7, the current annual average water demand is 130 gpcd. This decrease is attributed to water conservation by the system users as more efficient water practices have been adopted and as the cost of utilities has increased.

Table 4-7. Historical Per Capita Water Demands (2009-2013)			
Year	Average Day Production, mgd[a]	Estimated Water Delivery Population[b]	Average Day per capita water demand, gpcd
2009	26.0	173,438	150
2010	23.0	175,003	131
2011	22.2	175,828	126
2012	23.1	177,153	130
2013	23.8	183,055	133
		Average (2010-2013)	130

[a] See Table 4-1.
[b] Population of Eugene plus 18,818 in Lane County

4.3.3 Water Demand Peaking Factors

Water demand peaking factors were calculated for the MDD and the peak hour demand (PHD). The MDD peaking factor is equal to the MDD divided by the ADD. The PHD peaking factor is equal to the PHD on the maximum day divided by the ADD. To calculate the MDD peaking factor, the historical MDDs were divided by the annual ADDs for the years between 2000 and 2013, as shown in Table 4-8.

Individual maximum days were evaluated for the years 2010 to 2013 to calculate the PHD. The change in storage of all the water storage tanks from those in the Base Zone up to those in the 1325 service zones was calculated for the week surrounding the identified MDD. The PHD was calculated using a water balance between the produced water and the change in storage for the distribution system. The resulting PHD values and peaking factors are presented in Table 4-8. For purposes of this Water Master Plan, the recommended PHD peaking factor is 3.2.

Table 4-8. Maximum Day and Peak Hour Demand Peaking Factors

Year	ADD, mgd	MDD, mgd	Peaking Factor MDD/ADD	PHD, mgd	Peaking Factor PHD/ADD
2000	30.3	63.6	2.1		
2001	28.2	61.4	2.2		
2002	29.1	63.2	2.2		
2003	30.1	65.3	2.2		
2004	28.8	64.5	2.2		
2005	27.5	66.8	2.4		
2006	29.4	62.0	2.1		
2007	28.5	62.3	2.2		
2008	27.0	56.5	2.1		
2009	26.0	63.2	2.4		
2010	23.0	52.5	2.3	70.1	3.0
2011	22.2	51.4	2.3	73.8	3.3
2012	23.1	49.2	2.1	68.1	2.9
2013	23.8	49.6	2.1	84.4	3.5
Recommended Existing	24	50	2.1	77	3.2

ADD = Average Day Demand. Annual Volume divided by the number of days in that year.

MDD = Maximum Day Demand. Data from Flow Data Sheets for 2010 through 2013.

PHD = Peak Hour Demand. Data from EWEB.

4.4 WATER CONSERVATION PROGRAM

The 2012 Water Management and Conservation Plan details the current status of EWEB's water conservation program. Portions of the 2012 Water Management and Conservation Plan relevant to this Water Master Plan work are summarized in this section, followed by a discussion on the potential impact on projected water demand.

In 1998, EWEB adopted its 1998 Water Supply Plan. Specific water conservation goals established as part of the 1998 Water Supply Plan and estimated to be accomplished during the Plan's 40-year planning horizon are as follows:

1. Reduce ADD by 5.3 percent.
2. Reduce peak demands by 12.3 percent.

In addition, EWEB staff identified a third goal that focuses on shorter-term operation and reducing peak demand: To maintain a system MDD that is within 5 percent of a rolling, 3-year average.

According to the Water Management and Conservation Plan, EWEB currently has numerous water conservation measures and activities in place, which include:

- Tracking of NRW and the leak detection and pipe replacement program have kept NRW to 7.4 percent in 2009 and an average of 6.8 percent (2005-2009).
- A fully metered system.
- A three-tiered inverted-block rate structure for residential customers to encourage conservation.
- The Green Grass Gauge campaign, an outdoor watering public education effort.
- Ten thousand free rain gauges have been given away each summer since 2005.
- Information previously presented at EWEB workshops has been integrated into several education and home visit programs, such as Oregon State University Extension's Sustainable Landscapes and Lane Community College's Water Conservation Technician Associate Degree.
- From 1995-2008, about 1,600 inefficient toilets were replaced under EWEB's toilet rebate program, resulting in estimated savings of 34 MG per year.

As shown in Table 4-7, average day production has *decreased* more than 20 percent from 2000 to 2013, even though the total population of the service area has *increased* by roughly 18 percent. As a direct result, per capita water demands have *decreased* roughly 34 percent over that same time period.

4.5 PROJECTED WATER DEMAND

Water demand projections consider both land use and population. The groundwork for such an approach has been established through the calculation of historic land use and population based water use factors, as described in the first section of this chapter. At the current time, an inventory of buildable land within the various land use designations is not available to directly develop land use based water demand projections within each pressure zone. Therefore, water demands were projected for this master plan based upon projected dwelling unit, the relative mix of residential versus non-residential land use in each service zone, and projected population growth in the service area. With the historic usage factors that have been developed, the land use based projections can be calculated when required and when the buildable land inventories are available.

4.5.1 Per Capita Water Demand For Use In Demand Projections

As described above and shown in Table 4-7, per capita water demand in the EWEB service area has declined in the last decade. Projecting water demands based upon 2000-2008 per capita values would be based on an assumption that the decrease in per capita demand seen recently is temporary and demand will rebound to previous values during the study period. Projecting water demands based upon the current per capita value (130 gpcd) assumes that the decrease in per capita demand is permanent and that demand growth between the present and 2035 will be a function of population growth.

The per capita demand decrease that has been experienced in the last five years is likely based upon conservation efforts leading to more efficient water usage within the service area and by economic factors. It is unlikely that per capita water demand will rebound to the 150 gpcd or higher values seen previously. However, it is possible that per capita demand factors will rebound somewhat as economic conditions improve during the planning period. For the purposes of this water master plan, a value of 135 gpcd is recommended for use in average water demand projections. This value is in line values seen between 2009 and 2013, but it is not the minimum value observed for this time period.

4.5.2 EWEB Service Area Population and Dwelling Unit Projections

Lane County Council of Government (LCOG) is the governmental agency responsible for land use designations and population projections within the EWEB service area. LCOG provided population projections in the form of dwelling unit (DU) projections for the service area as part of this project. The DU projections are presented in Table 4-9. As presented, LCOG projects that the existing 79,864 DU in the EWEB service area will grow to a forecasted 2035 value of 98,193 DU with a Potential 2035 (possible to occur at full build-out) value of 108,645 DU. These values correspond to a Forecast 2035 growth of 23%, and a Potential 2035 growth of 36%. These growth values are consistent with the medium and high population growth projections, respectively, developed for the Eugene area by Portland State University.

Table 4-9. LCOG Residential Dwelling Unit (DU) Projected Growth (No Expansion Outside of Existing Urban Growth Boundary)

Description	Existing DU	Forecast 2035 DU	Potential 2035 DU
Single Family	46,582	58,496	64,877
Mobile Home (in park)	5,987	3,088	3,088
Duplex	3,088	6,518	6,949
Multi-Family	23,967	29,852	33,491
Group Quarters	240	240	240
Total	79,864	98,193	108,645
Percentage DU Growth	-	23%	36%

4.5.3 Dwelling Unit and Water Demand Projections by Service Zone Within Existing Urban Growth Boundary

LCOG provided existing and projected dwelling unit values for individual service zones within the EWEB service area. The Base Level Service Zone was divided into four sub-zones for the purposes of these projections in order to correctly allocate dwelling unit growth in the appropriate region of this large service zone. The resulting existing and projected dwelling units by service zone are shown in Table 4-10. As shown, the majority of existing dwelling units and projected dwelling unit growth in the service area is found in the Base Service Zone.

Table 4-10. Demand Projection Summarized by Service Zone
(No Expansion Past Existing Urban Growth Boundary)

Service Zone	2011 (Existing) Residential DU	2035 Forecast Residential DU	2035 Potential Residential DU	Existing ADD, mgd	2035 Forecast ADD, mgd	2035 Potential ADD, mgd	Existing MDD, mgd	2035 Forecast MDD, mgd	2035 Potential MDD, mgd
BASE SERVICE ZONE 60	69,561	83,128	91,752	21.05	25.17	27.78	44.21	52.85	58.34
BLOOMBERG 700	9	9	9	0.08	0.08	0.08	0.18	0.18	0.18
CITY VIEW 1150	245	378	434	0.10	0.14	0.15	0.22	0.29	0.32
CITY VIEW 800	1,901	2,168	2,285	0.47	0.54	0.56	0.99	1.13	1.19
CITY VIEW 975	722	966	1,025	0.20	0.26	0.28	0.42	0.56	0.59
COLLEGE HILL 703	515	519	521	0.13	0.13	0.13	0.28	0.28	0.28
CRENSHAW 800	1	10	14	0.00	0.00	0.01	0.00	0.01	0.01
CREST 1150	122	193	221	0.04	0.06	0.07	0.09	0.14	0.15
CREST 1325	25	25	25	0.01	0.01	0.01	0.03	0.03	0.03
CREST 703	144	175	194	0.03	0.04	0.04	0.06	0.08	0.09
CREST 800	162	188	199	0.04	0.04	0.05	0.08	0.09	0.10
CREST 975	881	1,158	1,257	0.24	0.32	0.35	0.51	0.67	0.73
DILLARD 800	440	674	924	0.10	0.17	0.25	0.20	0.36	0.53
DILLARD 975	36	48	69	0.01	0.01	0.02	0.02	0.03	0.04
FAIRMOUNT 850	630	886	986	0.20	0.27	0.29	0.42	0.56	0.61
FAIRMOUNT 975	76	96	102	0.01	0.02	0.02	0.03	0.04	0.04
FUTURE RUSSEL 800	-	1,000	1,121	0.00	0.42	0.47	0.00	0.88	0.99
FUTURE RUSSEL 975	-	317	384	0.00	0.13	0.16	0.00	0.28	0.34
FUTURE WEST 800	-	301	443	0.00	0.12	0.18	0.00	0.26	0.38
GILLESPIE BUTTE 800	10	11	11	0.01	0.01	0.01	0.02	0.02	0.02
HAWKINS VIEW 1150	105	119	126	0.04	0.05	0.05	0.09	0.10	0.10
LAUREL HILL 850	223	755	874	0.08	0.26	0.30	0.16	0.54	0.62
SHASTA 1150	157	233	266	0.09	0.11	0.12	0.20	0.23	0.25
SHASTA 800	481	566	601	0.14	0.17	0.18	0.30	0.35	0.37
SHASTA 975	307	456	515	0.12	0.16	0.18	0.25	0.34	0.37
SOUTH LOUIS LANE 800	13	121	142	0.00	0.04	0.05	0.01	0.09	0.11
STARTOUCH 1325	18	18	18	0.00	0.00	0.00	0.01	0.01	0.01
STONECREST 800	10	10	10	0.00	0.00	0.00	0.01	0.01	0.01
SUMMIT TERRACE 1150	116	208	225	0.04	0.07	0.08	0.09	0.15	0.16
SUMMIT TERRACE 1250	17	38	46	0.01	0.02	0.02	0.03	0.04	0.04
WILLAMETTE 1150	269	336	358	0.06	0.08	0.08	0.12	0.16	0.18
WILLAMETTE 1325	74	202	397	0.03	0.07	0.14	0.06	0.15	0.30
WILLAMETTE 800	1,942	2,104	2,152	0.48	0.52	0.54	1.01	1.10	1.13
WILLAMETTE 975	626	743	897	0.14	0.17	0.21	0.30	0.36	0.45
WOODSON 975	26	35	41	0.01	0.01	0.01	0.02	0.02	0.02
Total	79,864	98,193	108,645	24	30	33	50	62	69

As described above, a value of 135 gpcd is being used for demand projections. This value corresponds to a unit demand factor of 301 gpd/DU. This unit factor is higher than residential factors presented in Table 4-6 because it is a composite factor that accounts for all residential and non-residential demand in the service area. The unit demand factor of 135 gpcd (301 gpd/DU) corresponds to an existing ADD of 24 mgd for the entire service area, as presented in Table 4-10. Based upon the projected dwelling unit values described above, the projected 2035 Forecast and 2035 Potential ADD values are 30 mgd and 33 mgd, respectively for the entire service area.

The difference between the composite unit demand factor of 301 gpd/DU and the unit demand factors for each zone presented in Table 4-6 reflects the adjusted demand projections for each individual service zone. For those service zones that anticipate residential growth only, future dwelling units would be expected to demand an amount of water similar to the values in Table 4-6. For those service zones that anticipate both residential and non-residential growth, future dwelling units would be expected to correspond with higher demands because each residential dwelling unit is associated with non-residential growth as well. For this reason, areas with exclusively residential dwelling units have been assigned a value of 215 gpd/DU. Dwelling units associated with both residential and non-residential growth have been assigned a value of 420 gpd/DU. For each individual service zone, the ratio of residential to non-residential land was calculated using GIS overlay analysis. The growth in dwelling units for each service zone was distributed between residential-only and residential/non-residential dwelling units based upon the amount of residential and non-residential landing the zone. Some upper service zones contain only residential land, and thus were assigned residential-only dwelling units. The overall ratio of residential only to residential/non-residential dwelling units in the service area is 58% to 42%. The resulting service zone 2035 Projected and 2035 Potential projected water demands are presented in Table 4-10. As shown, the composite (average) unit demand factor remains 301 gpd/DU across the entire service area.

As described above in the section on peaking factors, the recommended MDD/ADD ratio for this master plan is 2.1. The existing, 2035 Forecast, and 2035 Potential MDD projections are shown as 50 mgd, 62 mgd, and 69 mgd, respectively in Table 4-10.

4.5.4 Dwelling Unit Growth and Water Demand Projections Outside of the Current Urban Growth Boundary

As part of the Envision Eugene process, LCOG has identified expansion areas that could lead to growth in the EWEB service area outside of the existing Urban Growth Boundary (UGB). The four expansion areas are shown in Table 4-11 with potential dwelling unit growth capacity. Although it is not anticipated that all of the potential growth presented in Table 4-11 will occur during the study period, growth could occur to these levels, and LCOG makes no predictions about the timing and phasing of the growth in each of these expansion areas.

Table 4-11. LCOG Envision Eugene UGB Expansion Maximum Capacity		
UGB Expansion Area Name	Potential Residential DU Capacity	Potential ADD at Full Capacity, mgd
Bailey Hill-Gimple Hill	908	0.27
Bloomberg-McVay	1,941	0.58
Crest-Chambers	2,204	0.66
Greenhill-DAG	739	0.22
Total	5,792	1.74

The ADD and MDD projections including growth both inside of and outside of the current UGB can be seen in Table 4-12. As shown, growth in all four of the expansion areas to the maximum capacity would result in the addition of one mgd to ADD projections, and in the addition of approximately three mgd to MDD projections.

Table 4-12. Service Area ADD and MDD Projections			
Scenario	Residential Dwelling Units	ADD, mgd	MDD, mgd
Existing Values	79,864	24	50
2035 Forecast Values	98,193	30	62
2035 Potential Values	108,645	33	69
2035 Potential Values with UGB Maximum Capacity Expansion	114,437	34	72

M E M O R A N D U M

EUGENE WATER & ELECTRIC BOARD

Rely on us.

TO: Commissioners Mital, Simpson, Helgeson, Manning and Brown,

FROM: Mel Damewood, Engineering Manager; Wally McCullough, Water Engineering Supervisor; Laura Farthing, Senior Engineer-Water;

DATE: May 15, 2015

SUBJECT: Water Master Plan - Resiliency

OBJECTIVE: Information Only

Issue

On June 2, 2015, staff will present the 2015 Water Master Plan Update to the board. Staff will prepare a series of four backgrounders for the Board to review prior to the June presentation. These backgrounders will cover the following information:

1. The need for a Master Plan, System Characteristics, and Demands
2. Resiliency Recommendations
3. Base and Upper Level Optimization
4. Capital Improvements Plan (CIP) and Summary

The first backgrounder was submitted to the Board on May 8. 2015. This is the second backgrounder in the series.

Background

EWEB's approach to resiliency planning has been accomplished through:

- Master planning (defining a resilient backbone), and
- Strengthening or replacing our existing infrastructure.

This backgrounder provides a discussion of each of these items and how they relate to potential projects at EWEB in the future.

Discussion

The following sections summarize the work that has been done regarding resiliency at EWEB.

Master Planning

As part of the 2015 Master Plan Update, EWEB completed a Resiliency Plan that defines potential hazards to our system and provides guidance in defining EWEB's resilient backbone. This work was used to drive the Base Level and Upper Level Optimization work for the Master Plan and to help prioritize projects in the Capital Improvements Plan (CIP).

EWEB's Resiliency Plan

The scope of the EWEB Resiliency Plan is primarily designed to advance the recommendations of "*The Oregon Resilience Plan, Reducing Risk and Improving Recovery for the Next Cascadia Earthquake and Tsunami*" (ORP) completed in February 2013, but also includes other possible hazards which are summarized in Table 1 below.

Table 1: Resiliency Plan Hazards

Hazard	**Impacts**	**Recurrence Interval, years**
Earthquake (Cascadia Subduction Zone)	Damage to pipelines and facilities from ground shaking, liquefaction, and permanent ground deformation (PGD).	300-380
Volcanoes	Degradation of water quality and potential damming of the McKenzie River due to lava, debris flow, and ash fall.	10's-10,000
Flood/Intense Storm	Submerged facilities and damage to foundations and electrical equipment from inundation and/or dam failure, potential damage to pipelines and foundations from erosion	10s – 10,000
Loss of Power	Loss of treatment and pumping capability, disruption to power lines.	100
Landslides	Damage to pipelines and facilities, degradation of water quality for slides within the McKenzie Watershed.	10's
Wildfire	Degradation of water quality.	100's
Accidental Spill	Degradation of water quality.	100's

All of the above hazards can cause short and long term outages. A detailed description of each hazard can be found in EWEB's Resiliency Plan included as Attachment 1.

Cascadia Subduction Zone Earthquake

The most significant hazard that could affect EWEB facilities is a Cascadia Subduction Zone (CSZ) earthquake. The CSZ is a long fault which extends from Vancouver British Columbia to Northern California. The fault separates the Juan de Fuca and North American Plates. It is called a subduction zone because the Juan de Fuca plate is moving under (subducting beneath) the North American Plate. At this point of subduction a magnitude 9.0 earthquake can result, similar to those seen in recent years in Japan and Chile. The last CSZ event occurred in 1700. It was traditionally thought that the recurrence interval for this earthquake was 500 years, however new research shows that the recurrence interval could actually be 300 to 380 years.

A magnitude 9.0 earthquake at the fault would produce a peak ground acceleration (shaking) in Eugene significantly less than what was experienced in the 2014 Napa, California Earthquake. In addition, Eugene does not have large areas that would be susceptible to liquefaction. Both of these facts should help to minimize the damage the system experiences however there is still a good probably of significant damage to parts of the system. While building codes have been updated to plan for a CSZ earthquake, existing infrastructure has not been upgraded and is therefore vulnerable to some level of failure in the event of a major earthquake. Maps showing the peak ground acceleration and, areas susceptible to liquefaction and landslides are included in the Resiliency Plan in Attachment 1.

Level of Service: ORP's Recommended Recovery Times

The ORP includes a phased approach to be used by water purveyors for system recovery. The approach builds on the idea of having a "hardened backbone", which per the plan would need to be capable of supplying key community needs including fire suppression, health and emergency response, and community drinking water distribution points while repairs are being made to the distribution system. The targets for recovery are summarized in Table 2 below.

Table 2: System Recovery

Target	Time for 80-90 Percent Recovery (Willamette Valley)
Potable water available at supply source (water treatment plant, wells, impoundment)	1-2 weeks (Coast 3-6 months)
Main Transmission System	0-24 hrs
Water supply to critical facilities	1-3 days
Water for fire suppression – at key supply points	0-24 hrs
Water for fire suppression at fire hydrants	2 weeks – 1 month
Water available at community distribution centers/points	2 weeks – 1 month
Distribution system operational	1-2 weeks

EWEB's Resiliency Plan provides a roadmap to develop the hardened backbone in the system over 50 years. The Resiliency Plan defines the system backbone by identifying first priority facilities; source, treatment, transmission, and base level reservoirs, and second priority facilities; infrastructure in the 800 level service areas. The first and second priority facilities are shown on

Figure 1.

First Priority Facilities

The priority 1 facilities include water supply, treatment and delivery into the city. The facilities are summarized below.

- Potable water available at the supply source:
    - Facilities required to be operational immediately following an earthquake:
        - One of the two intakes,
        - The raw water pump station,
        - One of the pipelines from the intake to the Hayden Bridge Water Filtration Plan (HBWFP),
        - One half of the HBWFP capacity,
        - The 15 million gallon (MG) Hayden Bridge reservoir,
        - Half of the finished water pump station, and
        - One of the two pipelines from the HBWFP to the intertie station near the intersection of I-5 and I-105.
    - Facilities required 1 to 2 weeks after an event:
        - The remaining half of the HBWFP,
        - The remaining finished water pump station capacity and
        - The other pipeline to the intertie station.
- Main transmission facilities, pipes, pump stations and reservoirs
        - The Hawkins Hill Reservoir,
        - The proposed new College Hill and Elliott Reservoirs and,
        - The transmission mains connecting these Reservoirs to the HBWFP.

This plan assumes that the existing College Hill 607 and the Santa Clara Reservoirs would be replaced by new, smaller reservoirs which would then become part of the first priority backbone system. The first priority backbone facilities will be discussed in detail in the third backgrounder which staff will provide to the Board on May 22, 2015.

Second Priority Backbone Facilities

The second priority backbone facilities would be major pump stations, reservoirs and pipelines that connect the Base Level Service Area to the 800 and 850 Service Areas. These facilities include the following:

- City View 800 Pump Station and West Reservoir
- Crest 800 Pump Station and Reservoir
- Willamette 800 Pump Station and West Reservoir
- Shasta 800 Pump Station and Reservoir

- Laurel Hill 850 Pump Station and Reservoir

These reservoirs were chosen because they are newer, or in the process of being replaced or upgraded. The second priority backbone will be discussed in detail in the third backgrounder which will be provided by staff on May 22, 2015.

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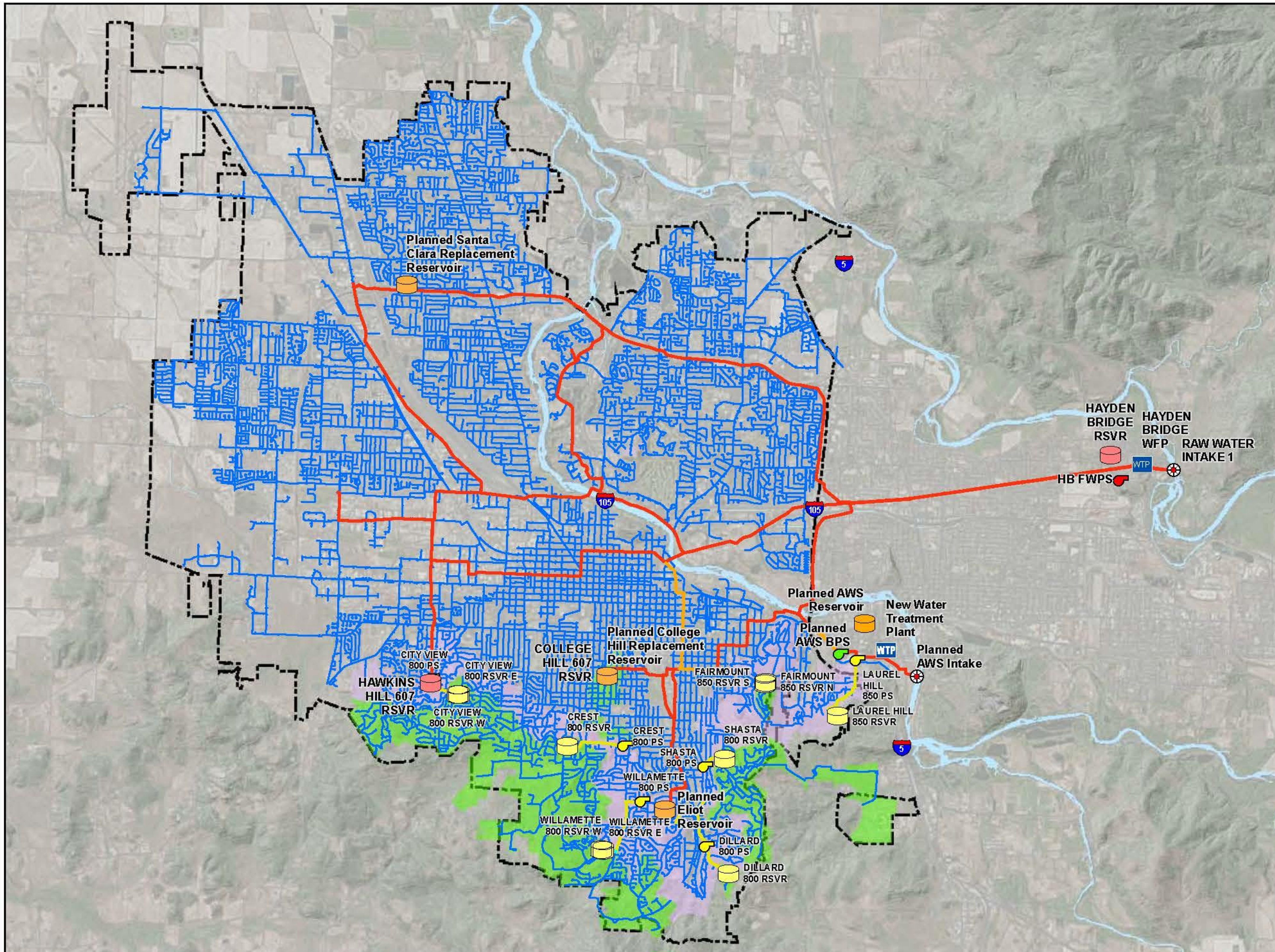
FIGURE 1

EWEB
2015 Water Master Plan

FIGURE 1. FIRST AND SECOND PRIORITY RESILIENT BACKBONE



0 3,000 6,000
Feet

Note:
Only first priority backbone facilities are shown.

LEGEND

- Water Treatment Plant
- Raw Water Intake
- Active First PriorityPump Station
- Active First Priority Reservoir
- Planned First Priority Reservoir
- Active Second Priority Pump Station
- Active Second Priority Reservoir
- First Priority Backbone Pipeline
- Future First Priority Pipeline
- Second Priority Backbone Pipeline
- Pipeline
- 800/850 Service Level
- Other Upper Service Levels
- Hydrology Feature
- EWEB Service Area

WEST YOST ASSOCIATES
Consulting Engineers

Third Priority Facilities

The third priority backbone facilities include the pump stations, reservoirs, and pipelines that connect the 800 service level to the 975 service areas, as follows: City View 975, Crest 975, Willamette 975, and Shasta 975. Systems within this group should be further prioritized based on water demand, those with larger demands would have a higher priority. Reservoir upgrades could be delayed or eliminated if pump stations were modified so they could be quickly reconfigured to run constantly if a reservoir was damaged. Potentially some of the reservoir improvements could be pushed back or eliminated if independent sections of the 975 service area were tied together.

The 2015 Master Plan Update only covers a 20 year planning period. For this reason, the Master Planning work assumes that the focus on strengthening the backbone should be focused on the first and second priority facilities since these serve the majority of customers.

Alternative Water Supply and Resiliency

The Alternative Water Supply (AWS) Willamette River Treatment Plant will become a crucial part of EWEB's capability to provide water after a catastrophic event. The new intake, transmission facilities and treatment plant will be designed to survive CSZ event and will become a critical part of the backbone system. In addition, supply disruption of the McKenzie River is not controllable by EWEB and therefore, providing an alternative supply is a crucial part of the resiliency plan. The required improvements to deliver water from the new plant to the system following an event will be covered in the third backgrounder provided by staff on May 22, 2015.

Staff is currently working towards developing this critical piece of infrastructure. Work is in progress on obtaining property for the intake and treatment plant sites and are currently working through the due diligence process. Permitting for the new intake will begin in summer 2015 to prepare to have the intake and plant constructed and operational by 2022.

Strengthening or Replacing Existing Infrastructure

EWEB has been working towards a hardened backbone system for years by upgrading or replacing critical facilities. These projects included building in some form of redundancy and/or applying current seismic codes to ensure resiliency.

Note that work to strengthen facilities for resiliency did not only include seismic upgrades. Pipelines, mechanical equipment, chemical feed facilities, electrical systems, and other ancillary items were also improved.

The work done to date has been mainly focused on the HBWFP and the Raw Water Intakes. These are first priority facilities in EWEB's Resiliency Plan. In the last eight years EWEB has invested more than $30 million on upgrades to the intake the treatment facilities which have included the following:

- 2009 HBFW Expansion
- 2010-2016 Filter Upgrades

- 2014-2016 Seismic Upgrades
- 2013-2015 Intake Upgrades
- Miscellaneous upgrades to almost all other systems and structures.

While the above previous projects are consistent with the recommendations of the ORP, going forward we will be relying on the EWEB Resiliency Plan and the resulting recommended projects included in the 2015 Master Plan Update. These recommended projects include but are not limited to:

- Replacing one raw water line from the Raw Water Intake to the HBWFP.
- Completing transmission and reservoir upgrades as defined in the Base Level Optimization work (part of the third backgrounder).
- Completing assessments on two of the four transmission pipeline river crossings.
- Completing condition assessments of the pipelines to the second priority facilities.
- Revising the Pipeline Design Standards to include restrained pipe.
- Providing redundancy between service areas and service levels.

All of these projects are focused on strengthening the first and second priority backbone facilities to prepare for a CSZ event.

Cost Implications

Previous CIP's have included placeholder funds for the resiliency effort. Although some of the recommendations described reach well past the 20 planning horizon of the Master Plan, staff does not anticipate an immediate impact to the 10-year CIP and Water Long Term Financial Plan in implementing the more immediate recommendations, at this time.

Policy Level Decisions

Moving forward there are several questions that the Board will need to answer. These include:

1) Does the EWEB Board agree with the recommended timelines for recovery as presented in the ORP (See Table 2) and should EWEB continue over the next 50 years to set our Water System up to meet these goals?

2) Is the EWEB Board comfortable with not having equal resiliency across the entire water system? Staff is requesting that the board approve the recommendations of the Master Plan, setting forth in future CIP's and budgets with strengthening the first and second priority facilities. By doing this not all customers in EWEB's service area will receive the same level of reliable service following a major disaster. The strategy will be to strengthen those facilities that provide water to the majority of customers and meet the recommendations made in the ORP for service following an earthquake.

Recommendation

None. This is an information item only. This memo is the second of four backgrounders. A final recommendation will be made in the last backgrounder.

Requested Board Action

On June 2nd 2015, EWEB staff will be asking the Board to approve the 2015 Water System Master Plan.

Approval by the Board sets forth staff to begin crafting future Capital Improvement Plans, Studies, and Programs to support the goals and recommendations of the Master Plan. Funds needed to implement the Master Plan will be conducted through Board approvals of the 10-Year CIP, Water's Long Term Financial Plan, and through annual Capital and O&M Budgets.

Staff will be available to answer questions at the June 2, 2015 Board meeting. Staff is also available throughout the month of May as these backgrounders get distributed to answer questions. If you have any questions, please call Mel Damewood at 541-685-7145 or email mel.damewood@eweb.org.

Attachment 1: EWEB Resiliency Plan

Eugene Water and Electric Board
Resiliency Plan

May 2015

Ballantyne Consulting, LLC

Eugene Water and Electric Board
Resiliency Plan

Prepared by

Ballantyne Consulting, LLC

REGISTERED PROFESSIONAL
ENGINEER
18922
OREGON
MARCH 19, 1996
DONALD BALLANTYNE
EXPIRATION DATE: 12/31/2015

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FIGURE 15. SECOND PRIORITY BACKBONE OF EWEB SYSTEM 32

1.0 INTRODUCTION

In the 1980s, scientists first recognized that the Cascadia Subduction Zone (CSZ) is an active seismic source that poses a major geological hazard in Oregon. While building codes have been updated, existing infrastructure is vulnerable to catastrophic failure in the event of a major earthquake. In April 2011, the Oregon State legislature directed the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) to lead and coordinate the preparation of an Oregon Resilience Plan (ORP) to encourage the State decision makers to be better prepared in the event of a major earthquake. OSSPAC completed "*The Oregon Resilience Plan, Reducing Risk and Improving Recovery for the Next Cascadia Earthquake and Tsunami*" (ORP) in February 2013, with recommendations currently being considered for adoption by the State legislature.

EWEB provides drinking water to an existing population of 183,000 in the City of Eugene and the unincorporated areas of Lane County in the Santa Clara and River Road region. Since drinking water supply and fire suppression are classified as critical services in the ORP, maintaining and restoring service as quickly as possible after a major event is critical. The scope of the EWEB Resiliency Plan is primarily designed to advance the recommendations of the ORP but also includes other possible hazards including landslides and wildfires.

The premise of this resiliency plan is the importance of EWEB quickly re-establishing water service after a catastrophic event. Guidance for the plan is primarily based on the recommendations of the ORP.

The initial section of this report identifies the hazards that could affect EWEB infrastructure and provides a probability of occurrence. Because the critical hazard is a major earthquake, the specific recommendations of the ORP are presented in the subsequent section which also includes specific targets for restoration of critical facilities. Critical water utility facilities that ultimately need to be hardened to withstand a major earthquake are identified as the backbone of the EWEB system. Finally, recommendations for the follow-up studies are included which will identify capital improvements necessary for strengthening the backbone of the EWEB system.

2.0 HAZARDS

The following section quantifies the probability (in terms of recurrence interval) of selected natural disaster related hazards that would be expected to have a significant long-term impact on the EWEB water system. The selected list of hazards with a description of each and their consequences are shown below:

I. Earthquake
   a. Shaking – damage to facilities and pipelines
   b. Liquefaction and permanent ground deformation (PGD) – damage to pipelines and facilities

II. Volcano
   a. Lahar, lava and debris flow – degrade water quality and damming of the McKenzie River.

b. Debris flow from a moraine lake – degrade water quality
c. Ash fall – degrade water quality

III. Flood/Intense Storm

a. Inundation – submerge facilities, damages electrical equipment
b. Erosion – loss of foundation (facilities) and/or cover (pipelines) resulting in failure
c. Dam failure – inundation of facilities downstream

IV. Loss of Power

a. Grid disruption – loss of treatment, pump, and control capability
b. Earthquake –damage to substations resulting in loss of power
c. Wind – power line damage – disruption of power to facilities
d. Snow/Ice – power line damage - disruption of power to facilities

V. Landslide

a. In service area – damage to buried pipe and facilities
b. In watershed – degrade water quality

VI. Wildfire in watershed – degrade water quality during rainfall

VII. Accidental spill – degrade water quality

In the text following, each hazard is described, and an estimated recurrence interval provided. The hazards and their estimated recurrence are then summarized.

2.1 Earthquake

The Cascadia Subduction Zone (CSZ) is the most significant source zone that can potentially impact EWEB facilities. The CSZ has traditionally been considered to have a 500-year recurrence interval with an event breaking its entire length, from Mid-Vancouver Island to Eureka California, with a magnitude on the order of 9.0 (M9.0) (see Figure 1). The last event occurred in 1,700 AD. Multiple smaller events would also be possible breaking adjacent segments of the fault.

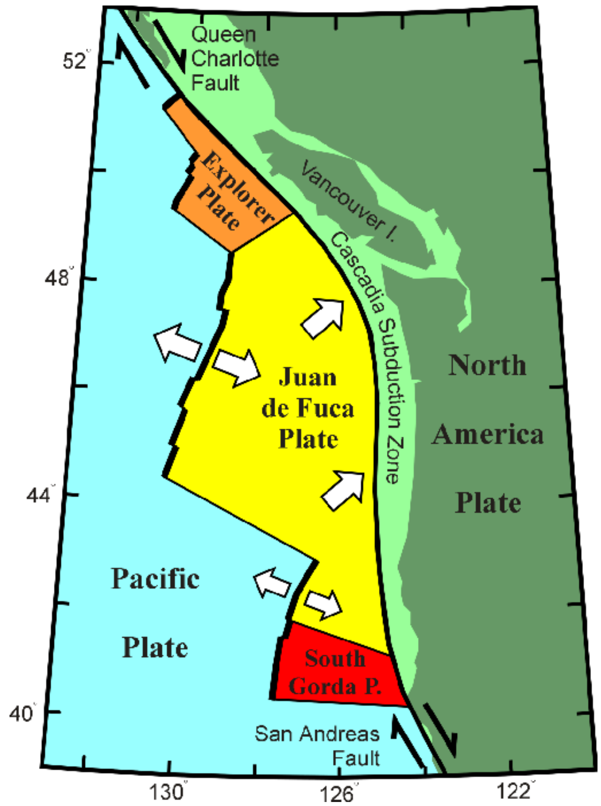

Figure 1. Map of the Cascadia Subduction Zone (Source USGS)

In recent years, Dr. Chris Goldfinger at Oregon State University has studied turbidites, geological deposits formed by turbidity currents induced by slope failures, along the CSZ and concluded that there is a shorter recurrence interval in southern segments of the CSZ. In the segment from approximately Yaquina Bay south to Coos Bay (i.e. due west from Eugene), he proposes a recurrence interval of 300 to 380 years. One would expect some of these events to be smaller than a M9.0 expected on the average of every 500 years.

For the CSZ M9.0 event, the Eugene area would expect peak ground acceleration (PGA) on the order of 15 to 20 percent times gravity. By comparison, events such as the 1994 Northridge, California Earthquake and the 1995 Kobe, Japan Earthquake produced PGAs on the order of 60 to 80 percent times gravity. The 2014 South Napa, California Earthquake produced a PGA on the order of 50 percent times gravity.

Earthquakes cause shaking that can result in structural damage to facilities and buried piping. They can also cause liquefaction and associated lateral spreading, and landslides, both of which are forms of PGD. PGD is particularly damaging to buried piping. In the 1995 Kobe Earthquake, wide-spread liquefaction was the primary cause of over 1,200 pipeline failures. However, for the 1994 Northridge Earthquake, liquefaction was limited because of the types of soils.

The CSZ information included on the DOGAMI Open File Report 13-06 (O-13-06) was used to develop the Oregon Resilience Plan for a magnitude 9.0 earthquake. Hazard mapping from

O-13-06 is shown for the EWEB service area in the figures that are included at the end of the report. The content of each figure is described in the following paragraphs.

Figure 2. Peak Ground Acceleration (PGA) vs. Large Diameter Pipelines - shows low to moderate ground motions (0.15 to 0.25 PGA) throughout the service area. With these ground motions, modern engineered structures should perform well.

Figure 3. Peak Ground Velocity (PGV) vs. Large Diameter Pipelines - uses another parameter for shaking intensity (PGV) used for assessing pipe performance. Steel and gasketed pipes should perform well at these PGV intensities. Some leaks are expected to develop in cast iron pipe with leaded joints.

Figure 4. Liquefaction Probability vs. Large Diameter Pipelines and **Figure 5.** Permanent Ground Deformation Due to Liquefaction vs. Large Diameter Pipelines – show that there is only a low probability of liquefaction actually occurring (5 percent of the area) in the valley where large diameter pipelines are located. Should liquefaction actually occur, PGDs could range from 0 to 4 inches. Steel pipe should have a limited vulnerability to those levels of PGD.

Figure 6. Earthquake Induced Landslide Probability vs. Large Diameter Pipelines and **Figure 7.** Permanent Ground Deformation Due to Landslides vs. Large Diameter Pipelines – show that landslides and associated PGD is limited to the hills to the south. No large diameter pipelines are in landslide areas.

Figure 8. Liquefaction Probability vs. Cast Iron Pipelines and **Figure 9.** Permanent Ground Deformation Due to Liquefaction vs. Cast Iron Pipelines - show that there is only a low probability of liquefaction actually occurring (5 percent of the area) in the valley, and medium probability in the hills to the south (5-15 percent of the area). Only small amounts of cast iron pipe are in these medium probability liquefaction areas. If liquefaction occurs, the expected PGDs would range from 0 to 4 inches in the valley to as high as 39 inches (approximately 1 meter) in the hills to the south. Cast iron pipe is vulnerable to even small magnitudes of PGD.

Figure 10. Earthquake Induced Landslide Probability vs Cast Iron Pipelines and **Figure 11.** Permanent Ground Deformation Due to Landslides vs. Cast Iron Pipelines – show that landslides and associated PGD is limited to the hills to the south. Cast iron pipe is vulnerable to even small magnitudes of PGD.

Figure 12. Liquefaction Probability vs Asbestos Cement Pipelines – shows some asbestos cement pipe in areas with a low liquefaction probability. Asbestos cement pipe is vulnerable to PGD.

Figure 13. 100-year Flood Plain vs. Large Diameter Pipelines – shows large diameter pipe in the flood plain. While the pipe should not be directly vulnerable to inundation, it could be vulnerable to erosion caused by flooding.

2.2 Volcano

The McKenzie River and its tributaries drain the west slopes of the Three Sisters Volcanos. The Three Sisters Volcanos have four potential threats. The two composite volcanos, Middle and South Sister, could erupt, potentially resulting in lahar flows, lava flows, and explosive expulsion of tephra. Lahar flows are mud or debris flows composed of a slurry of pyroclastic material, rocky debris, and water. Tephra is fragmental (broken up) material produced by a volcanic eruption. The last event was approximately 2,000 years ago, but it appears that, based on limited geologic information, such events only occur once every 10,000 years. The most recent composite volcano activity has been on the southeastern slopes of the Middle and South Sisters. Because of the location of such events relative to the McKenzie River and the City of Eugene, severe damage to the water supply is unlikely. However, if such an event resulted in lahar flows on the west side, it could impact the water quality in the McKenzie River for many years.

North Sister, and many additional cinder cones and vents in the region are mafic volcanos. Mafic volcanos have magma that contains lower amounts of silica and is generally less viscous and less gas-rich than silicic magma. It tends to erupt effusively, as lava flows. A mafic volcanic eruption resulting in tephra and lava is expected about once every 1,500 years. The upper McKenzie River has been dammed by lava flow from such an event (e.g. Clear Lake) in the past. A recurrence could disrupt flow in the McKenzie River for a period of time. There is some potential for water quality impacts of the McKenzie River due to lahar flow and ash fall. However, in the past, the prevailing wind has taken most of the ash fall easterly. Debris/lahar flow had drastic impacts on the Toutle River following the Mt. St Helens eruption, plugging the intake of the Longview Washington Water Treatment Plant. However, the McKenzie River watershed is outside the impact area of the most severe debris/lahar flows from a Three Sisters event.

In any case, seismic monitoring would likely identify the potential for such volcanic events well before they occurred. While this would allow time for evacuation, there is potential that the McKenzie River supply could be disrupted.

The most likely type of event related to the Three Sisters is a debris flow due to failure of high altitude moraine dams, resulting in outflow of water and debris on the upper reaches of the volcanos (e.g., White Branch from the Collard Glacier 1970's). Historically, these debris flows have reached the McKenzie River causing impacts in water quality. Recurrence of this type of an event could be on the order of decades. There would likely be no warning if a moraine dam would fail.

2.3 Flood and Intense Storms

Flood and intense storms could result in inundation, erosion due to swift currents, landslides and associated water quality impacts. Flooding along the Willamette River and its tributaries has largely been controlled by a series of flood control dams built and operated by the U.S. Army Corp of Engineers (COE). There are two of these COE dams on the McKenzie River. Refer to Figure 13 for the 100-year flood plain map.

The flows associated with intense regional storms would normally be controlled by the flood control dams. Flows generated by localized intense storms may generate high flows that result in erosion and undercutting of embankments and structures (buried pipeline river crossings). It's difficult to develop an estimate on the return period of a damaging storm; its destructiveness is going to be dependent on the design of structures in the floodway.

Landslides both small and large can be caused from extended periods of rainfall that saturate slopes, making them unstable. Landslides in the upper McKenzie River could result in raw water turbidity events. Turbidity spikes are expected multiple times on an annual basis. At some point, extreme turbidities may require shutting down raw water suction facilities.

The nine largest dams in Lane County are flood control dams owned and operated by the COE. The COE is responsible for designing, operating and maintaining these structures (dams and particularly spillways) to remain operable during a probable maximum flood (PMF) in conjunction with a maximum credible earthquake (MCE). The probability of having a PMF is near zero (but not zero). The return period is generally taken to be in the range of 10,000 to 10,000,000 years depending on the consequence of failure associated with the dam.

2.4 Loss of Power

Wide spread loss of power can be caused by a variety of mechanisms, such as power transmission grid failure, earthquake, wind, and ice storms. The transmission grid can be brought down by failure of key components and/or operator error. Cascading failures have brought down areas that cross multiple states. Complete loss of the regional grid might be expected to recur on the order of decades or longer but with relatively short restart times of a few days.

High voltage substations, particularly those with voltages of 230kv and above, are highly vulnerable to earthquake shaking. These substations, unless they have been upgraded to modern designs, are even vulnerable the levels of shaking expected in the CSZ. In the case of a CSZ event, substations could fail hundreds of miles distant from EWEB and still have a local impact on the power supply. Transformer insulators and bushings are particularly vulnerable. Restoration is highly dependent on the extent of damage. Power transmission systems are quite redundant except during peak demand periods, so failure of a single circuit of even a complete substation could potentially be bypassed. However, failure of multiple substations could result in outage times of weeks or months as replacement of high voltage transformers is very time consuming. Depending on the system, some capacity may be restored using lower voltage transmission capability.

Wind and ice storms can cause transmission towers to fail in extreme conditions. The Bonneville Power Administration has had failure of older transmission towers when subjected to 100 miles per hour (mph) winds near the coast in Washington. In eastern Canada, miles of a high voltage transmission towers failed due to buildup of ice. These failures could occur remotely from the City of Eugene. Wind and ice storms could cause failures of transmission towers in the western US with a recurrence interval on the order of 10 years. It is highly unlikely that failure of a single high voltage transmission line would result in loss of power to EWEB due to system redundancy. On a local level, power distribution lines are also vulnerable to wind and ice storms, particularly due to trees falling on wires. These types of outages typically occur on a yearly basis with some outages. In some areas of the Pacific Northwest, outages have lasted for over a week in remote areas.

2.5 Landslide

Landslide areas are mapped in the southern parts of the EWEB service area. These areas may be vulnerable not only to earthquake shaking, but also to rainfall induced slides that could impact EWEB facilities and pipelines (see Figure 6).

Landslides in the McKenzie River and its tributaries impact water quality. Landslides can be initiated by significant rainfall saturating soils and river undercutting the toes of slopes, and earthquakes. The recent Oso landslide in northwest Washington was influenced by a period of high rainfalls and undercutting the toe of the slope. Water quality impacts from rain induced landslides would be expected annually to some degree, but with significant impacts recurring on the order of tens of years.

Landslide materials such as those found in the hills in the southern part of the EWEB service area can have variable properties. DOGAMI flagged them as being susceptible to both liquefaction and landslide. Site-specific investigations are required in these areas to determine their liquefaction and landslide susceptibility.

The 1994 Northridge Earthquake caused widespread landslides in the mountains north of Los Angeles, but did not affect any surface water supplies. In the 1991 Limon Costa Rica Earthquake, landslides resulted in severe water quality impacts increasing the raw water solids content to several percent.

2.6 Wildfires

Water quality in the McKenzie River can be severely impacted by wildfires. Wildfires in the watershed of the McKenzie River and its tributaries would make the ground more susceptible to erosion and landslides. In the Portland Bull Run watershed, naturally occurring wild fires that were large enough to cover the entire watershed were estimated to have a recurrence of 500 years. A similar recurrence in the McKenzie watershed seems reasonable. Smaller wildfires would be expected to be more common but have a lesser impact on water quality.

2.7 Accidental Spills

An accidental spill of a contaminant into the McKenzie River could be catastrophic, making the source unusable for a short to medium duration, and possibly long duration depending on the contaminant. Highway 126 follows the McKenzie River easterly up the western slope of the Cascades. A tank truck carrying fuel, pesticides, or other potential contaminants could overturn and spill its contents into the River. Tanks storing contaminants ruptured along the Monongahela River in West Virginia in the spring of 2014. EWEB should investigate whether any such tanks are located along the McKenzie River and evaluate their risk. In another event in 1991, a tank car derailed spilling a toxic chemical into Shasta River in Northern California. In consideration of a future Willamette River supply, Highway 58 and a rail line follow the River going southeast from Eugene. However, the two supplies will provide a backup supply if either is contaminated.

2.8 Recurrence of Hazards

The hazard events and their estimated recurrence are shown in Table 1.

Table 1. Hazards and their Estimated Recurrence

Hazard	Impact	Recurrence, years
Earthquake - CSZ		
15%-20% g	Old structures, CIP with leaded joints	300 - 380
PGD - inches	Unrestrained joint pipe	300 - 380
Volcano		
Composite eruption	McKenzie River heavily impacted	10,000
Debris flow-moraine Lake	Water quality	10's
Mafic ash fall (wide spread)	Water quality	1,500
Mafic lava flow (McKenzie)	Interruption in flow	5,000
Flood/Intense Storm/Dam Failure		
Inundation	Pump stations	100, 500
Erosion	River crossings	100's
Landslide	Pipelines (south EWEB), water quality	10's
Dam failure	Flooding, erosion,	10,000
Loss of Power		
Grid failure	Wide-spread outage - several days	10's
Earthquake	Widespread outage - days to months	300 - 380
Wind Storm (local)	Localized outage - days	10's
Ice Storm (local)	Localized outage - days	10's
Landslides		
SW, S, and SE parts of EWEB service area	Impact on pipelines, pump stations and reservoirs- days to months	10's
Water Quality		
Mafic volcanic activity	Water quality - ash, debris flow	1,500
Debris flow - moraine lake	Turbidity	10's
Wildfire	Turbidity during winter rain	100's
Landslide	Turbidity	10's
Earthquake	Landslide-turbidity	300 - 380
Accidental spill	Contaminate McKenzie River	100's

3.0 OREGON RESILIENCE PLAN DIRECTION

This sections reviews supply, transmission, distribution and storage system facilities, and ranks the criticality of key assets. The ranking is based on the asset's need to meet the level of service (LOS) goals identified in the ORP following a Cascadia Subduction Zone earthquake and other natural hazard events.

The ORP recommended approach is reproduced below:

> *To provide water to critical areas and establish wastewater service to protect public health and safety as soon as possible following the seismic event, a phased approach to system recovery was developed. The phased approach is built upon having hardened backbone elements of the water and wastewater systems. The backbone system would consist of key supply, treatment, transmission, distribution, and collection elements that, over the 50-year timeframe, have been upgraded, retrofitted, or rebuilt to withstand a Cascadia subduction zone earthquake.*
>
> *The backbone water system would be capable of supplying key community needs, including fire suppression, health and emergency response, and community drinking water distribution points, while damage to the larger (non-backbone) system is being addressed. The backbone wastewater system would protect the community from health hazards and minimize environmental impacts associated with raw sewage as larger repair and response efforts are underway. Identification of a community's backbone water and wastewater systems would become essential to maximizing the effectiveness of investments in resilience and ultimately to expediting recovery efforts following a Cascadia subduction zone earthquake.*
>
> *The proposed approach—each community establishes a backbone water system—does not alleviate critical water and wastewater concerns following a Cascadia subduction zone earthquake. Large portions of the water distribution system will remain vulnerable and presumably inoperable. In addition, vulnerabilities of the wastewater collection and treatment system will likely result in raw sewage discharges to receiving waters and public health risks in affected communities.*

The recommended performance goals are summarized in Table 2.

Table 2. Target States of Recovery, Water Sector for the Willamette Valley (from the ORP)

	Event occurs	0–24 hours	1–3 days	3–7 days	1–2 weeks	2 weeks–1 month	1–3 months	3–6 months	6 months-year
Domestic water supply									
Potable water available at supply source. (WTP, wells, impoundment)		R	Y		G			X	
Main transmission facilities, pipes, pump stations, and reservoirs ("backbone") operational		G					X		
Water supply to critical facilities available.		Y	G				X		
Water for fire suppression - at key supply points.		G		X					
Water for fire suppression - at fire hydrants.				R	Y	G			X
Water available at community distribution centers/points			Y	G	X				
Distribution system operational			R	Y	G				X

Target Timeframe for Recovery:

- G Desired time to restore component to 80-90% operational
- Y Desired time to restore component to 50-60% operational
- R Desired time to restore component to 20-30% operational
- X Current state (90% operational)

The ORP provides the following descriptions of each of the domestic water supply categories:

- *Potable water available at supply source (water treatment plants, wells, impoundments). This category represents the initial point of the finished water supply system. Given the age, geotechnical vulnerability, and complexity of many treatment plants, a phased recovery was assumed and would be dedicated to seismically hardening the treatment processes. Communities with more resilient storage may consider longer recovery timeframes for the supply source, as they could rely on stored water in lieu of producing more treated water.*
- *Main transmission facilities, pipes, pump stations and reservoirs operational. This category refers to the backbone system discussed above. The intent is to be able to convey water from resilient storage and treatment plants to key distribution points as soon as possible following the event. Manual operation of valves—to isolate the backbone system from damaged areas of the system and minimize water loss—accounts for some of the delay in implementation.*
- *Water supply to critical facilities available. This category assumes critical facilities will be nearly fully operational due to on-site water storage or the capacity of the local supply. Critical facilities, such as hospitals and first-aid facilities, command and control centers, and industries essential to recovery and restoration efforts, should be identified for individual communities.*

- *Water for fire suppression at key supply points. Thorough planning efforts, involving fire officials and emergency responders, should identify key supply points for reliable access to water for fire suppression. These areas should be included in the backbone system.*
- *Water for fire suppression at fire hydrants. Water will be available at fire hydrants when leaks and breaks in the distribution system have been repaired. Communities in heavily damaged areas will likely not be able to rely on fire hydrants until the majority of the distribution system is operational. Until that benchmark can be reached, communities would have to rely on the key fire-suppression supply points and fire-suppression strategies described above.*
- *Water available at community distribution centers/points. As in the case of fire hydrants, the distribution of water to individual homes and neighborhoods may not be possible given damage to the distribution system. If community distribution centers/points are provided at strategic locations along the hardened backbone, people can have access to potable water soon after the event. Such issues as the logistics of staffing and setting up a distribution center and of identifying containers were also considered during the development of the target recovery timeframes for this category.*
- *Distribution system operational. In order to provide water throughout the community (including fire hydrants), the distribution system would need to be operational. Through vulnerability assessment, material stockpiles, supply identification, and workforce planning, communities would be able to target anticipated repairs as part of their comprehensive response and recovery efforts.*

To meet these recommendations, the following approach is suggested.

3.1 Repair Assumptions

In the hours and days immediately following the earthquake, response capability will be impaired by damaged transportation systems and inability of staff to respond. As a result, the following assumptions are made:

- Within the first 24 hours, valves can be operated, but no pipeline repairs will be made. Therefore, anything that must be operable within the first 24 hours must not be damaged in the earthquake.
- In the 1 to 3 day time frame; only minor repairs will be made. One transmission pipeline could be repaired if it is in an accessible location and repair materials are available. Several distribution mains to key facilities could be repaired if repair materials were available. Temporary distribution facilities could be set up to draw water taking water from the backbone system or storage tanks.
- From 3 days to one month, distribution piping would continue to be repaired.

3.2 Policy Decision

The ORP recommends that each community identify the backbone segments of their system. Backbone segments are recommended below in three priority levels designated as priority 1, 2, or 3. EWEB should decide to adopt priority 1, 1 and 2, or all of the priority levels to be in the backbone system and design the system accordingly to provide continued service following the CSZ earthquake. Priority 1 includes the supply and key assets required to operate the 607 Base Level service area, Priority 2 the 800 and 850 service areas and Priority 3 the 975 and higher service areas.

3.3 Prioritized Facilities

With the targeted recovery goals, facility and pipeline priorities are identified below:

3.3.1 Priority 1

Water supply, treatment and delivery into the City of Eugene are the highest priority and include the following facilities

- Potable water available at supply source – The first priority includes one of the two intakes including its associated raw water pumps and transmission main, half of the Hayden Bride WTP capacity, the Hayden Bridge reservoir and half of the finished water pump station to be available immediately following the earthquake. The remaining half of the intake, raw water pump station and transmission main, WTP and the finished water pump station would be required within 1 to 2 weeks which would only allow for limited repairs.
- Main transmission facilities, pipes, pump stations and reservoirs operational – The ORP leaves definition of the backbone system up to each community. The first priority backbone facilities would be the backbone pipelines connecting the WTP to the Base Level reservoirs including the Hawkins Hill Reservoir and the reservoir at the planned Elliott Site Reservoir. The existing College Hill 607 Reservoir and the Santa Clara Reservoir would be replaced by new, smaller reservoirs which will be part of the backbone. The first priority backbone system is shown in Figure 14.
- Alternative Water Supply (AWS) – AWS is a crucial part of EWEB's capability to provide water after a catastrophic event. New construction will be designed to survive a CSZ M9.0 event which will be part of the backbone system. In addition, supply disruption of the McKenzie River are not controllable by EWEB and therefore, providing an alternative supply is a crucial part of the resiliency plan. AWS will be designed to supply water to the entire EWEB service area in the event that the Hayden Bridge WTP is not available.

3.3.2 Priority 2

The second priority backbone facilities would be major pump stations, reservoirs and pipelines that connect the Base Level service area to the 800 and 850 service areas which includes the following systems:

- City View 800
- Crest 800
- Willamette 800
- Dillard 800
- Shasta 800
- Fairmont 850
- Laurel Hill 850

Both to provide efficient operation and to improve resiliency of the Upper Level service areas, consolidation of the 800 and 850 service areas is included as part of the recommended improvements. In the first phase of this consolidation, City View, Crest, Willamette and Dillard service areas will be consolidated. With this consolidation, any one of the reservoirs in these service areas could provide emergency water supply in the 800 service area. City View 800 West Reservoir has been upgraded and the Willamette 800 Reservoir will be upgraded this year.

In the 850 service area, the Laurel Hill and Fairmont service areas will be consolidated. The Laurel Hill Reservoir is relatively new construction and the Fairmont 850 BPS will be abandoned.

Figure 15 shows the second priority backbone system. This system is essential for service of the higher elevation service areas which are part of subsequent priorities.

3.3.3 Priority 3

Backbone facilities including major pump stations/reservoir systems and pipelines connecting the 800 service area to the 975 service areas, as follows: City View 975, Crest 975, Willamette 975, and Shasta 975. Systems within this group should be further prioritized based on their demand, those with larger demands having a higher priority. Reservoir upgrades could be delayed or eliminated if pump stations were modified so they could be quickly reconfigured to run constantly if a reservoir was damaged. Potentially some of the reservoir improvements could be pushed back or eliminated if independent sections of the 975 service area were tied together.

3.4 Planning

Resiliency planning should also address the following factors as the resiliency plan is refined:

- Water supply to critical facilities – Two of the major Critical care facilities (Hospitals) in the region are in Springfield. However, EWEB does serve the Sacred Heart General Hospital at E. 11th Avenue and Hilyard Street and may want to identify other critical facilities which should have a reliable pipeline connecting each of them to the transmission system. Similarly, EWEB may want to identify key industries or institutions on which Eugene is dependent for recovery, and provide a reliable connection to the transmission system.

- Water for fire suppression at key supply points – The first, second, and third priority components of the backbone system are identified above. Water for fire suppression can be delivered from any location along these backbone facilities. Hydrant locations should be reviewed accordingly to enhance coverage.
- Water for fire suppression at fire hydrants – Water at fire hydrants not connected to the designated backbone system will lag one time segment (as shown in Table 1) behind restoration of the distribution system piping.
- Water available at community distribution centers/points – Water distribution centers can be located throughout the service area associated with selected locations along the designated backbone system.
- Distribution system operational – The EWEB distribution system is primarily cast iron and ductile iron. It is expected that many of the areas with ductile iron will be undamaged and will remain in service. Most of the damage will be to cast iron pipe most of which is in the 607 Base Level service area.

It is recommended that system assessment and improvements to enhance the capability of the first and second priority backbone system be addressed in the initial resiliency plan for the water distribution system. Third priority backbone needs should be addressed whenever an improvement is made for other reasons and once the first and second priority improvements have been implemented.

4.0 RECOMMENDATIONS

This section provides direction to EWEB on steps that need to be taken to meet the recommendations of the ORP. The ORP established requirements as shown in Table 2 and a summary of actions to meet the ORP recommendations over a 50-year time horizon are discussed below. Both supply and treatment system improvements and distribution and storage facilities are addressed.

4.1 Supply and Treatment

Supply system components required to be operable within 24 hours following the earthquake include the following:

- One raw water intakes, raw water pump station and raw water supply pipeline at both the HBWTP and AWS
- Half of the HBWTP capacity and the AWS WTP
- The Hayden Bridge and the planned AWS reservoir
- Finished water pump station capacity at HBWTP and AWS
- One of the pipelines from the Hayden Bridge finished water pump station to the Intertie just east of I-105

In 24 hours there is only enough time to operate valves and to make superficial repairs so there can be no significant damage to these facilities. Also, backup power would be essential.

The remaining half of the WTP finished water pump station capacity and the second pipeline from the finished water pump station to the split would be required within 1 to 2 weeks which would only allow for limited repairs. A summary of the recommended first priority assessments are shown in Table 3.

Table 3. Recommended First Priority Seismic Assessments for Water Supply and Treatment

Facility	Seismic Assessment	Upgrade/ Replace	Priority
Raw Water Intake 1		Completed	
Raw Water Intake 2		Completed	
Raw Water Pipeline to HBWTP	Required	As Required	1
Raw Water Pump Station		Completed	
Water Treatment Plant	Required	Partially Completed	1
Reservoir	Required	As Required	1
Finished Water Pump Station	Required	As Required	1

While the AWS is required for overall system reliability, it will not have the capacity to meet ADD. The ORP does not address water demand. EWEB may decide to develop a Level of Service policy where post-earthquake demand goals are something less than peak hourly demand. If EWEB were to set a policy that ADD will be provided, the “required” capacity of the supply would only have to meet the ADD. Potentially, that could be achieved with the facilities described in the first paragraph in this section. The second set of facilities should be operational within a reasonable time frame.

To determine whether these facilities will be functional following the event, EWEB will need to conduct a seismic vulnerability assessment of each component including all potential failure modes such as geotechnical, structural, hydraulic, power availability and treatment chemical availability. If it is determined that any of the elements of the supply system will not remain functional, they will have to be upgraded accordingly.

4.2 Transmission and Storage

First priority facilities required to be operational within 24 hours following an event are shown in Figure 14 and generally include the backbone pipelines connecting the WTP and the Hawkins Hill Reservoir, the proposed future reservoirs and backbone pipelines serving the 607 service area and the AWS facilities. Two of the four Willamette River crossings are required to meet ADD to move water from the Hayden Bridge WTP into the system south of the river.

In 24 hours, there is only enough time to operate valves and not to repair pipelines so there can be no pipeline breaks that would cause loss of hydraulic continuity. Small leaks that do not impact overall system operation would be acceptable.

Some of the backbone pipelines are steel with welded joints which are resistant to failure caused by modest ground deformation. Significant quantities of this pipe are in areas subject to liquefaction as shown in Figure 4 but with only a five percent probability of liquefying as shown in Figure 5. If ground liquefaction did occur, most of the pipe is in areas which are expected to undergo permanent ground deformation of four inches or less. The Willamette River Crossings have the highest risk due to the vulnerability related to PGD associated with the river bank topography. The consequence of failure would be the most severe. One of the key drivers for PGD is proximity to a river bank. Therefore, to have assurance that the Priority 1 backbone system will remain intact, it is recommended that a geotechnical assessment be conducted for the underground Willamette River crossing to determine the soil's liquefaction susceptibility and other potential hazards. The expected PGD in a CSZ earthquake will need to be identified and a structural analysis on the pipelines will need to be performed.

The Hawkins Hill Reservoir has been assessed for seismic vulnerability and should be upgraded accordingly. New reservoirs will be built according to current seismic standards. Table 4 summarizes the recommended assessments for the first priority systems.

Table 4. Recommended Seismic Assessments for First Priority Transmission and Storage

Facility	Seismic Assessment	Upgrade/ Replace	Priority
River Crossings	Required	Upgrade 2 of 4	1
Hawkins Hill Reservoir	Completed	Upgrade	1
New Reservoirs	Included in Design	New	1
Transmission Pipelines	Required	As Required	1

4.3 Distribution

The Second and Third Priority recommendations are "backbone" facilities but may be considered part of the distribution system.

Second priority facilities required to meet current seismic standards are shown in Figure 15. These consist of Upper Level booster pump stations, pipelines and reservoirs that move and provide water from the Base Level 607 service area to the 800 or 850 service areas. Pumps stations and reservoirs should be evaluated for performance in a CSZ earthquake and upgraded accordingly. The connecting piping, starting at the Base Level 607 service area transmission pipelines, connections to the pump stations and the supply pipelines to the reservoirs should also be evaluated.

With the consolidation of the of the 800 and 850 service areas, these service areas already have some resiliency from upgrades competed to date. The following facilities are new, have been upgraded or are in the process of being replaced:

- City View 800 West Reservoir
- Willamette 800 BPS
- Willamette 800 Reservoir (Being replaced)
- Laurel Hill 850 Reservoir
- Shasta 800 BPS

Both the 800 and 850 service area have resilient storage. The remaining priority will be to complete seismic assessments for the supply pump stations, connection supply pipelines and reservoirs including the facilities shown in Table 5.

Table 5. Recommended Seismic Assessments for Second Priority Distribution and Storage

Facility	Seismic Assessment	Upgrade/ Replace	Priority
City View 800 BPS and Pipeline	Required	As Required	2
Crest 800 BPS, Reservoir and Pipeline	Required	As Required	2
Willamette 800 Pipeline	Required	As Required	2
Laurel Hill 850 BPS and Pipeline	Required	As Required	2
Dillard 800 Reservoir and Pipeline	Required	As Required	2
Shasta 800 Reservoir and Pipeline	Required	As Required	2

The Willamette 800 reservoir is scheduled to be replaced with a new reservoir this year. The connecting pipeline between Willamette 800 service area and the Dillard 800 service area needs to be given a high priority. With this pipeline in service, the Dillard 800 BPS can be decommissioned and the Dillard service area will be backed up by the Willamette service area.

Third priority improvements include the facilities that supply and store water for the service areas at elevation 975 and higher. In these service areas, EWEB has new facilities or already upgraded the following:

- City View 975 BPS and Reservoir
- Willamette 975 Reservoir (To be replaced in 2016)
- Shasta 975 BPS
- City View 1150 Reservoir (Confirm)
- Willamette 1325 Reservoir

Since there are connecting valves between both City View 975 and Crest 975 service area and the Willamette 975 and Crest 975 service area, these service areas have significant amount of resiliency. On the east side, the Shasta 975 BPS is new and could provide service if the Shasta 975 reservoir were damaged.

Future improvements in the 3rd Priority areas should be planned after the Priority 1 and 2 improvements have been implemented.

4.4 Standards

In addition to the supply pipelines, pump stations and reservoirs, distribution piping will eventually need to be replaced. Both from a condition perspective and to improve fire flows, small diameter piping will need to be replaced. Replacement priorities should also include the resiliency perspective.

Pipelines in liquefiable and/or landslide zones are all subject to PGD. In these areas with low PGD of 4 inches or less, existing pipe should be replaced with ductile iron with restrained joints. In areas with an expected PGD is greater than 4 inches, pipe should be replaced with seismic resistant pipe that can accommodate a strain of plus or minus 1 percent. This can be accomplished through use of a special restrained pipe joint relying on joint slippage, or the pipe barrel strain relying on the strain in the pipe material. Special restrained joint pipe is available from at least three ductile iron pipe manufacturers.

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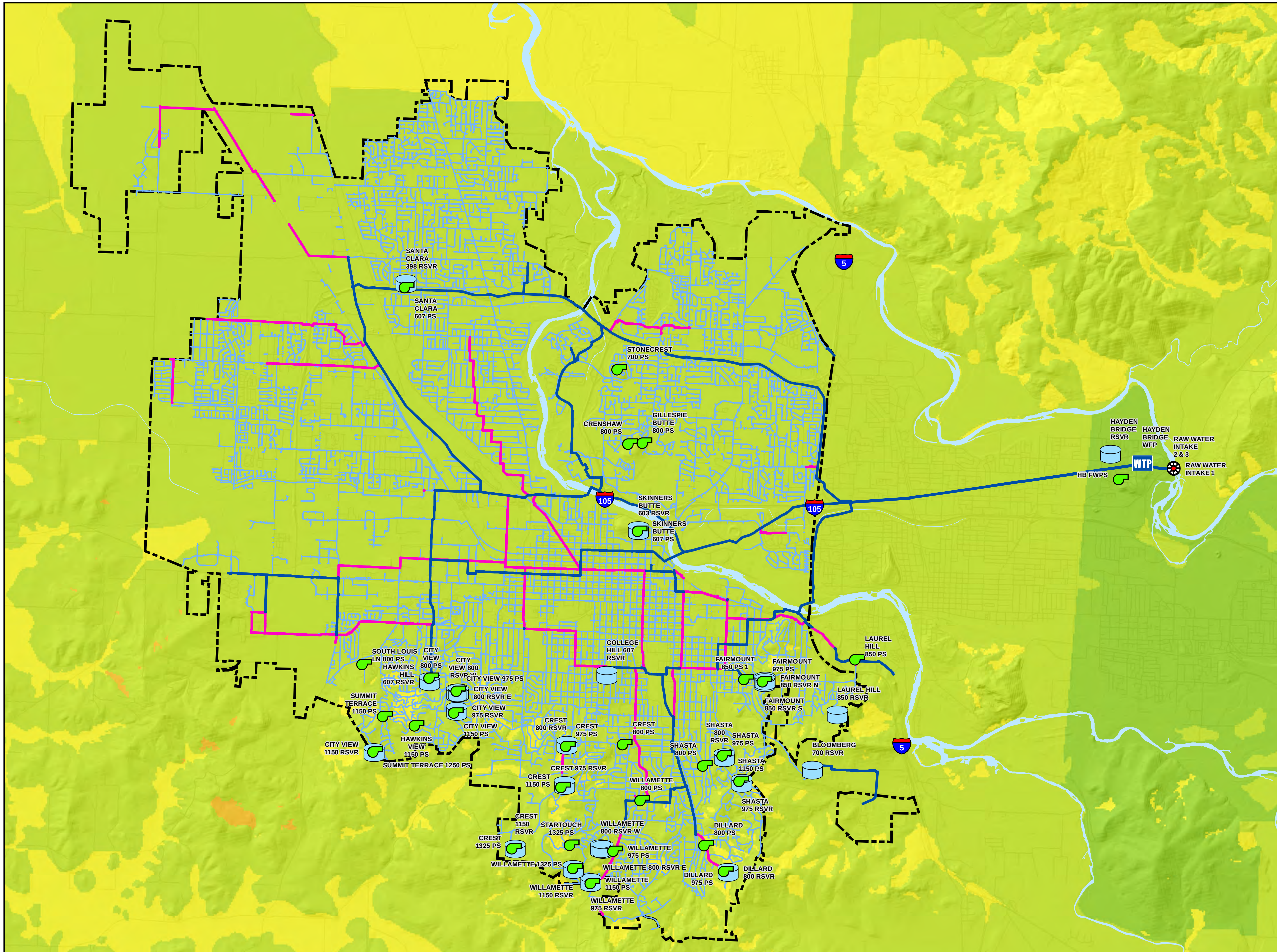
FIGURE 2

EWEB
2015 Water Master Plan

RESILIENCY PLANNING - PEAK GROUND ACCELERATION (PGA) VS. LARGE DIAMETER PIPELINES



Notes
1. Source: Oregon_Resilience_Plan_Ground_Motion_and_Ground_Failure_Maps.gdb.

LEGEND

- Water Treatment Plant
- Raw Water Intake
- Active Pump Station
- Existing Reservoir

Pipe Diameter

- Distribution Main (<16")
- Major Distribution Main (16"-18")
- Transmission Main (<18")
- Hydrology Feature
- EWEB Service Area

Peak Ground Acceleration (PGA)

- 0 - 0.05g
- 0.05 - 0.10 g
- 0.10 - 0.15 g
- 0.15 - 0.20 g
- 0.20 - 0.25 g
- 0.25 - 0.30 g
- 0.30 - 0.35 g
- 0.35 - 0.40 g
- 0.40 - 0.45g

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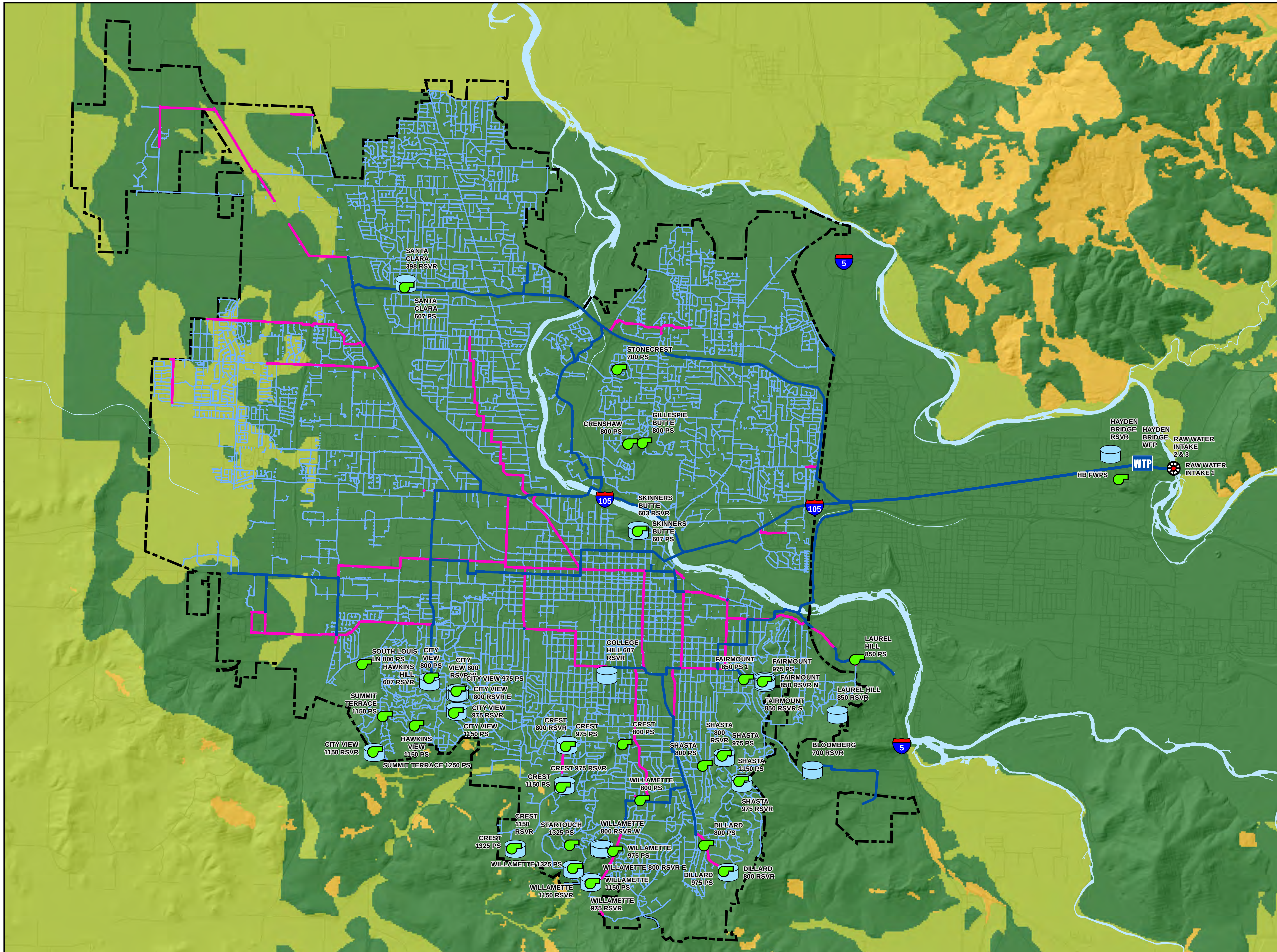

FIGURE 3

EWEB
2015 Water Master Plan

RESILIENCY PLANNING - PEAK GROUND VELOCITY (PGV) VS. LARGE DIAMETER PIPELINES

N

0 3,000 6,000
Feet

Notes
1. Source: Oregon_Resilience_Plan_Ground_Motion_and_Ground_Failure_Maps.gdb.

LEGEND

- Water Treatment Plant
- Raw Water Intake
- Active Pump Station
- Existing Reservoir

Pipe Diameter

- Distribution Main (<16")
- Major Distribution Main (16"-18")
- Transmission Main (<18")
- Hydrology Feature
- EWEB Service Area

Peak Ground Velocity (PGV)

- 0 - 20 cm/sec (0-8 in/sec)
- 20-40 cm/sec (8-16 in/sec)
- 40-60 cm/sec (16-24 in/sec)
- 60-77 cm/sec (24-30 in/sec)

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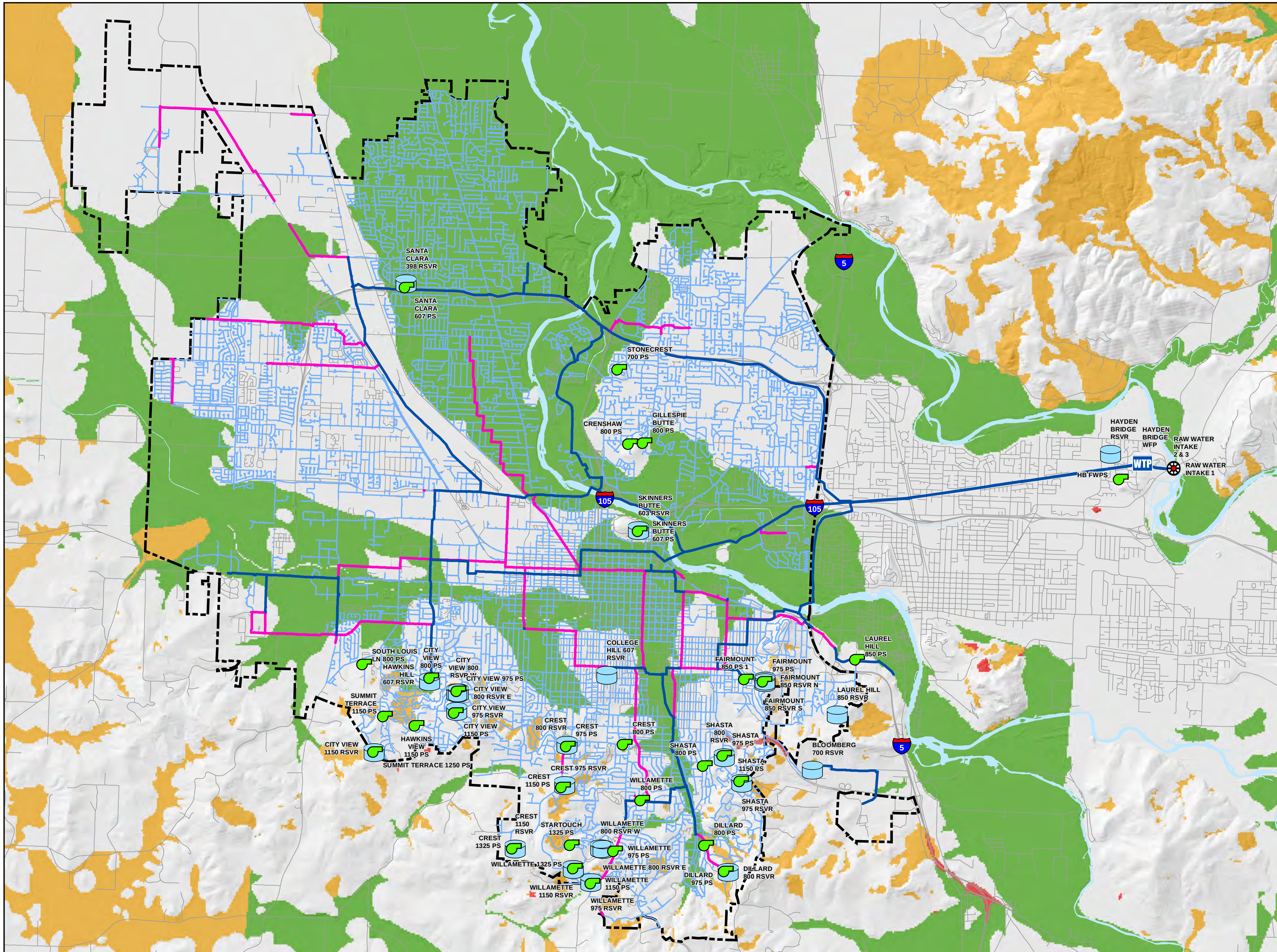

FIGURE 4

EWEB
2015 Water Master Plan

RESILIENCY PLANNING - LIQUEFACTION PROBABILITY VS. LARGE DIAMETER PIPELINES

N

0 3,000 6,000
Feet

Notes
1. Source: Oregon_Resilience_Plan_Ground_Motion_and_Ground_Failure_Maps.gdb.

LEGEND

- Water Treatment Plant
- Raw Water Intake
- Active Pump Station
- Existing Reservoir

Pipe Diameter

- Distribution Main (<16")
- Major Distribution Main (16"-18")
- Transmission Main (<18")
- Hydrology Feature
- EWEB Service Area

Probability of Liquefaction

- Not Liquefiable
- Low (0-5%)
- Medium (5-15%)
- High (15-27%)

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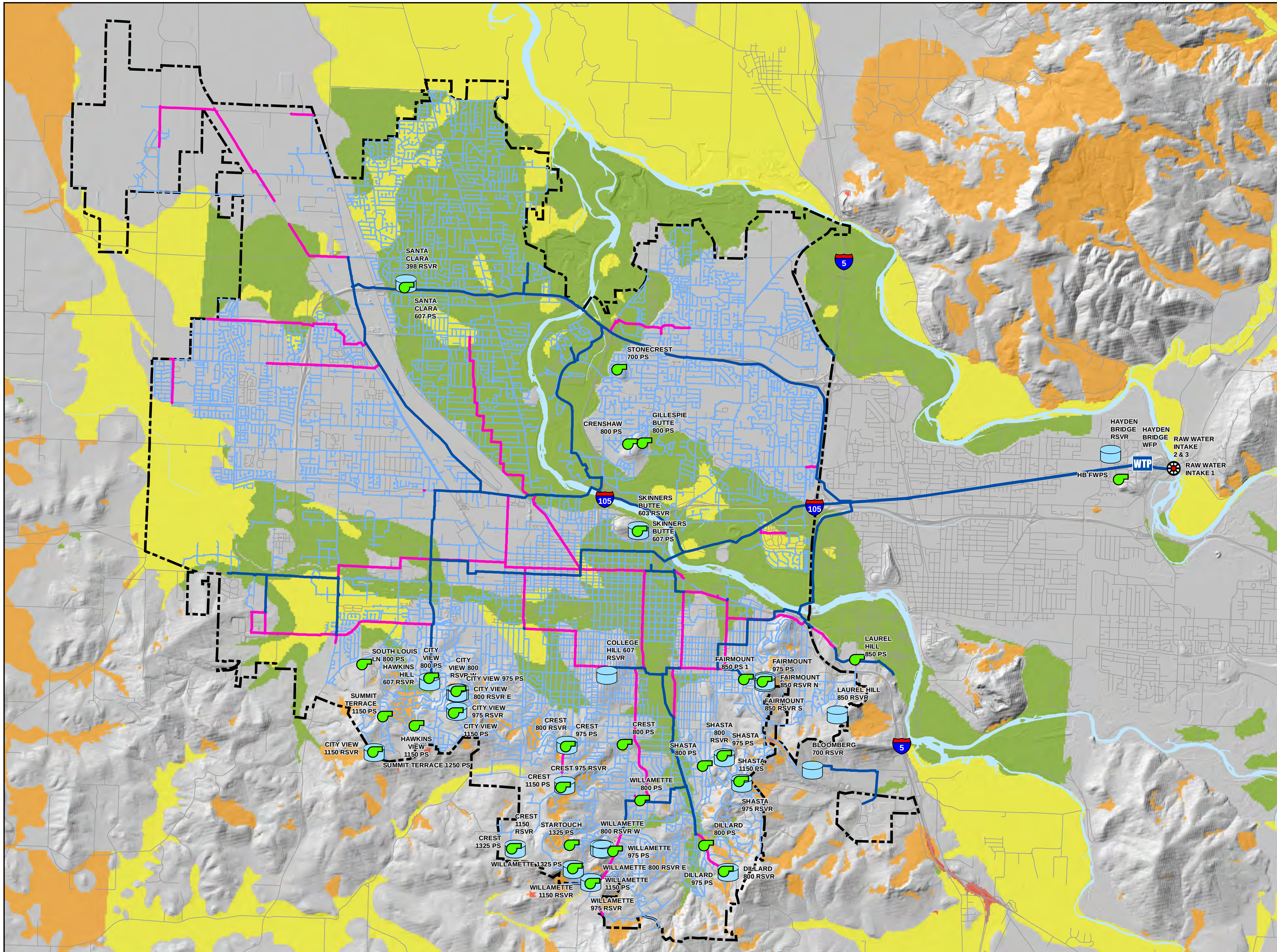

FIGURE 5

EWEB
2015 Water Master Plan

RESILIENCY PLANNING - PERMANENT GROUND DEFORMATION DUE TO LIQUEFACTION VS. LARGE DIAMETER PIPELINES

N

0 3,000 6,000
Feet

Notes
1. Source: Oregon_Resilience_Plan_Ground_Motion_and_Ground_Failure_Maps.gdb.

LEGEND

WTP Water Treatment Plant
Raw Water Intake
Active Pump Station
Existing Reservoir

Pipe Diameter

Distribution Main (<16")
Major Distribution Main (16"-18")
Transmission Main (<18")
Hydrology Feature
EWEB Service Area

Permanent Ground Deformation

None
Low (0-10 cm; 0-4 inches)
Medium (10-30 cm; 4-12 inches)
High (30-100 cm; 12-39 inches)
Very High (100-453 cm; 39-178 inches)

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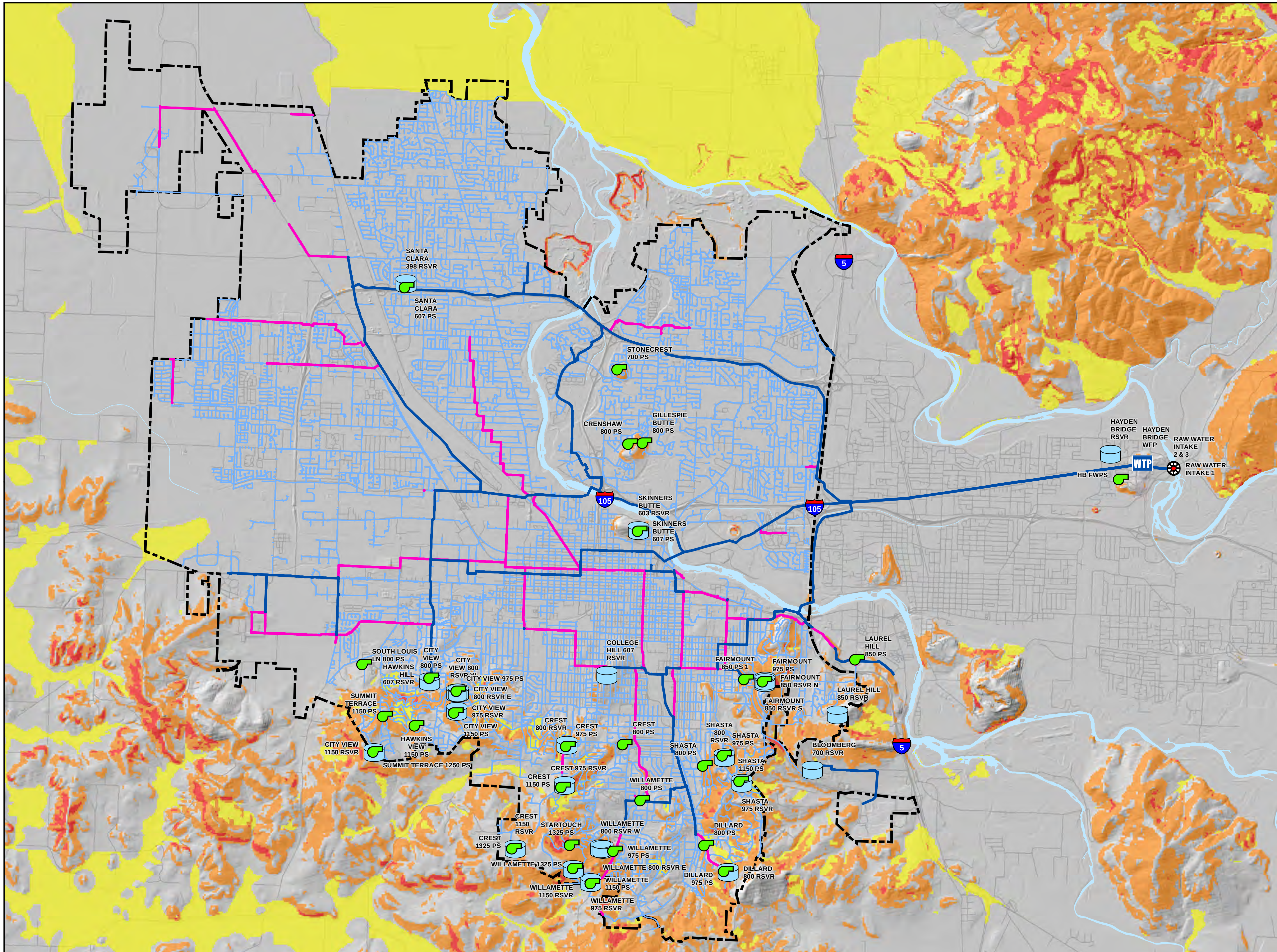
FIGURE 6

EWEB
2015 Water Master Plan

RESILIENCY PLANNING - EARTHQUAKE INDUCED LANDSLIDE PROBABILITY VS. LARGE DIAMETER PIPELINES



N

0 3,000 6,000
Feet

Notes
1. Source: Oregon_Resilience_Plan_Ground_Motion_and_Ground_Failure_Maps.gdb.

LEGEND

- WTP Water Treatment Plant
- Raw Water Intake
- Active Pump Station
- Existing Reservoir

Pipe Diameter

- Distribution Main (<16")
- Major Distribution Main (16"-18")
- Transmission Main (<18")
- Hydrology Feature
- EWEB Service Area

Landslide Probability

- None
- Low (HAZUS 3% - 8%)
- Medium (HAZUS 10-15%)
- High (HAZUS 20%-25%)
- Very High (HAZUS 30%)

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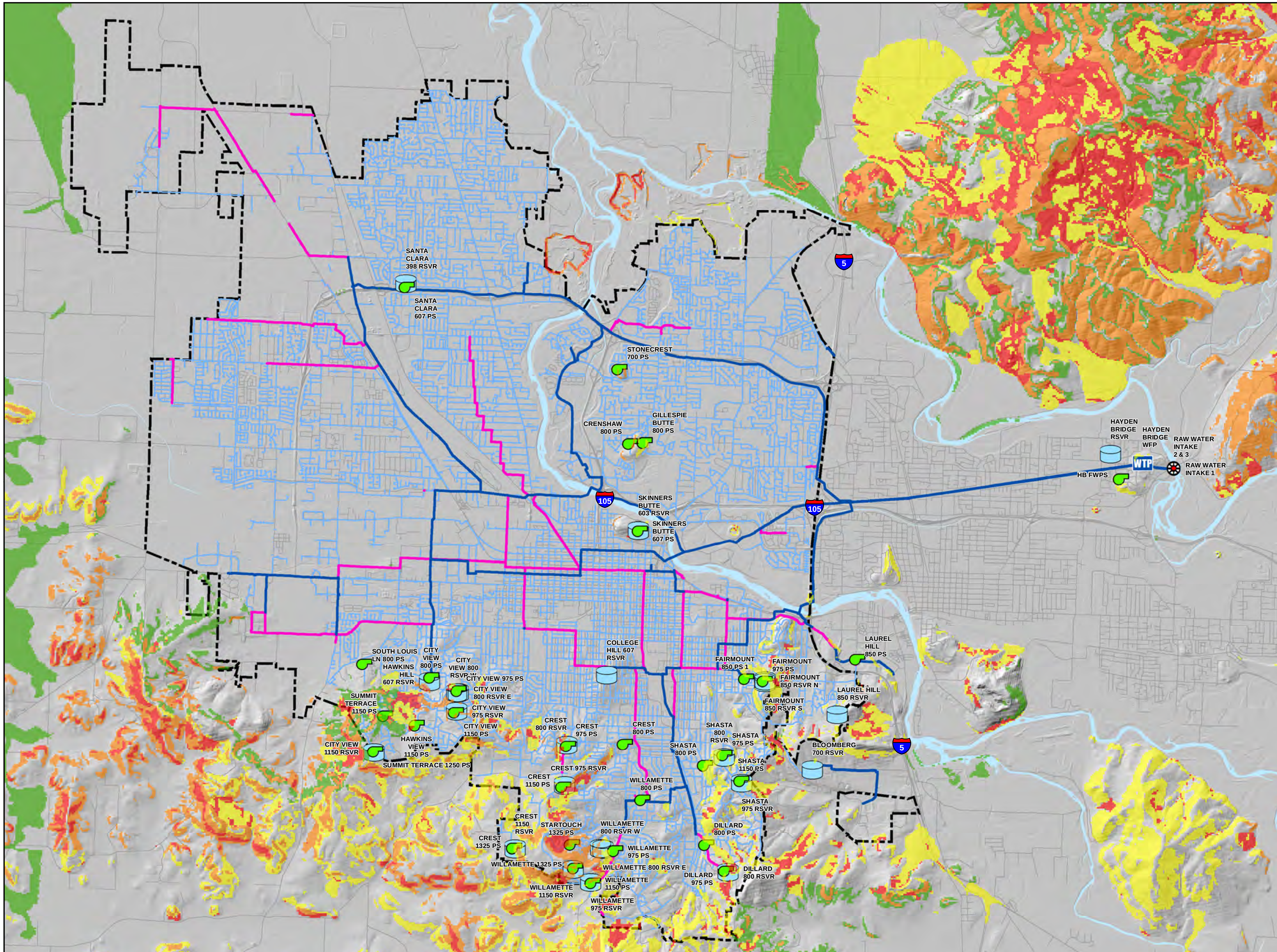

FIGURE 7

EWEB
2015 Water Master Plan

RESILIENCY PLANNING - PERMANENT GROUND DEFORMATION DUE TO LANDSLIDES VS. LARGE DIAMETER PIPELINES

N

0 3,000 6,000
Feet

Notes
1. Source: Oregon_Resilience_Plan_Ground_Motion_and_Ground_Failure_Maps.gdb.

LEGEND

- WTP Water Treatment Plant
- Raw Water Intake
- Active Pump Station
- Existing Reservoir

Pipe Diameter

- Distribution Main (<16")
- Major Distribution Main (16"-18")
- Transmission Main (<18")
- Hydrology Feature
- EWEB Service Area

Permanent Ground Deformation

- None
- Low (0-10 cm; 0-4 inches)
- Medium (10-30 cm; 4-12 inches)
- High (30-100 cm; 12-39 inches)
- Very High (100-1180 cm; 39-464 inches)

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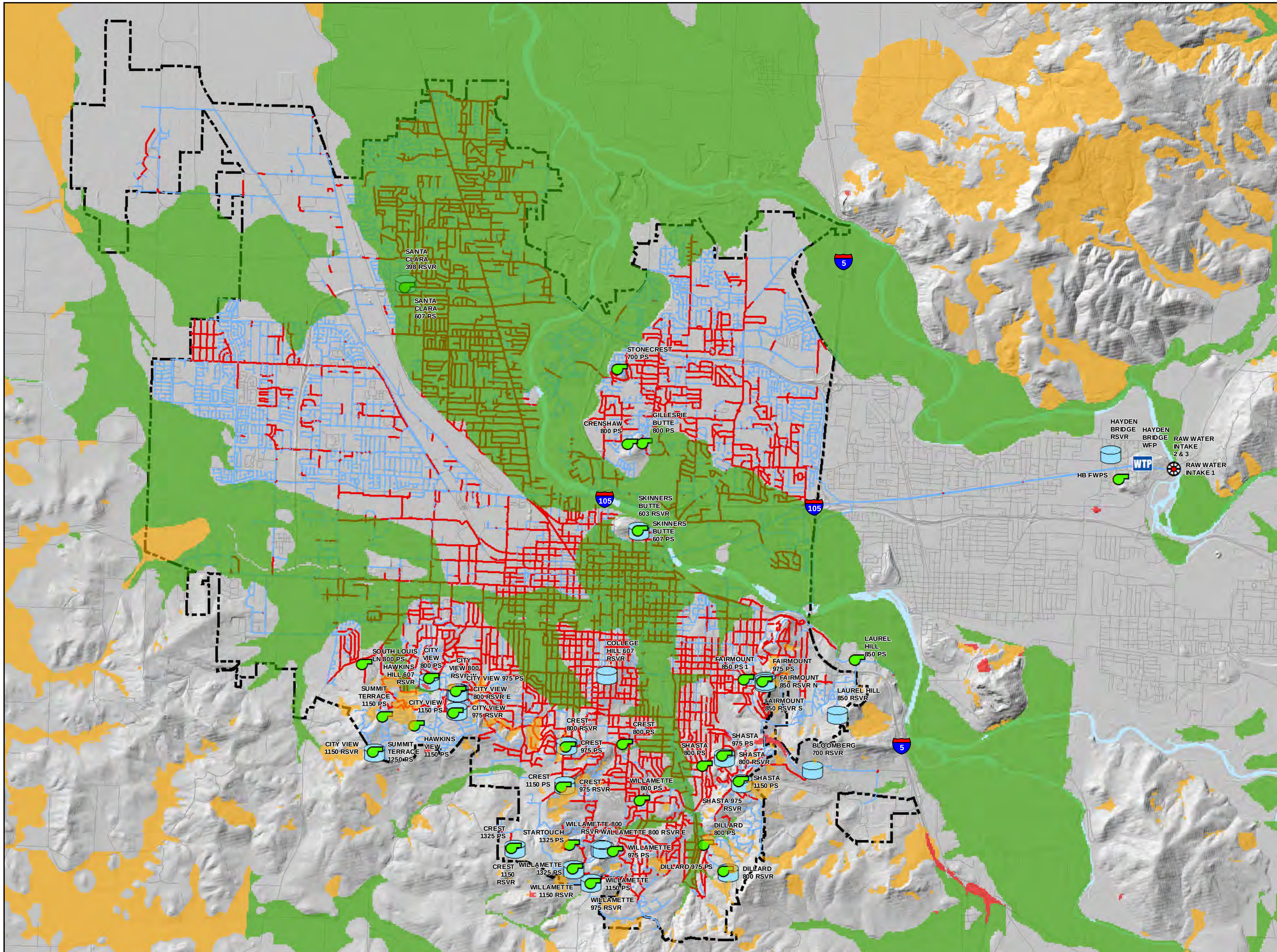

FIGURE 8

EWEB
2015 Water Master Plan

RESILIENCY PLANNING - LIQUEFACTION PROBABILITY VS. CAST IRON PIPELINES

N

0 3,000 6,000
Feet

Notes
1. Source: Oregon_Resilience_Plan_Ground_Motion_and_Ground_Failure_Maps.gdb.

LEGEND

- Water Treatment Plant
- Raw Water Intake
- Active Pump Station
- Existing Reservoir

Pipe Material

- Other
- Cast Iron
- Hydrology Feature
- EWEB Service Area

Probability of Liquefaction

- Not Liquefiable
- Low (0-5%)
- Medium (5-15%)
- High (15-27%)

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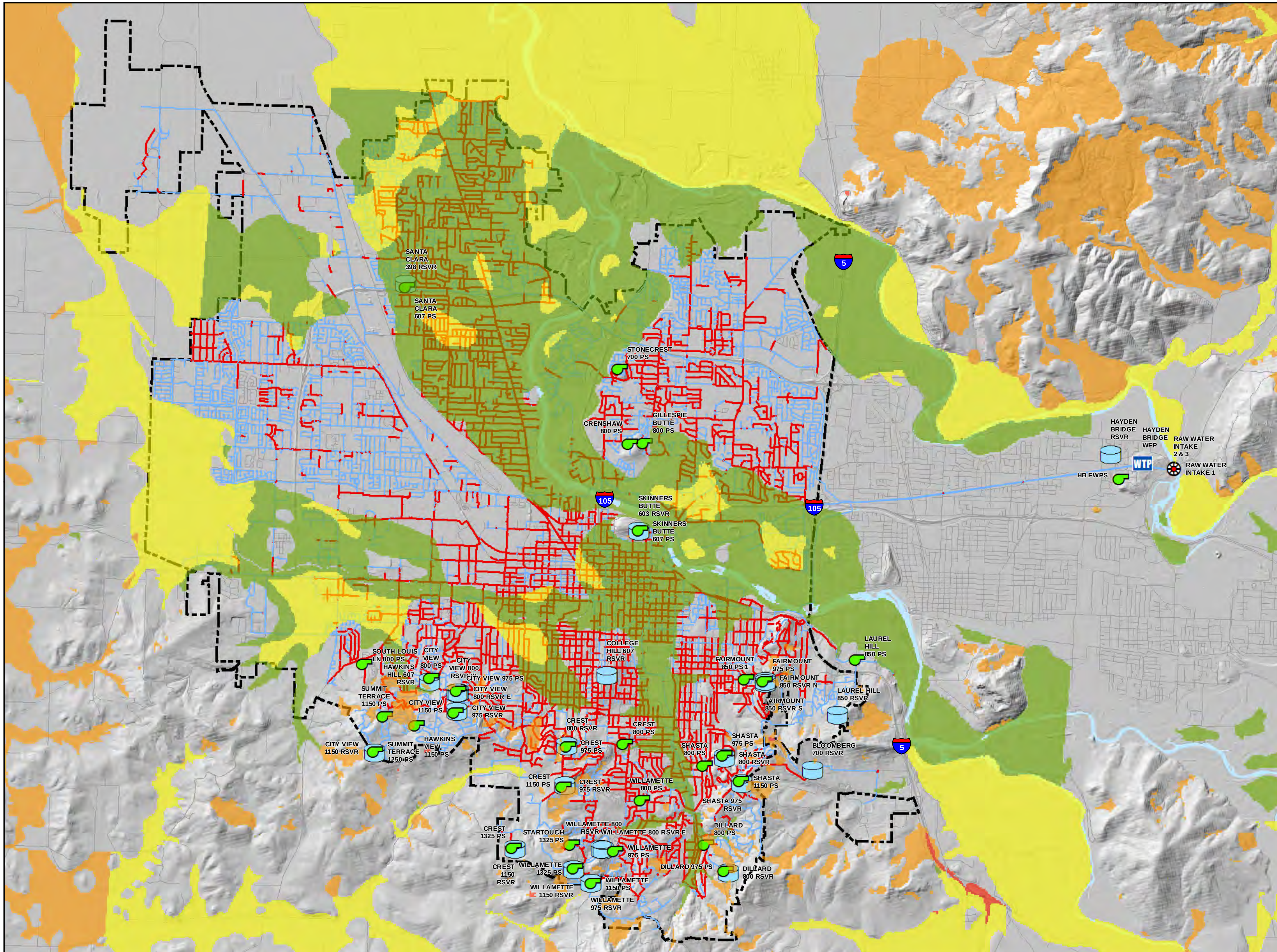

FIGURE 9

EWEB
2015 Water Master Plan

RESILIENCY PLANNING - PERMANENT GROUND DEFORMATION DUE TO LIQUEFACTION VS. CAST IRON PIPELINES

N

0 3,000 6,000

Feet

Notes
1. Source: Oregon_Resilience_Plan_Ground_Motion_and_Ground_Failure_Maps.gdb.

LEGEND

- Water Treatment Plant
- Raw Water Intake
- Active Pump Station
- Existing Reservoir

Pipe Material

- Other
- Cast Iron
- Hydrology Feature
- EWEB Service Area

Permanent Ground Deformation

- None
- Low (0-10 cm; 0-4 inches)
- Medium (10-30 cm; 4-12 inches)
- High (30-100 cm; 12-39 inches)
- Very High (100-453 cm; 39-178 inches)

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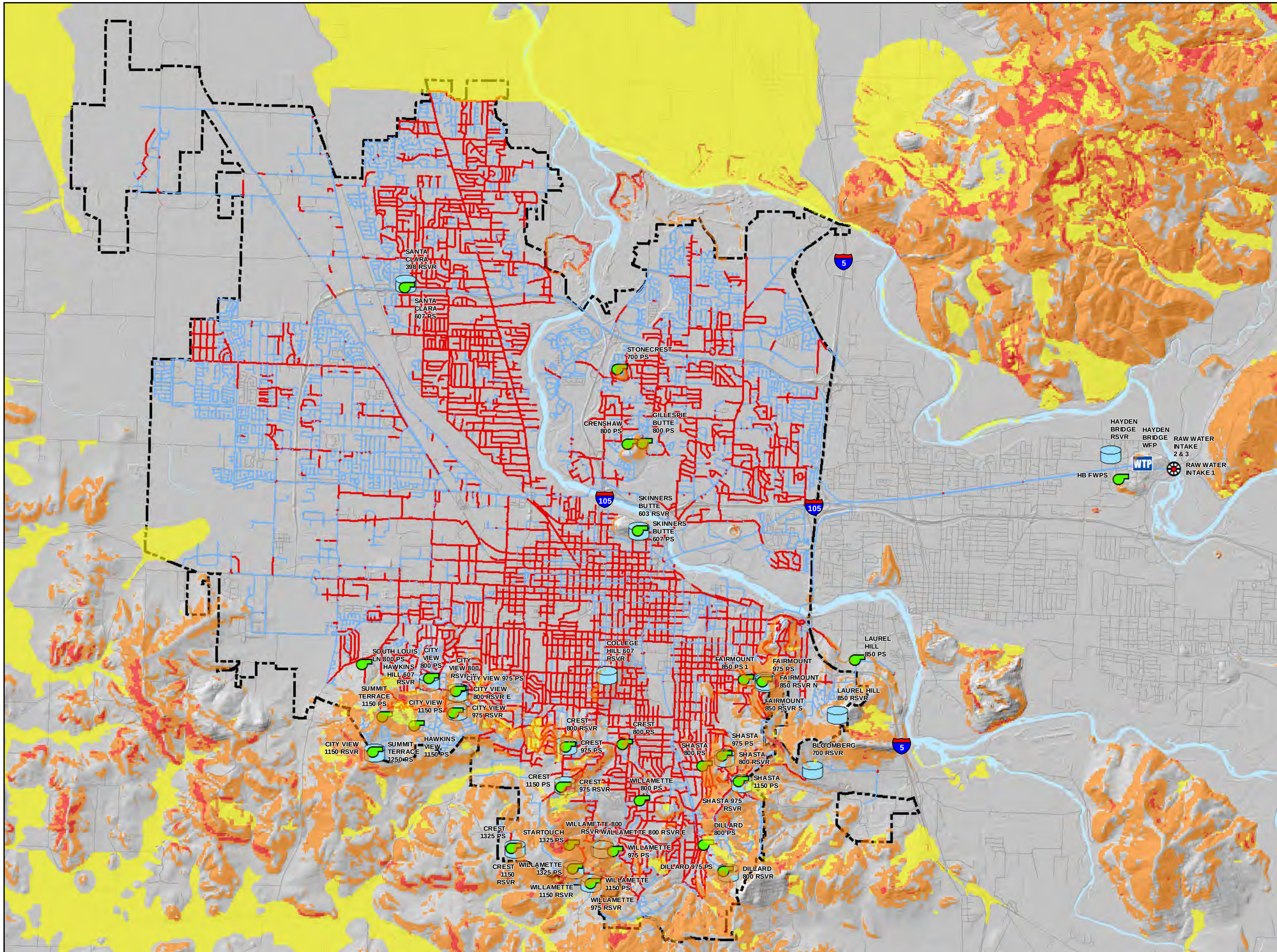

FIGURE 10

EWEB
2015 Water Master Plan

RESILIENCY PLANNING - EARTHQUAKE INDUCED LANDSLIDE PROBABILITY VS. CAST IRON PIPELINES

N

0 3,000 6,000
Feet

Notes
1. Source: Oregon_Resilience_Plan_Ground_Motion_and_Ground_Failure_Maps.gdb.

LEGEND

- WTP Water Treatment Plant
- Raw Water Intake
- Active Pump Station
- Existing Reservoir

Pipe Material

- Other
- Cast Iron
- Hydrology Feature
- EWEB Service Area

Value

- None
- Low (HAZUS 3% - 8%)
- Medium (HAZUS 10-15%)
- High (HAZUS 20%-25%)
- Very High (HAZUS 30%)

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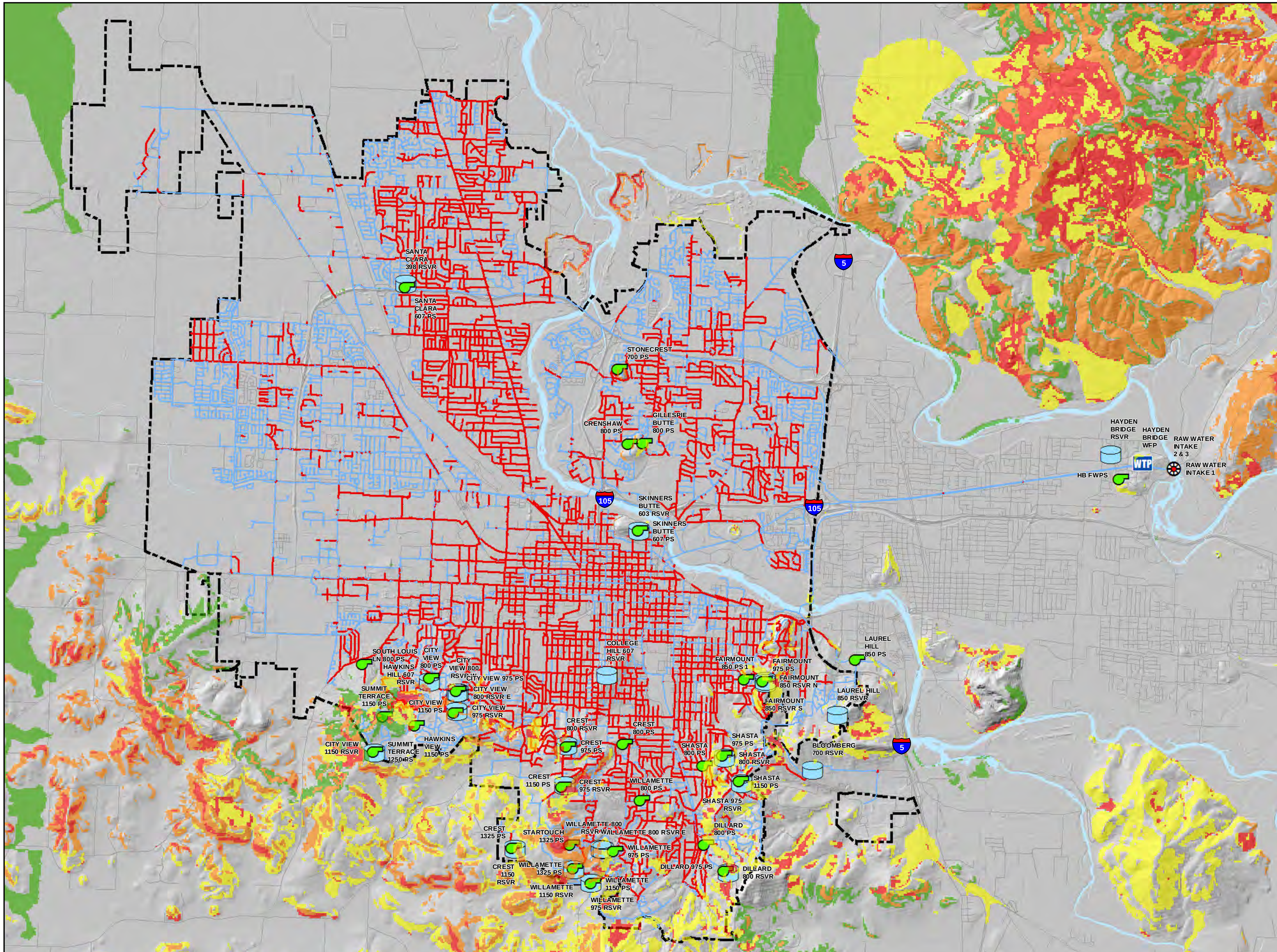

FIGURE 11

EWEB
2015 Water Master Plan

RESILIENCY PLANNING - PERMANENT GROUND DEFORMATION DUE TO LANDSLIDES VS. CAST IRON PIPELINES

N

0 3,000 6,000
Feet

Notes
1. Source: Oregon_Resilience_Plan_Ground_Motion_and_Ground_Failure_Maps.gdb.

LEGEND

- Water Treatment Plant
- Raw Water Intake
- Active Pump Station
- Existing Reservoir

Pipe Material

- Other
- Cast Iron
- Hydrology Feature
- EWEB Service Area

Permanent Ground Deformation

- None
- Low (0-10 cm; 0-4 inches)
- Medium (10-30 cm; 4-12 inches)
- High (30-100 cm; 12-39 inches)
- Very High (100-1180 cm; 39-464 inches)

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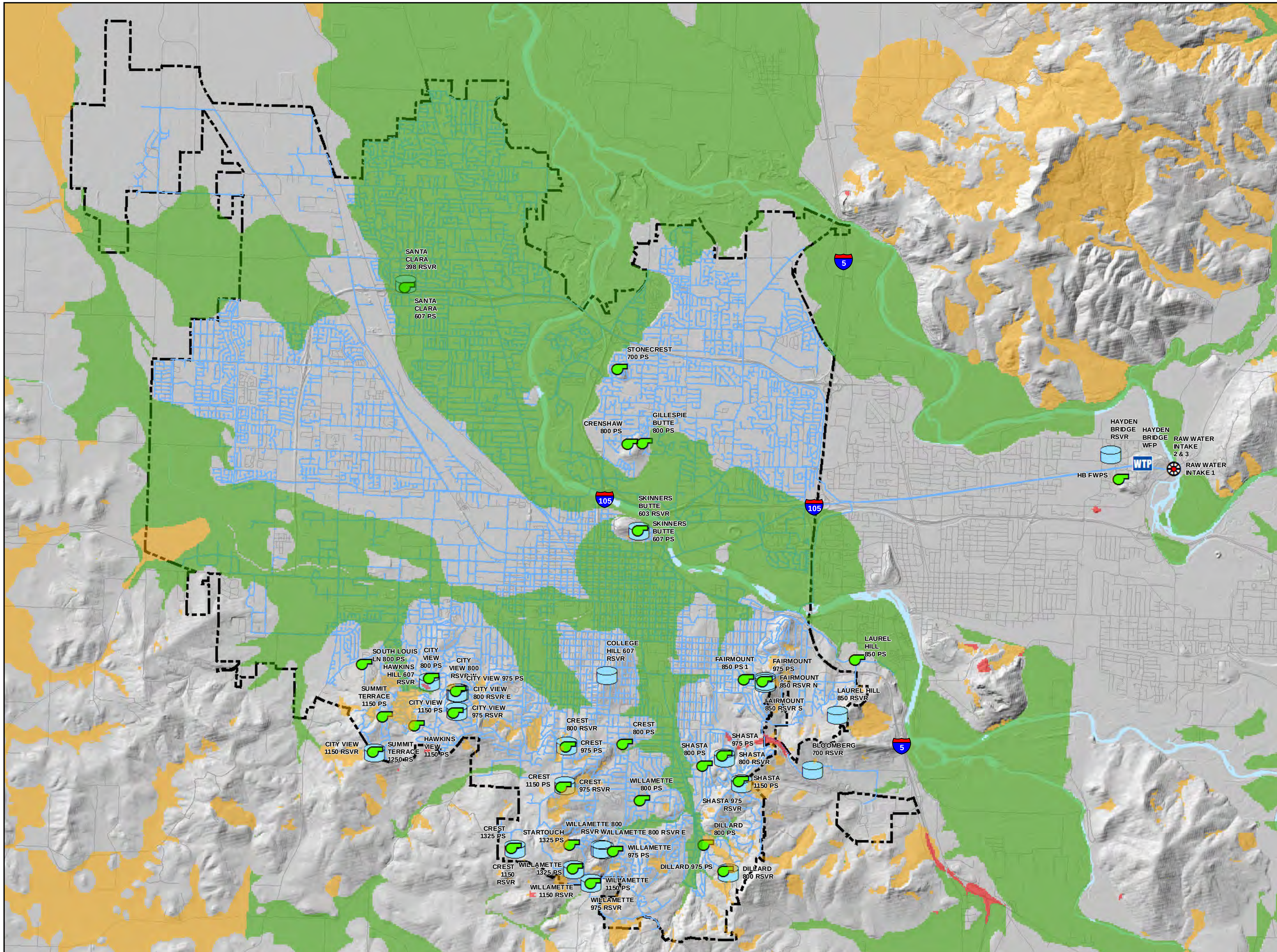

FIGURE 12

EWEB
2015 Water Master Plan

RESILIENCY PLANNING - LIQUEFACTION PROBABILITY VS. ASBESTOS CEMENT PIPELINES

N

0 3,000 6,000
Feet

Notes
1. Source: Oregon_Resilience_Plan_Ground_Motion_and_Ground_Failure_Maps.gdb.

LEGEND

- Water Treatment Plant
- Raw Water Intake
- Active Pump Station
- Existing Reservoir

Pipe Material

- Other
- Asbestos Cement
- Hydrology Feature
- EWEB Service Area

Probability of Liquefaction

- Not Liquefiable
- Low (0-5%)
- Medium (5-15%)
- High (15-27%)

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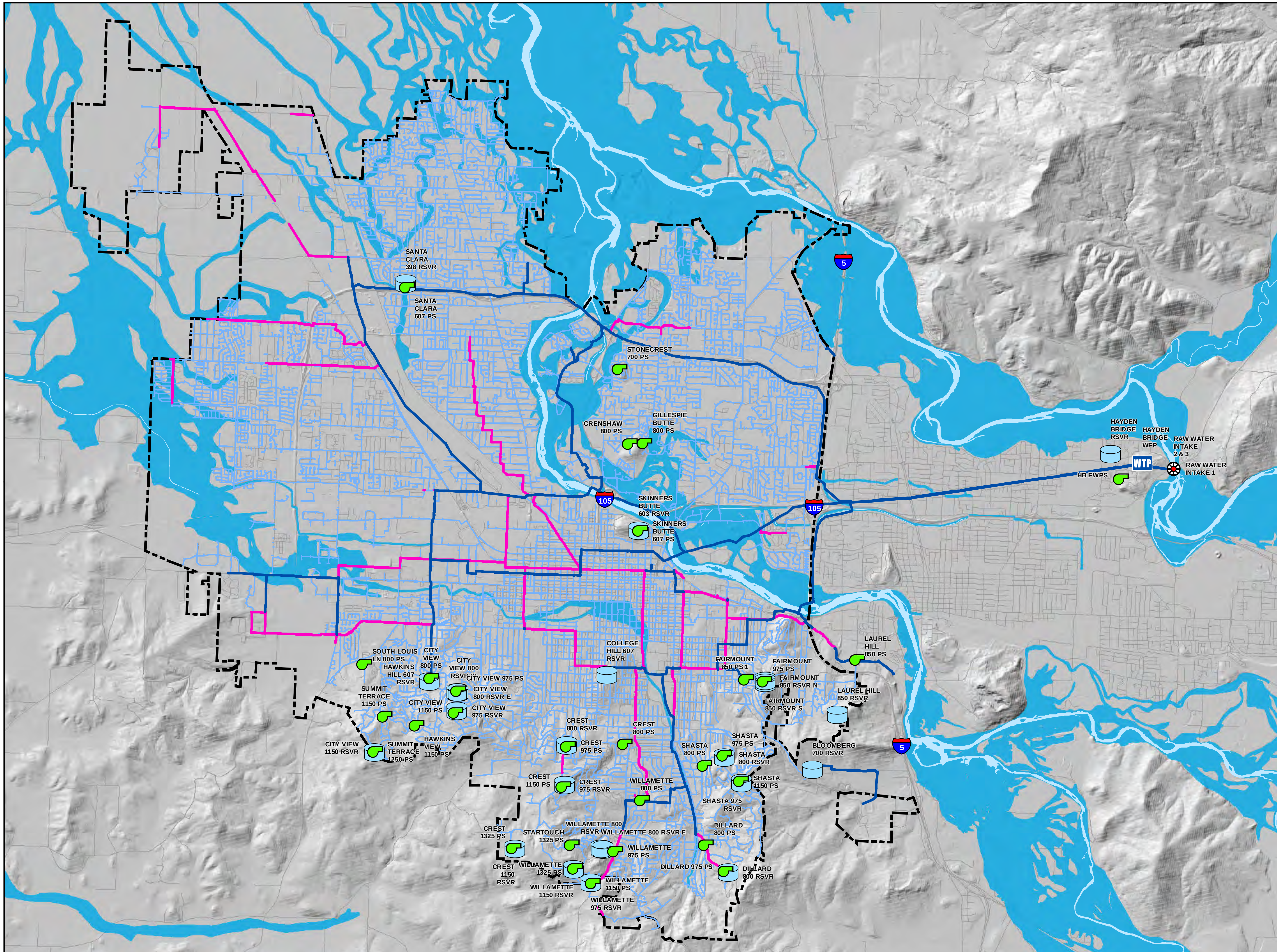

FIGURE 13

EWEB
2015 Water Master Plan

RESILIENCY PLANNING - 100 YEAR FLOOD PLAIN VS. LARGE DIAMETER PIPELINES

N

0 3,000 6,000
Feet

Notes
1. Source: Federal Emergency Management Agency (FEMA).

LEGEND

- Water Treatment Plant
- Raw Water Intake
- Active Pump Station
- Existing Reservoir

Pipe Diameter

- Distribution Main (<16")
- Major Distribution Main (16"-18")
- Transmission Main (<18")
- Hydrology Feature
- EWEB Service Area
- 100 Year Flood Zones

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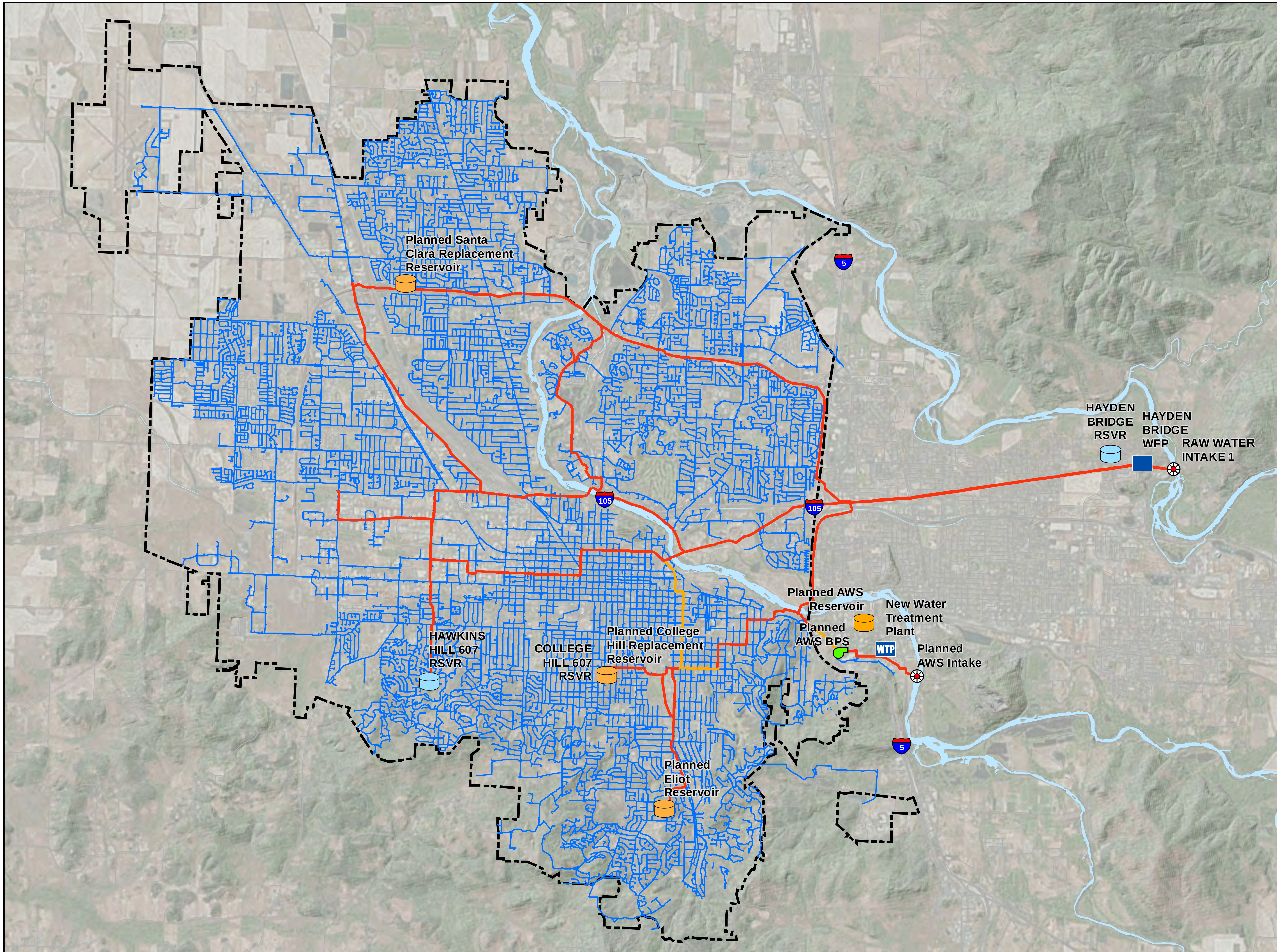

FIGURE 14

EWEB
2015 Water Master Plan

FIRST PRIORITY BACKBONE OF EWEB SYSTEM

N

0 3,000 6,000
Feet

Note:
Only first priority backbone facilities are shown.

LEGEND

- Water Treatment Plant
- Raw Water Intake
- Active Pump Station
- Existing Reservoir
- Planned Reservoir
- First Priority Backbone Pipeline
- Future Pipeline Improvement
- Pipeline
- Hydrology Feature
- EWEB Service Area

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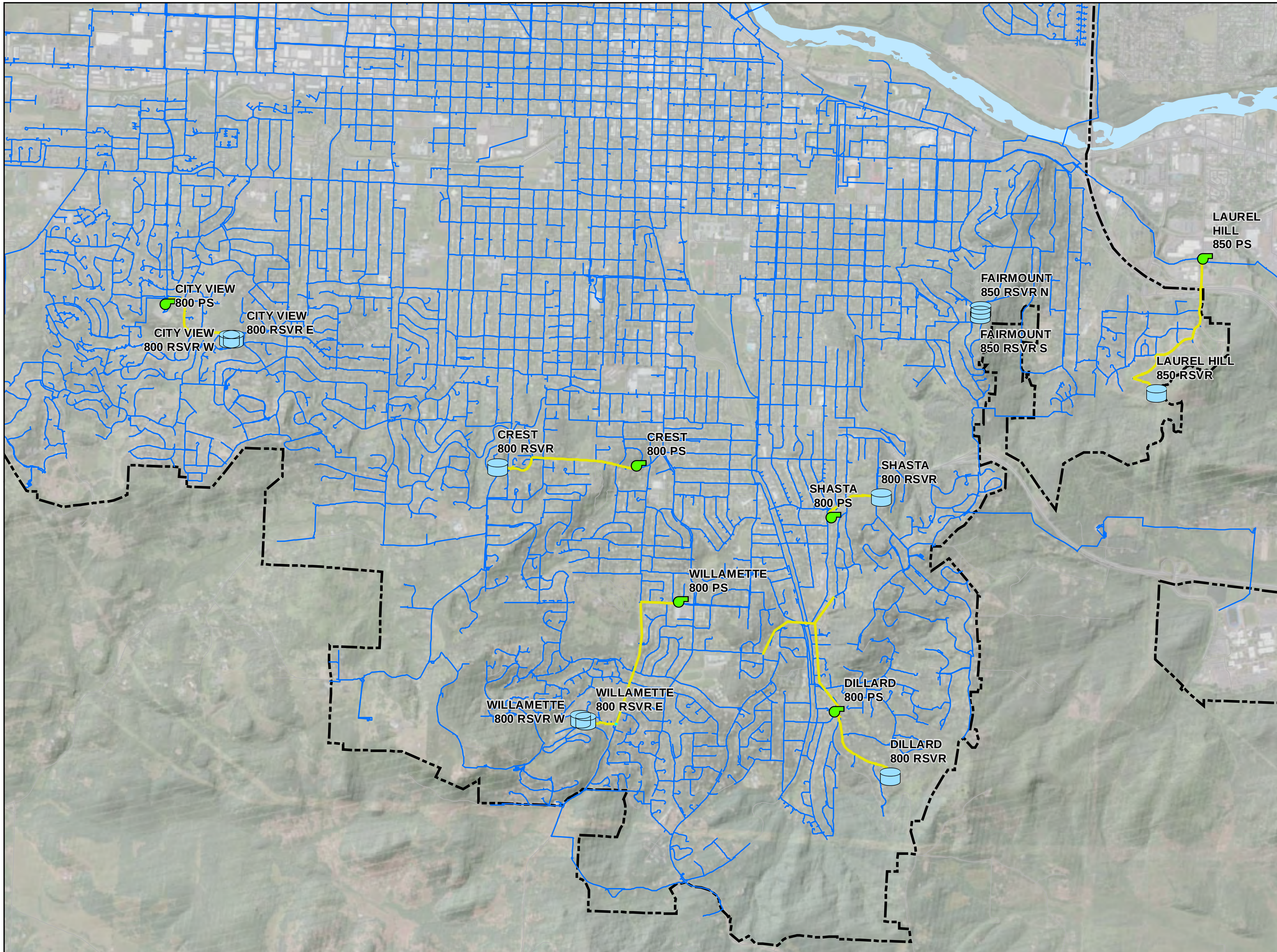

FIGURE 15

EWEB
2015 Water Master Plan

SECOND PRIORITY BACKBONE OF EWEB SYSTEM

N

0 1,250 2,500
Feet

Note:
Only second priority backbone facilities are shown.

LEGEND
- Water Treatment Plant
- Raw Water Intake
- Active Pump Station
- Existing Reservoir
- Second Priority Backbone Pipeline
- Pipeline
- Hydrology Feature
- EWEB Service Area

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Consulting Engineers

MEMORANDUM

EUGENE WATER & ELECTRIC BOARD

Rely on us.

TO: Commissioners Mital, Simpson, Helgeson, Manning and Brown,

FROM: Mel Damewood, Engineering Manager; Wally McCullough, Water Engineering Supervisor; Laura Farthing, Senior Engineer-Water;

DATE: May 22, 2015

SUBJECT: Water Master Plan – Base and Upper Level Optimization

OBJECTIVE: Information Only

Issue

On June 2, 2015, staff will present the 2015 Water Master Plan Update to the board. Staff will prepare a series of four backgrounders for the Board to review prior to the June presentation. These backgrounders will cover the following information:

1. The need for a Master Plan, System Characteristics, and Demands
2. Resiliency Recommendations
3. Base and Upper Level Optimization
4. Capital Improvements Plan (CIP) and Summary

The second backgrounder was submitted to the Board on May 16, 2015. This is the third backgrounder in the series.

Background

EWEB serves the area within the City of Eugene's (City) Urban Growth Boundary (UGB), Lane Community College, the airport, and four wholesale customers; River Road Water District, Santa Clara Water District, the City of Veneta, and the Willamette Water Company. The total population of the service area is approximately 183,000.

EWEB's distribution system, which serves approximately 183,000 customers, consists of the base level, which has the majority of customers and approximately 88 percent of the demand, and the Upper Level System, which has the majority of the infrastructure and provides water service to customers in the south hills of Eugene. Water is delivered to customers through a network of approximately 800 miles of mains, discussed in the next backgrounder.

This backgrounder includes a discussion of the work completed as part of the 2015 Water Master Plan Update to optimize both the Base Level System and the Upper Level System. Details of the facilities and current operation of the Base Level and Upper Level Systems was provided in the first backgrounder submitted to the Board on May 9, 2015.

Discussion

The following sections summarize the optimization work completed for the 2015 Water Master Plan Update. Chapter 8 "Base Level System" and Chapter 9 "Upper Level System" provide more detail about the optimization work and have been included as Attachment 1 and 2 respectively.

Base Level System Optimization

A comprehensive assessment of the Base Level System has been completed to define the long term reliability of the system. The following objectives related to system performance were basis for the evaluation that is summarized in this chapter:

- A resilient backbone of transmission, pumping and storage is required that can be operational after a major earthquake. Facilities that are a part of the system backbone must either meet the resiliency criteria, be upgraded, or be replaced for long term operation;
- The condition of the system must be maintained for reliable service;
- The combined operation of water treatment, pumping, transmission and storage system must provide customers with acceptable water quality and quantity; and
- System wide redundancy and backup is needed both for unplanned outages and for planned major maintenance.

At existing water demands the Base Level Transmission Infrastructure is able move water from the Hayden Bridge Water Filtration Plant (HBWFP) throughout the Base Level within EWEB's design and operational criteria. However, the system has some deficiencies that need to be addressed to ensure reliable water service:

- The 20 million gallon (MG) Hawkins Hill, 15 MG College Hill and 20 MG Santa Clara Reservoirs would likely become inoperable following a major earthquake. A resilient spine of treatment, transmission and storage is essential to ensure restoration of service soon after a major earthquake in compliance with the EWEB Resiliency Plan.

- Conveying treated water throughout the distribution system requires active intervention by EWEB operational personnel. HBWFP personnel monitor system pressures and reservoir levels and make manual adjustments to finished water pumping rates and base level pump operation to maintain water quality and pressure criteria.
- The existing large reservoirs are not fully utilized because it is difficult to maintain good water quality when the water does not frequently turn over.
- To maximize the benefits of the Alternative Water Supply (AWS), transmission improvements need to be made for long term operation.
- System redundancy needs to be enhanced so maintenance and improvements can be incorporated without influencing the level of service to customers.

Base Level System Evaluation

The meet the objectives and resolve the issues summarized above, the work for the 2015 Master Plan looked at each base level reservoir, the transmission system and the new AWS and used the hydraulic model to evaluate different scenarios. The system was evaluated under existing and future average day demands (ADD) and maximum day demands (MDD). A full description of the evaluation methodology can be found in Chapter 8, attached to this backgrounder.

Three alternatives were evaluated for optimizing storage in the base level system:

- Alternative 1 - Upgrade the existing College Hill Reservoir.
- Alternative 2 – Upgrade the Santa Clara Reservoir and Pump Station.
- Alternative 3 – Construct distributed storage across the Base Level.

Each of the above alternatives were developed to achieve 60MG of storage in 2035, to meet the projected storage requirements.

In addition to the alternatives listed above, an assessment of the Hawkins Hill Reservoir was completed. It was determined that the Hawkins Hill cannot be taken out of service for a long period of time because of operational issues. The reservoir also does not meet seismic codes. To remedy these, it was recommended that the Hawkins Hill Reservoir be divided in half which will allow for half of the reservoir to be taken out of service at a time to complete the required seismic upgrades. All of the alternatives evaluated assume that the work at Hawkins Hill will be completed.

Alternative 1: Upgrade College Hill Reservoir

Alternative 1 involves making improvements to the College Hill Reservoir so the reservoir can provide long term service to the Base Level. The following improvements are required for Alternative 1:

- Perform seismic upgrades and miscellaneous improvements at the College Hill Reservoir;
- Complete transmission improvements;
- Construct 10 MG of storage at the Elliott site (in two phases); and
- Decommission the Santa Clara Reservoir and Pump Station;

Alternative 2 – Upgrade the Santa Clara Reservoir

Alternative 2 includes upgrading the existing Santa Clara Reservoir and Pump Station for long term storage and operation. The following improvements are required for Alternative 2:

- Construct seismic improvements at Santa Clara Reservoir and replace the existing pump station,
- Construct a new 5 MG reservoir at the Elliott site,
- Construct Transmission System Improvements,
- Decommission the College Hill Reservoir

Alternative 3 – Distributed Storage

With Alternative 3, both the College Hill and Santa Clara Reservoirs would be replaced with smaller reservoirs in addition to construction of storage at the AWS site. The following improvements are required for this alternative:

- Construct a 5 MG reservoir at College Hill and decommission the existing reservoir,
- Construct a 5 MG reservoir at the AWS facility,
- Demolish the existing Santa Clara Reservoir and construct a 5 MG reservoir and pump station at the Santa Clara Site,
- Construct a 5 MG reservoir at the Elliott Site,
- Construct a second 5 MG reservoir at the Elliott Site, and
- Construct transmission improvements.

A full description of the evaluation, alternatives, the advantages and disadvantages, and a summary of the capital costs are included in Chapter 8.

Summary of Recommendations

While the cost of Alternative 3 is higher than that of Alternatives 1 and 2, the overall effectiveness of Alternative 3 is superior. Building distributed storage allows EWEB to stage improvements based both on capital resources and demand, and provide the most resilient system. Alternative 3 also allows EWEB to invest in new facilities, rather than investing in repairing old reservoirs that are in need of significant upgrades. For example, the Santa Clara Reservoir is in need of significant structural rehabilitation because it is constructed on liquefiable soils and requires a new pump station because the existing pump station has run to failure. The College Hill Reservoir is also in need of significant structural repairs, roof modifications and all new inlet and outlet piping. These projects will be difficult and expensive to complete and at the end of the repairs we are still left with old infrastructure. A full description of the recommended improvements is provided in Chapter 8. Figure 1 below shows what the base level will look like after the improvements are complete.

To complete the improvements, the 2015 Master Plan Update provided the following phasing for staff to use in developing the Capital Improvements Plan. Figure 2 shows how the improvements will be implemented.

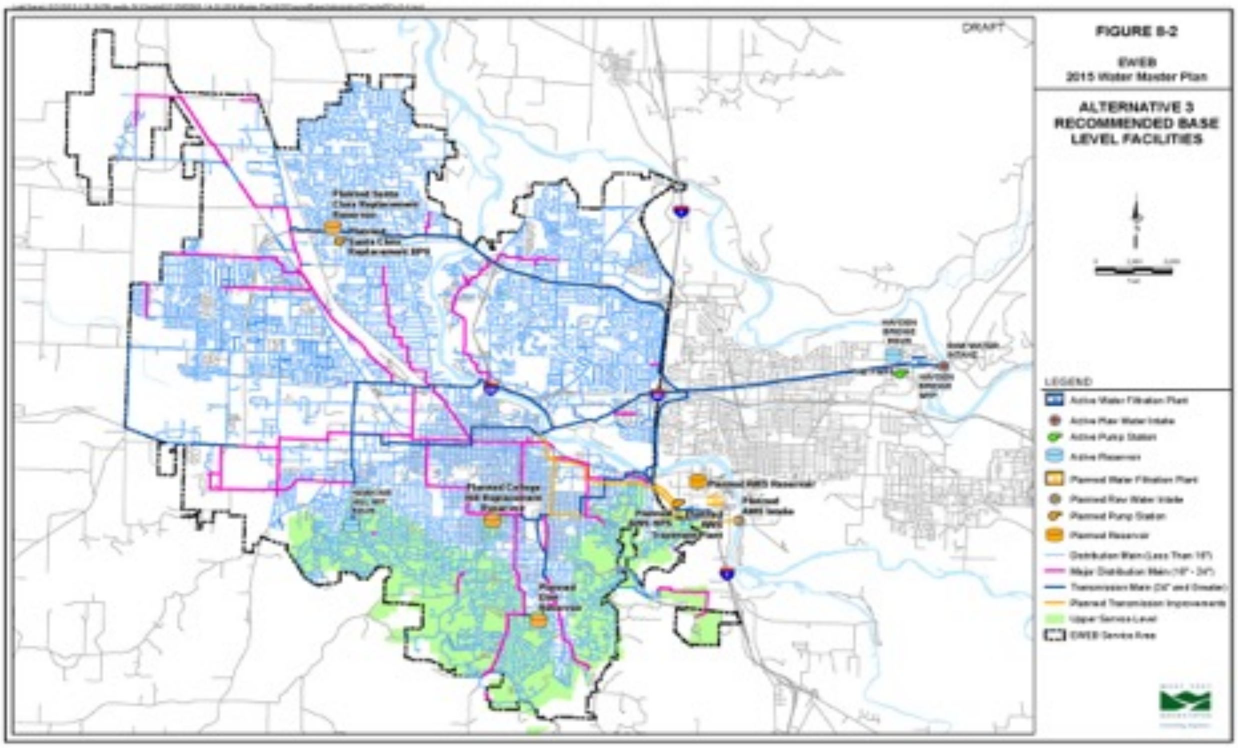

Figure 1: Alternative 3 Distributed Storage

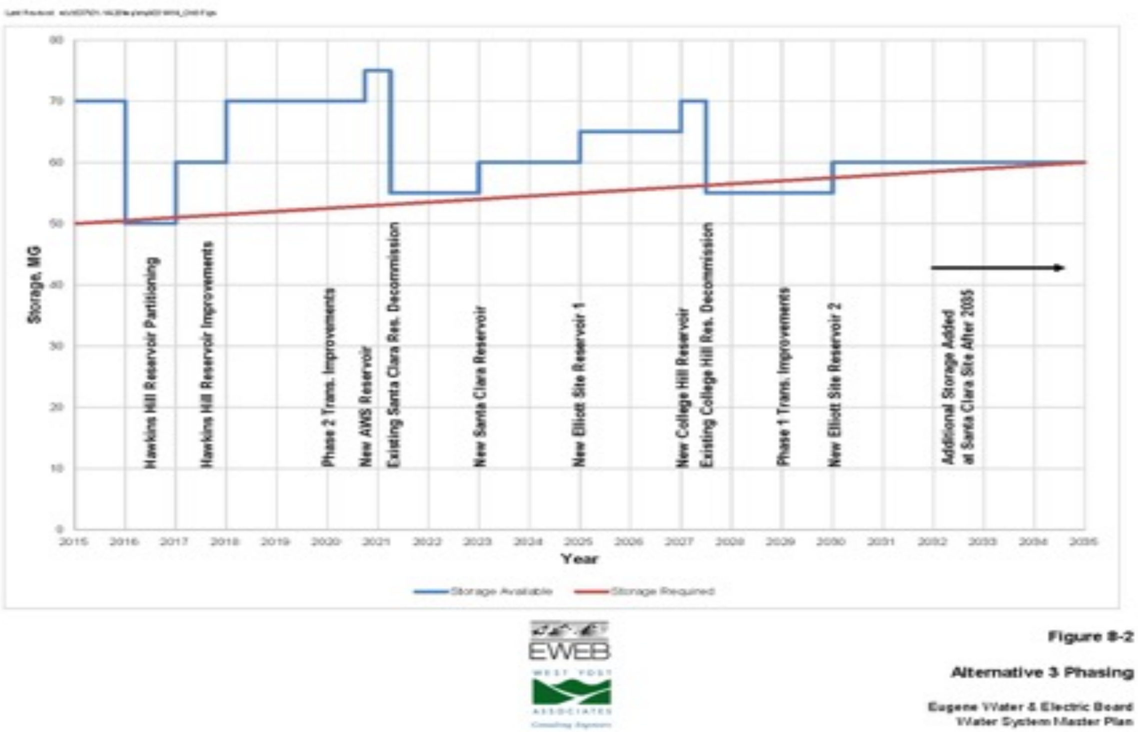

Figure 2, Alternative 3 Phasing

Upper Level System

A comprehensive evaluation of the Upper Level System was completed to define the long term reliability of the system. The following objectives related to system performance were the basis for the evaluation:

- Consolidate service areas to simplify operations, improve system resiliency so reservoirs and pump stations that are capable of withstanding an earthquake can serve the maximum area possible.
- Maintain the condition of the system for reliable service;
- Look for opportunities to avoid constructing new facilities;
- Provide redundancy and backup between service area and service levels both for unplanned outages and for planned maintenance activities and;
- Provide vertical redundancy between service levels.

There are several issues with the existing Upper Level System that include the following:

- A lack of interconnection among service levels limits operational flexibility and can leave a large number of customers without water service if one facility is out of service for either planned or unplanned reasons.
- The operation of the system is complex and requires manipulation by the operators to deliver water from the base level to higher service levels.
- Under the existing configuration of the Upper Level service areas, very little redundancy is included since each service area and each pressure ladder operates independently.
- The Fairmount 850 PS experiences low suction pressures because it is located at too high of an elevation. The entire base level system operation is manipulated to mitigate these low pressures.
- There are facilities that have a pumping capacity or storage deficit.
- There is no flexibility to provide water to new development in the Upper Level System.
- The pump stations are all aging and in need of electrical, control, communication, mechanical and structural upgrades. Electrical, control, and communication upgrades help to make the pump station operate more efficiently and offer opportunities to save on operation costs. Mechanical and structural upgrades extend the life of the facility.

Upper Level System Evaluation

To meet the objectives and address the issues in the Upper Level system in an economic manner, opportunities to combine service area were evaluated using EWEB's hydraulic model. The combination of service areas generally helps with reservoir turnover, provides redundancy in an area, helps to meet the recommendations of the EWEB Resiliency Plan, and provides operational flexibility. The evaluation found that the following recommendations improved the system for the lowest capital investment.

- Recommendation 1: Consolidate the 800 service areas into one service level. This recommendation allows water to move east or west across the entire system (between elevation 500 and 700) and meets the requirements of the EWEB Resiliency Plan. The improvements required to implement this recommendation are summarized in Chapter 9.
- Recommendation 2 - Decommission the Fairmount 850 Pump Station. This recommendation will allow EWEB to eliminate the Fairmount 850 Pump Station, which at this point drives the operation of the entire water system. This will allow EWEB to operate the system in a more efficient manner and better serve customers. The improvements required to implement this recommendation are summarized in Chapter 9.
- Recommendation 3 –Maintain separate 1150 service areas. This recommendation will require the construction of a new pump station and a connection to the 1325 service level to provide redundancy in the event of an emergency.

A full description of the alternatives, the advantages and disadvantages, capital costs and recommendations can be found in Chapter 9.

In addition to completing the above improvements to optimize the system and provide additional resiliency, Chapter 9 includes a summary of the required pump station and reservoir upgrades to bring the condition of the facilities up to current seismic code and improve their operability.

Cost Implications

The recommended improvements for both the Base Level and the Upper Level Systems will be phased and included in the 10-year CIP. Although some of the recommendations described reach past the 20 planning horizon of the Master Plan, staff does not see immediate near term impacts to the 10-year CIP and Water Long Term Financial Plan in implementing these recommendations. In the later years of the 10-year CIP, expenditures are anticipated to increase over what is currently anticipated.

Policy Level Decisions

Moving forward there are questions that the Board will need to answer. These include:

1) Given staff's recommendations to begin a new philosophy of building smaller reservoirs that are distributed across the system, built for resiliency and long life, is the Board willing to spend more capital funds (in the out years) to build new infrastructure rather than rehabilitate existing infrastructure?

2) Although simplification of the upper level system will reduce overall Operations and Maintenance costs in the long run, and prevent the necessity of future new facilities being constructed, does the Board support this shift even though it may cause some rise in capital expenditures upfront to enable this strategy? Spending no significant funds and continuing operations and upgrade (Status qou) is an option.

Recommendation

None. This is an information item only.

Requested Board Action

On June 2nd 2015, EWEB staff will be asking the Board to approve the 2015 Water System Master Plan.

Approval by the Board sets forth staff to begin crafting future Capital Improvement Plans, Studies, and Programs to support the goals and recommendations of the Master Plan. Funds needed to implement the Master Plan will be conducted through Board approvals of the 10-Year CIP, Water's Long Term Financial Plan, and through annual Capital and O&M Budgets.

Staff will be available to answer questions at the June 2, 2015 Board meeting. Staff is also available throughout the month of May as these backgrounders get distributed to answer questions. If you have any questions, please call Mel Damewood at 541-685-7145 or email mel.damewood@eweb.org.

Attachment 1: Chapter 8 Base Level System

Attachment 2: Chapter 9 Upper Level System

8.1 INTRODUCTION

The following sections of this chapter describe criteria, methodology, and recommendations for improvements to the transmission system and Base Level facilities in EWEB's distribution system. Improvements identified as part of the evaluation presented in this chapter are incorporated in the CIP of the 2015 Master Plan, along with projects identified in the Upper Level evaluation, the assessment of fire flows, the resiliency study and the condition assessment.

EWEB's water distribution system is comprised of the Base Level and Upper Level systems. The base level contains 88 percent of the existing water demands and the majority of the water storage. The Upper Level System serves the higher elevations in the southern portion of the system and is entirely served off the Base Level system.

A comprehensive assessment of the transmission system has been completed to define the long term reliability of the system. The following objectives related to system performance are the basis for the evaluation that is summarized in this chapter:

- A resilient backbone of transmission, pumping and storage is required that can be operational after a major earthquake. Facilities that are a part of the system backbone must either meet the resiliency criteria, be upgraded, or be replaced for long term operation;
- The condition of the system must be maintained for reliable service;
- The combined operation of water treatment, pumping, transmission and storage system must provide customers with acceptable water quality and quantity; and
- System wide redundancy and backup is needed both for unplanned outages and for planned major maintenance.

8.2 EXISTING SYSTEM ISSUES

At existing water demands the Base Level Transmission Infrastructure is able move water from the HBWFP throughout the Base Level within EWEB's design and operational criteria. However, the system has some deficiencies that need to be addressed to ensure reliable water service:

- The Hawkins Hill, College Hill and Santa Clara Reservoirs would likely become inoperable following a major earthquake. A resilient spine of treatment, transmission and storage is essential to ensure restoration of service soon after a major earthquake. Therefore, the most effective plan for building resiliency for storage has been assessed as part of this chapter.
- Conveying treated water throughout the distribution system requires active intervention by EWEB operational personnel. Hayden Bridge Water Filtration Plant (HBWFP) personnel monitor system pressures and reservoir levels and make manual adjustments to finished water pumping rates and base level pump operation to maintain water quality and pressure criteria as defined in the Hayden Bridge Standard Operating Procedures (HB SOP). To the degree feasible, future improvements are planned to allow for more efficient operation of the HBWFP.

- The existing large reservoirs are not fully utilized because it is difficult to maintain good water quality when the water does not frequently turn over in the reservoirs. Planning for future reservoirs addresses the need to maintain stored water as fresh as possible.
- To maximize the benefits of the AWS, transmission improvements need to be made for long term operation.
- System redundancy needs to be enhanced so maintenance and improvements can be incorporated without influencing the level of service to customers.

8.3 RESILIENCY

In April 2011 the Oregon State legislature directed the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) to lead and coordinate the preparation of an Oregon Resilience Plan (ORP) to encourage the State decision makers to be better prepared in the event of a major earthquake. OSSPAC completed "*The Oregon Resilience Plan, Reducing Risk and Improving Recovery for the Next Cascadia Earthquake and Tsunami*" (ORP) in February 2013, with recommendations currently being considered for adoption by the State legislature.

Because drinking water supply and fire suppression are critical services, maintaining and restoring service as quickly as possible after a major event is critical. As part of the 2015 Water Master Plan, EWEB developed a Resiliency Plan (EWEB Resiliency Plan), which is included as Appendix A of the 2015 Master Plan. The primary scope of the EWEB Resiliency Plan is to advance the recommendations of the ORP, but also includes other possible hazards including landslides and wildfires. The EWEB Resiliency Plan identifies critical water utility facilities that ultimately need to be hardened to withstand a major earthquake, creating a Resilient Backbone.

The ORP leaves definition of the Resilient Backbone up to each community. EWEB has defined the first priority backbone facilities to be the transmission pipelines connecting the HBWFP to the distribution system and Base Level Reservoirs. Additionally, future facilities including potential base level reservoir sites, an Alternative Water Supply (AWS) on the Willamette River, and the planned transmission pipeline improvements necessary to connect these facilities to the system have been identified as part of the first priority Resilient Backbone. New improvements will be designed to withstand a Cascadia Earthquake and these new facilities will serve to create strength and redundancy in the Base Level System, thereby making the Resilient Backbone more robust.

Based on the recommendations of the EWEB Resiliency Plan, the following projects are the highest priority to strengthen the backbone of the Base Level System:

- Conduct a seismic assessment of the transmission system river crossings and upgrade two of the four crossings,
- Upgrade the Hawkins Hill Reservoir,
- Upgrade the College Hill Reservoir and the Santa Clara Reservoir if integrated into the long term plan for the Base Level system, and
- Implement AWS and complete its integration into the distribution system.

8.4 TRANSMISSION

The existing Base Level transmission system is robust and generally provides adequate capacity to move water from the HBWFP to the reservoirs. A comprehensive assessment of the transmission system was conducted to evaluate operations during both normal operating conditions and during emergency conditions.

8.4.1 Base Level Evaluation Criteria

At a work shop with EWEB staff and West Yost, it was determined that the goal of the Base Level Optimization work is to identify improvements to the Base Level System that will enhance the operations while making the best use of the remaining life of all existing infrastructure. Improvements include both those required for hydraulic reasons, and those required for condition considerations. Enhancement of operations in the Base Level is defined as improving the ability of the Base Level Infrastructure to move water from the HBWFP throughout the Base Level under normal operation within EWEB's design and operational criteria and without the manual intervention of EWEB operations personnel.

The following criteria were developed for optimizing and evaluating the Base Level:

- Modeled all conditions with an Extended Period Simulation (EPS) of 240 hours that allowed dynamic equilibrium to be established.
- Modeled HBWFP at a constant rate that meets the daily demands (existing or future ADD and MDD) for the particular scenario (the following demands include seven percent added for non-revenue water):
  - Existing ADD = 25.7 mgd
  - Existing MDD = 53.9 mgd
  - Future (2035) ADD = 34.9 mgd
  - Future (2035) MDD = 73.4 mgd
- Met daily variations in demands using Base Level storage facilities.
- Ensured that the HB SOP criteria were met:
  - Maintained pressure at the intake of Fairmount 850 Pump Station to be no less than 1.0 pound per square inch (psi). (This criterion was excluded in scenarios for which the Fairmount 850 PS was assumed to be removed from service.)
  - Maintained pressure in the distribution system near Santa Clara Reservoir to not exceed 105 psi.
  - Maintained Base Level Reservoir turnover at greater than 11% turnover daily.
  - Maintained pressure at the intake to the Gillespie Butte Pump Station above 24 psi.
- Maintained minimum pressure of 40 psi under ADD and MDD conditions at service locations.
- Maintained maximum velocity in pipelines 5 feet per second (fps) in transmission pipelines.

8.4.2 Transmission Improvements

Based on this assessment, the following transmission improvements have been identified. These improvements are shown on Figure 8-1.

1. Phase 1 – Transmission System Improvements along 23rd Avenue and Alder Street. The Phase 1 improvements serve to complete the transmission system network, and to better connect the College Hill Reservoir site and potential future storage sites to the transmission systems. The Phase 1 improvements have been divided into two distinct segments. The Phase 1a improvements include 7,500 feet running north-south in Alder Street. The Phase 1b improvements run east-west in 23rd Avenue and total 2,500 feet. In total, the improvements of Phase 1 consist of upsizing to 36-inch diameter pipeline approximately 10,000 feet of pipeline that currently ranges between 12-inches in diameter and 20-inches in diameter. The estimated total capital costs for the Phase 1 Improvements is $8,971,000.
2. Phase 2 – AWS Transmission Integration. The AWS will be located in the area of the Laurel Hill 850 Pump Station, which is fed by a 24-inch diameter transmission main. There is a 2,000 feet segment of 16-inch diameter pipeline that restricts the capacity of this part of the transmission system to effectively integrate the AWS. The Phase 2 improvements consist of replacing the 16-inch diameter pipeline with 24-inch diameter pipeline to complete the backbone connection from the Laurel Hill 850 Pump Station into the transmission system. The estimated total capital costs for the Phase 2 Improvements is $1,263,000.
3. Phase 3 – Transmission System Improvements to Improve Connection of College Hill Reservoir and Hawkins Hill Reservoir. The most direct way to improve the ability of the College Hill Reservoir to fill and drain in concert with the Hawkins Hill Reservoir is to improve the hydraulic connection between the two reservoirs. Such a connection also improves the ability of the distribution system to operate with either the College Hill Reservoir or Hawkins Hill Reservoir out of service for maintenance or repair. The Phase 3 improvements improve this connection by upsizing to 24-inch diameter pipeline approximately 13,600 feet of pipeline from 12-inches in diameter and 16-inches in diameter along 23rd Avenue, Friendly Street, and 18th Avenue. The Phase 3 improvements are not necessary if the College Hill site is not utilized for storage in the future, and the necessity of Phase 3 improvements can be delayed through continuing the manual manipulation of the Base Level. However, as demand increases, the amount of manipulation, and the impacts of that manipulation throughout the Base Level, will increase. The estimated total capital costs for the Phase 3 Improvements is $7,374,000.
4. Phase 4 – Second Phase AWS Transmission Improvements. When the capacity of AWS is increased to 20 mgd, a 36-inch diameter pipeline from the AWS to the Knickerbocker Bridge will be required to tie the AWS into the transmission system. This pipeline along with Phase 1 transmission improvements will allow the AWS to supply the entire distribution system without supply from the HBWFP, assuming that demands in the distribution system are curtailed to the AWS maximum supply of 20 mgd. The combination of the Phase 1 and Phase 4 improvements allows the entire

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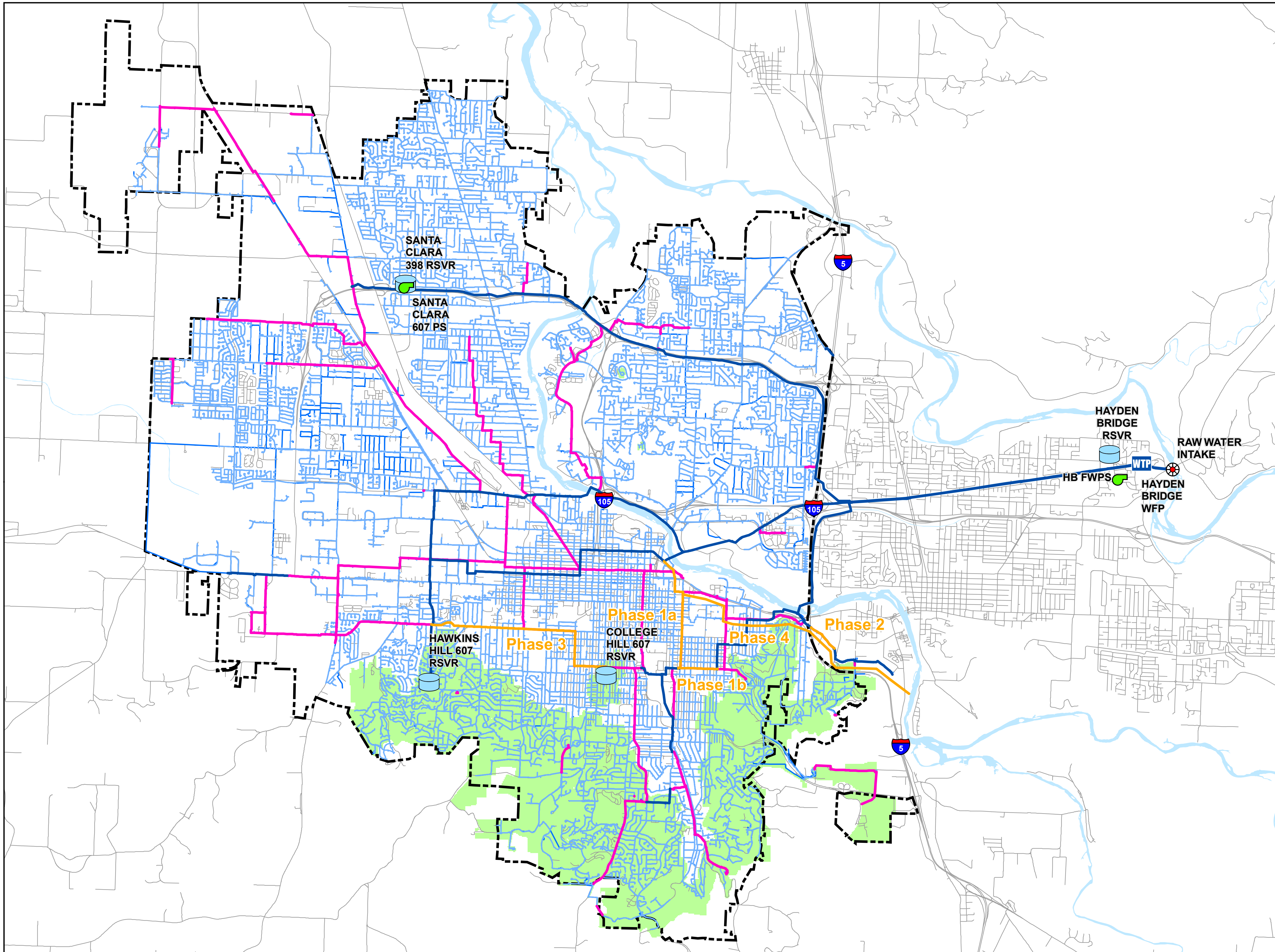
FIGURE 8-1

EWEB
2015 Water Master Plan

BASE LEVEL TRANSMISSION IMPROVEMENT PHASES



N

0 3,000 6,000
Feet

LEGEND

- Water Filtration Plant
- Raw Water Intake
- Pump Station
- Reservoir

Pipeline

- Distribution Main (Less than 16")
- Major Distribution Main (16" - 24")
- Transmission Main (24" and Greater)
- Transmission Improvements
- Upper Service Level
- EWEB Service Area

WEST YOST ASSOCIATES
Consulting Engineers

distribution system to be served from the AWS even if the river crossing at the Knickerbocker Bridge were lost. The estimated total capital costs for the Phase 4 Improvements is $8,433,000.

8.5 BASE LEVEL STORAGE

The existing Base Level storage capacity is summarized in Table 8-1.

Table 8-1. Existing Base Level Reservoir Capacity

Reservoir	Capacity in MG
Hayden Bridge	15
Hawkins Hill	20
College Hill	15
Santa Clara	20
TOTAL	70

A complete assessment of storage is included in Chapter 7. With the implementation of the AWS, the additional reliability provided by the second source will lessen the need for emergency storage. For the Base Level, EWEB should have 50 MG of Storage at existing conditions and will require 60 MG in 2035.

8.5.1 Hayden Bridge Reservoir

The Hayden Bridge Reservoir is relatively new, having been placed into service in 2003, and provides 15 MG of storage to the Base Level. It has an overflow elevation of 585 feet while the overflow elevation of the other Base Level Reservoirs and the service hydraulic grade line (HGL) of the Base Level is 607 feet. Therefore, the Hayden Bridge FWPS is used to provide the required pressure to convey water to the Base Level. Because this reservoir and pump station are a critical part of the system backbone, an on-site standby generator will be necessary. The estimated capital cost for the standby generator and related improvements is $1-2 million.

8.5.2 Hawkins Hill Reservoir

The Hawkins Hill Reservoir, constructed in 1963, provides 20 MG storage for the Base Level. In 2004, EWEB completed the *Hawkins Hill Reservoir Facility Assessment,* which identified structural improvements required for the reservoir. Since this reservoir has been identified as part of the resilient backbone of the system and must remain operational after an earthquake, it is critical to determine how to take this reservoir offline to complete the required improvements while maintaining system operating criteria.

To determine if the Hawkins Hill Reservoir can be taken out of service, the Base Level system was evaluated using existing ADD conditions. If the reservoir is out of service under these conditions, a minimum of 40 psi is maintained in the system except at limited locations at high elevations near the border of the Upper Level System. These are areas that have low pressures because the elevation is too high for full pressure service from the base level. In addition, the pressure at the suction side of the Fairmont 850 PS would be negative so this station should not be operated when Hawkins Hill Reservoir is offline.

In summary, Hawkins Hill Reservoir can be removed from service during ADD conditions (without the improvements required to enhance the performance of the College Hill Reservoir described below). Pressures will need to be monitored near the reservoir location. When the reservoir is offline, Fairmont 850 Reservoir will need to be filled by the Laurel Hill 850 PS. The evaluation also showed that the reservoir cannot be taken out of service under existing or future MDD without significant pressure impacts across the Base Level.

It is recommended that Hawkins Hill Reservoir be divided into two sections to increase the redundancy and resiliency of the reservoir, and so that the reservoir can be repaired and maintained in the future without removing it entirely from service. It is further recommended that the seismic upgrades be prioritized for completion once the reservoir has been divided. The following improvements are required to improve operations and provide redundancy and to strengthen Hawkins Hill Reservoir:

- Complete the required improvements to the Laurel Hill 850 Service Area so that the Fairmount 850 Pump Station can be removed from service. The estimated total capital costs for these improvements is $689,000.
- Partition the Hawkins Hill Reservoir into two operationally separate compartments. The estimated total capital cost for this project is $1,000,000.
- Perform the identified seismic updates for the Hawkins Hill Reservoir, including the installation of a membrane roof system, and repairing wall spalls, beam seat spalls and floor expansion joints. The estimated total capital cost for this project is $922,000.

The capital cost for these improvements is estimated to be $1,927,000, excluding the costs for improvements to the Laurel Hill 850 Service Area which are included in Chapter 9.

8.5.3 College Hill Reservoir

The College Hill Reservoir was constructed in 1939 and provides 15 MG of storage. Under current operations, the College Hill Reservoir does not drain and fill as effectively as the Hawkins Hill Reservoir. Lack of reservoir turnover causes both ineffective use of storage at the reservoir and water quality problems due to water age in the distribution system. To force turnover, EWEB operational personnel increase the flow rate out of HBWFP, sometimes in conjunction with pumping water out of the Santa Clara Reservoir. In addition to these hydraulic challenges, the College Hill Reservoir requires structural improvements to enhance the condition of the reservoir.

The following improvements are required to enhance the condition and performance of the existing College Hill Reservoir:

- Perform seismic upgrades, replacement of expansion joints and concrete pour strips as recommended in the College Hill 607 Reservoir Evaluation, January 10, 2014, by Peterson Structural Engineers, Inc.
- Complete miscellaneous condition improvements as recommended in the College Hill 607 Reservoir Evaluation.
- Construct the Phase 1 Transmission System Improvements.
- Construct the Phase 3 Transmission System Improvements.

With these improvements, the reservoir will be better connected to the Hawkins Hill Reservoir and will operate effectively as base level storage. Seismic and concrete improvements will extend the useful life of the reservoir for 25 years and likely longer. The estimated total capital costs for the above work is $23,018,000.

8.5.4 Santa Clara Reservoir

The Santa Clara Reservoir, constructed in 1976, provides 20 MG of storage at an elevation of 398 feet. Water stored in the reservoir needs to be pumped into the distribution system.

A geotechnical analysis of the Santa Clara site indicated that the soil embankments that support the reservoir liner would not be stable during a major earthquake. The existing pump station which is required to make use of the storage in the reservoir is not serviceable and needs to be replaced.

The following improvements will be required to continue using this reservoir:

- Complete seismic stabilization of the embankment,
- Replace the Santa Clara Pump Station,
- Add standby power at the pump station, and
- Periodically replace the reservoir liner.

The estimated total capital costs for this work is $18,432,000.

8.5.5 Alternative Storage Sites

Suitable locations have been identified to augment or replace storage in the Base Level. These locations must be both geographically suitable (provide sufficient open land for construction that is potentially available to EWEB) and hydraulically suitable. EWEB personnel have identified three potential locations for Base Level storage as being geographically suitable: the Elliott Site, the Gillespie Butte Site, and the Laurel Hill Site.

8.5.5.1 Alternative Storage: Elliott Reservoir

The elevation at the Elliott Site is suitable for constructing a base level reservoir at the same elevation as the Hawkins Hill Reservoir. The following improvements would be required to utilize the Elliott site for Base Level Storage:

- New Elliott Reservoir, and
- Phase 1 Transmission System Improvement.

8.5.5.2 Alternative Storage: Gillespie Butte Reservoir

The Gillespie Butte site is geographically and hydraulically suitable for the construction of a reservoir on the top of the butte. The following improvements would be required to use the Gillespie Butte site for Base Level Storage:

- New Gillespie Butte Reservoir, and
- Install 5,000 feet of new 24-inch pipe installed in a new easement up the south side of Gillespie Butte.

Because EWEB no longer owns the Gillespie Butte site and obtaining approval from the City of Eugene Planning Department could be difficult, the site was considered to not be viable, and the site was not considered in any further alternative analysis.

8.5.5.3 Alternative Storage: Laurel Hill Reservoir

The final site identified as geographically suitable for storage in the Base Level is the Laurel Hill site that is located above the Laurel Hill 850 Pump Station. Although a suitable location exists at this site for a reservoir, the hydraulic analysis found that the hydraulic grade line does not vary adequately at this location to allow a potential reservoir to fill and drain. Therefore the site was not considered in the evaluation of alternatives going forward.

Based on the limitations and constraints associated with the other potential sites, planning in subsequent sections assumes use of the Elliott Site.

8.5.6 Alternatives

The following factors related to the existing storage reservoirs have been considered to define the options that will provide the existing and build-out storage, improve the resiliency of the backbone system and improve the operational characteristics of the system.

- For the Base Level, EWEB should have 50 MG of Storage at existing conditions and 60 MG by 2035.
- All storage reservoirs must be capable of withstanding a major earthquake.
- The present value of future costs is calculated using a four percent discount rate.
- Transmission improvements required for efficient integration of the reservoirs into the Base Level are included in the options.

- Improvements that are common to all of the alternatives are not included in the comparison of present values.

Three alternatives for providing Base Level storage were evaluated:

- Alternative 1 – Upgrade College Hill Reservoir
- Alternative 2 – Upgrade Santa Clara Reservoir
- Alternative 3 – Provide Distributed Storage at Multiple Site

8.5.7 Evaluation of Alternatives

The three alternatives for providing resilient and redundant base level storage are presented below. Since the staging of improvements and future replacement costs are important, the present value of each alternative has been determined and is presented in Table 8-2. The potential advantages and disadvantages of each alternative are summarized below.

8.5.7.1 Alternative 1 – Upgrade College Hill Reservoir

Alternative 1 involves making improvements to the College Hill Reservoir so the reservoir can provide long term service to the Base Level. With this alternative, the Santa Clara Reservoir would be decommissioned. The following improvements are required for Alternative 1:

- Perform seismic upgrades, replacement of expansion joints and concrete pour strips as recommended in the *College Hill 607 Reservoir Evaluation*, January 10, 2014, by Peterson Structural Engineers, Inc.;
- Complete miscellaneous condition improvements as recommended in the *College Hill 607 Reservoir Evaluation;*
- Construct piping improvements to improve reservoir mixing;
- Construct the Phase 1 Transmission System Improvements;
- Construct the Phase 3 Transmission System Improvements;
- Construct 10 MG of storage at the Elliott site (in two phases); and
- Decommission the Santa Clara Reservoir.

The repairs will extend the useful life of the College Hill Reservoir by at least 25 years. At that time, it is assumed that the reservoir will need to be replaced or additional improvements will be required.

The Alternative 1 advantages include the following:

- The present value cost is competitive with other alternatives,
- The site is already being used for storage,
- The alternative utilizes existing storage facilities, and
- The alternative eliminates the Santa Clara Reservoir and Pump Station, saving on the rehabilitation and O&M costs for these facilities.

Disadvantages related to this alternative include:

- The transmission improvements that are required for this alternative will be very disruptive to local streets because both Phase 1 and Phase 3 improvements are required.
- Even with the repairs, the reservoir is 75 years old and is not constructed to current standards and codes.
- No storage will be available north of the Willamette River inside the service area.
- Lack of storage distribution in the Base Level lessens the resiliency of the system.
- Maintaining water quality in a 15 MG reservoir at the College Hill location is difficult.
- Five MG of storage are lost.

The estimated total present worth for Alternative 1 is $32.5 million.

Table 8-2. Present Value of Alternatives With Storage Summary										
Alternatives		Present Value, dollars	Storage at Reservoirs							
			Hayden Bridge	Hawkins Hill	College Hill	Santa Clara	Elliott	AWS	Total
1	Upgrade College Hill Reservoir, Transmission Improvements, Future Elliot Reservoir and Decommission Santa Clara Reservoir	32,456,000	15	20	15	0	10	0	60
2	Upgrade Santa Clara Reservoir, Replace Pump Station, Future Elliot Reservoir and Decommission College Hill Reservoir	29,110,000	15	20	0	20	5	0	60
3	Replace College Hill and Santa Clara Reservoirs with On-Site Reservoirs and AWS Storage, Transmission Improvements and Future Elliot Reservoir	36,625,000	15	20	5	5	10	5	60

8.5.7.2 Alternative 2 – Upgrade Santa Clara Reservoir

Alternative 2 includes upgrading the existing Santa Clara Reservoir and Pump Station for long term storage and operation. With this alternative, the College Hill Reservoir would be decommissioned. The following improvements are required for Alternative 2:

- Construct seismic improvements at Santa Clara Reservoir,
- Replace the existing pump station,
- Provide stand-by power at the pump station,
- Construct a new 5 MG reservoir at the Elliott site,
- Construct the Phase 1 Transmission System Improvements,
- Periodically replace liner, and
- Decommission the College Hill Reservoir

Alternative 2 advantages include the following:

- The present value cost is competitive with other alternatives,
- Improvements can be phased based upon demands and funding,
- The Santa Clara site is already being used for storage,
- Storage is provided north of the Willamette River within the service area, and
- Phase 3 Transmission System Improvements are not required.

Disadvantages related to this alternative include:

- The extent, cost and reliability of the embankment stabilization is uncertain,
- Lack of storage distribution in the Base Level lessens the resiliency of the system,
- Continued pumping from the Santa Clara Reservoir is required,
- The Santa Clara Reservoir is less effective operationally than reservoirs at other locations and elevations,
- Decommissioning the College Hill Reservoir could be a formidable process, and
- A membrane reservoir is vulnerable and not as secure as a concrete reservoir.

The estimated total present worth for Alternative 2 is $29.1 million.

8.5.7.3 Alternative 3 – Distributed Storage

With Alternative 3, both the College Hill and Santa Clara Reservoirs would be replaced with smaller reservoirs in addition to construction of storage at the AWS site. In the future, additional storage would be provided at the Elliott Site. The following improvements are required for this alternative:

- Construct a 5 MG reservoir at College Hill and decommission the existing reservoir,
- Construct a 5 MG reservoir at the AWS facility,
- Construct a 5 MG reservoir and pump station at the Santa Clara Site,
- Construct a 5 MG reservoir at the Elliott Site,
- Construct a second 5 MG reservoir at the Elliott Site, and
- Construct the Phase 1 Transmission System Improvements.

Alternative 3 advantages include the following:

- Distributed storage provides excellent resiliency,
- EWEB owns the sites,
- Existing storage sites are maintained for future service needs,
- Reservoirs will be new and meet code,
- Water quality can be better maintained in the smaller reservoirs,
- Operationally distributed storage is easier to control,
- Phase 3 Transmission Main Improvements are not required, and
- Improvements can be phased based upon demand and funding.

Disadvantages related to this alternative include:

- The present worth is higher than that of the other options.

The estimated total present worth for Alternative 3 is $36.6 million.

8.5.7.4 Summary of Evaluation

While the present worth of Alternative 3 is higher than that of Alternatives 1 and 2, the overall effectiveness of Alternative 3 is superior to the other alternatives. Building distributed storage also allows EWEB to stage improvements based both on capital resources and demand. Most importantly, the resiliency of the system will be enhanced, and all of the investment will be in new structures that have an extended useful life and that meet current seismic codes.

8.6 RECOMMENDED IMPROVEMENTS

The recommended improvements for Alternative 3 are summarized in this section. The improvements are presented on Figure 8-2 and the recommended phasing for this alternative is shown on Figure 8-3.

8.6.1 Transmission Improvements

8.6.1.1 Phase 1

The Phase 1 improvements have been divided into two distinct segments. The Phase 1a pipelines run north-south in Alder Street and Phase 1b improvements run east-west in 23rd Avenue. In total, the improvements of Phase 1 consist of upsizing to 36-inch diameter pipeline approximately 10,000 feet of pipeline. This pipeline should be planned to be operable by the time storage greater than 5MG is developed at the new Elliott Site.

As shown on Figure 8-3, the Phase 1 Transmission Improvements are projected to be completed after the initial phase of distributed reservoir construction. This phasing is recommended in order to allow the more critical reservoir projects to be funded and completed first, while still allowing the transmission improvements to be completed before the second reservoir is brought online at the Elliott Site.

8.6.1.2 Phase 2

Phase 2 improvements (common to all alternatives) consist of replacing 2,000 feet of 16-inch diameter pipeline with 24-inch diameter pipeline. This will complete the backbone connection from the Laurel Hill 850 PS into the transmission system and should be timed to be on line concurrently with AWS.

As shown on Figure 8-3, the Phase 2 Transmission Improvements are projected to be completed in 2021. This phasing is recommended so that the new water supply from the AWS can be hydraulically integrated into the distribution system.

8.6.1.3 Phase 3

These improvements are not required in Alternative 3 because of the small (5 MG) tank required at the College Hill Site under this alternative.

8.6.1.4 Phase 4

When the capacity of AWS is increased to 20 mgd, a 36-inch diameter pipeline from AWS to the Knickerbocker Bridge will be required to tie AWS into the transmission system. This project involves construction of 10,000 feet of 36-inch pipeline but will not be needed until AWS is expanded. Along with the Phase 1 improvements, this pipeline will fully integrate AWS into the transmission system to facilitate service to the entire service area with AWS.

The projected date for completion of this project will depend on the capacity of the AWS and the timing of AWS capacity upgrades.

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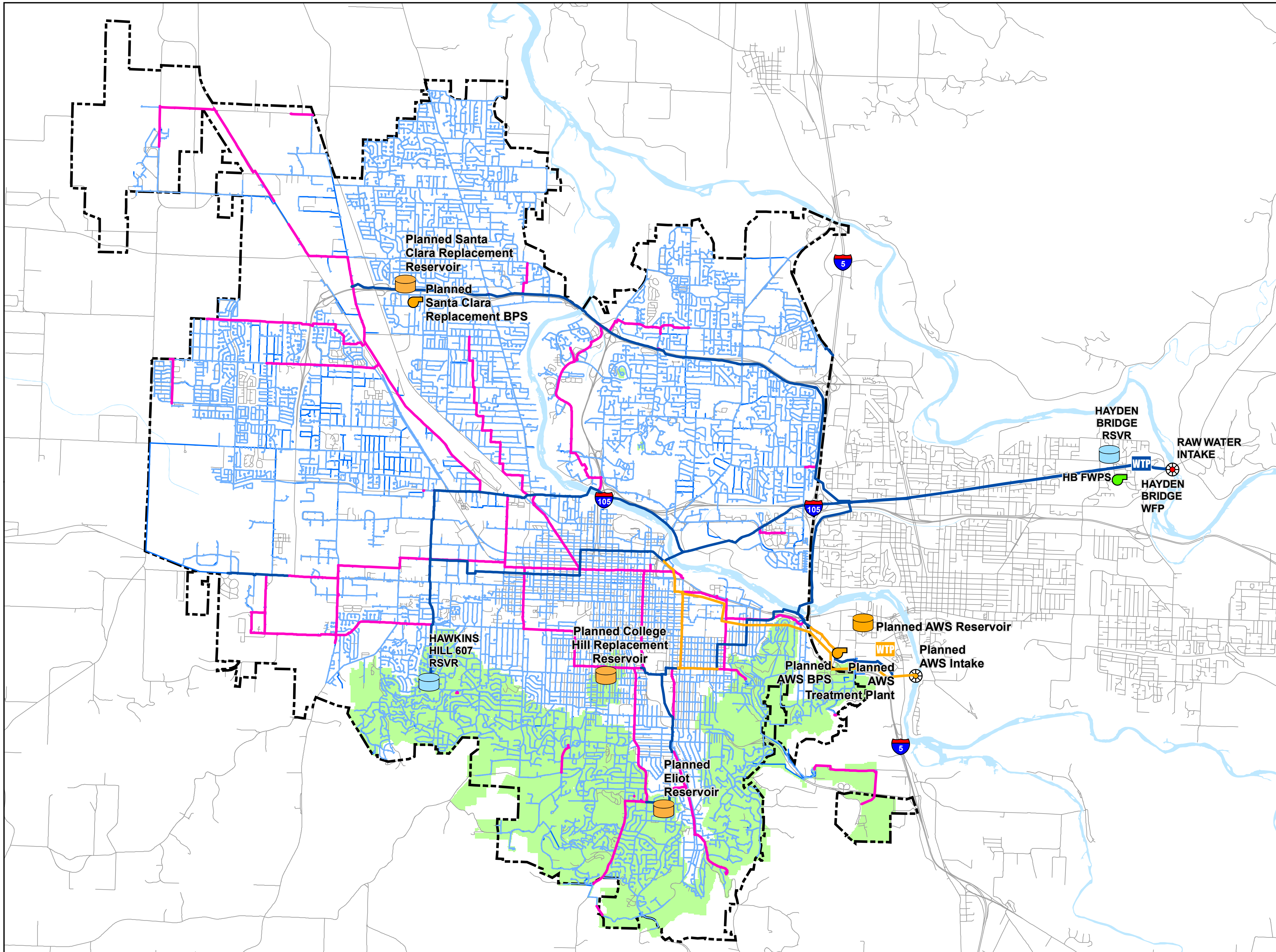
FIGURE 8-2

EWEB
2015 Water Master Plan

ALTERNATIVE 3 RECOMMENDED BASE LEVEL FACILITIES



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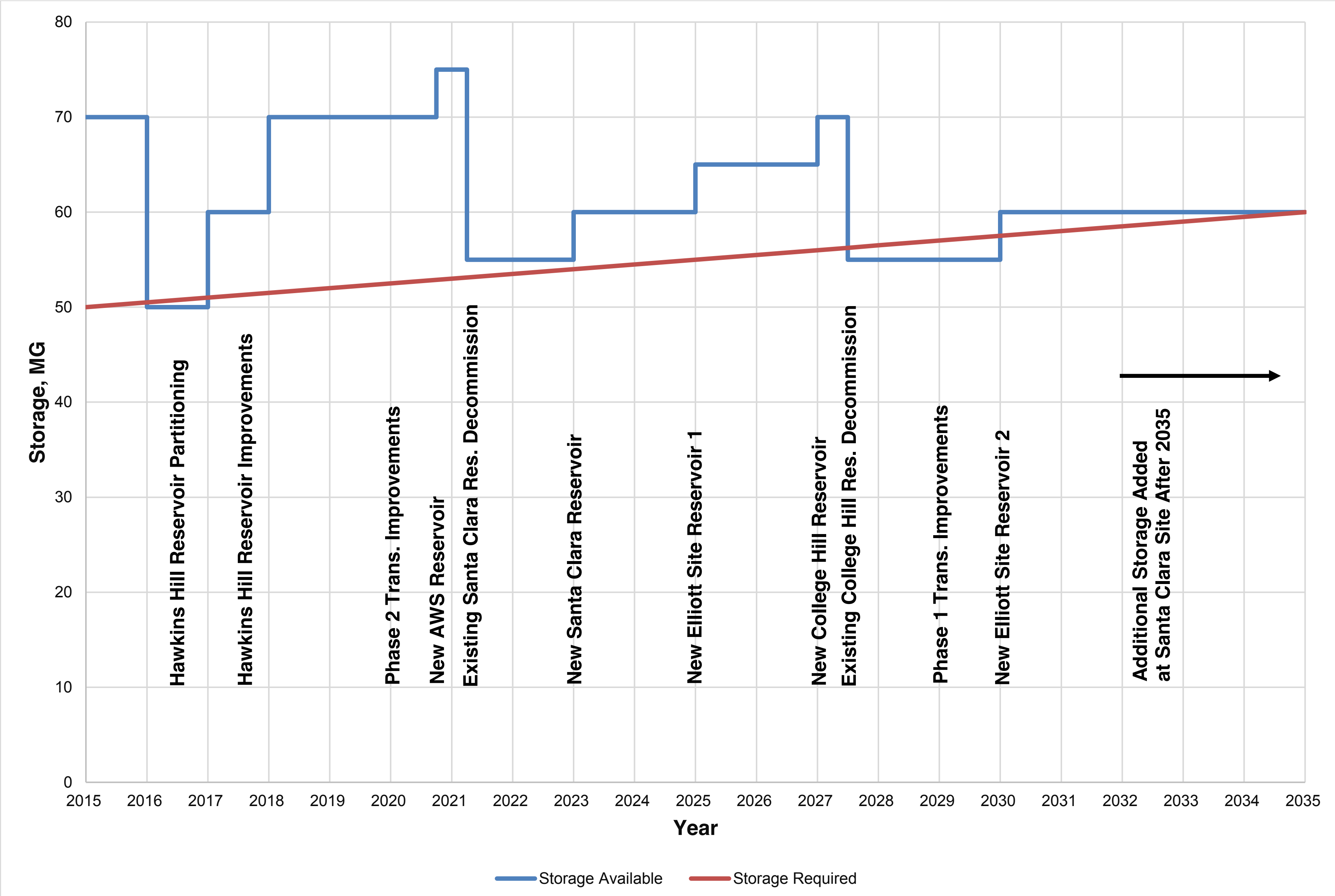

Figure 8-3

Alternative 3 Phasing

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Water System Master Plan

8.6.2 Storage Improvements

8.6.2.1 Perform Hawkins Hill Reservoir Improvements

The first priority at Hawkins Hill Reservoir is to construct a dividing wall so half of the reservoir can be taken out of service. Once EWEB can operate with half of the storage available, the seismic improvement should be constructed. As shown on Figure 8-3, these improvements are prioritized to begin immediately so that the reliability and redundancy of the reservoir is improved.

8.6.2.2 Construct AWS Reservoir

Concurrent with the construction of AWS, a 5 MG reservoir needs to be constructed. As shown on Figure 8-3, this project is projected to be completed by 2021.

8.6.2.3 Decommission Existing Santa Clara Reservoir and Construct New Reservoir

Following completion of the AWS project, the existing 20MG Santa Clara Reservoir and Pump Station can be decommissioned. The site area will then be available to construct a new 5MG reservoir and pump station along with standby power to provide storage in that region of the service area.

8.6.2.4 Construct 5 MG Elliot Reservoir

To provide additional storage in preparation for the decommissioning of the College Hill Reservoir, 5 MG of storage is anticipated to be constructed by 2025.

8.6.2.5 Construct 5 MG at College Hill Reservoir Site and Decommission Existing College Hill Reservoir

Construction of the new College Hill Reservoir will allow EWEB to avoid all upgrading costs at the College Hill Site. As can be seen on Figure 8-3, the existing College Hill Reservoir is to be decommissioned and the new reservoir built around 2028. This phasing prevents the decommissioning of the existing reservoir and its 15 MG of storage from leading to large storage deficits in the Base Level.

8.6.2.6 Future Storage

As storage demands increase in the future, additional storage is anticipated to be constructed at both the Santa Clara and Elliot Sites. .

8.6.3 Summary

The capital cost for the recommended improvements is summarized in Table 8-3. All costs are in July 2015 costs. The phasing for these improvements will depend upon the available funding and will be addressed in the CIP Chapter of the 2015 Master Plan. However, the results of this study show that the improvements to the Hawkins Hill reservoir, including splitting the reservoir into two compartments, should commence as the first project.

Table 8-3. Capital Cost for Recommended Improvement	
Description	Cost
Transmission	
Phase 1 - 10,000 feet of 36-inch Pipeline in 23rd Avenue and Alder Street	$8,971,000
Phase 2 - 2,000 feet of 24-inch Pipeline for AWS Integration	$1,263,000
Phase 4 - 9,400 feet of 36-inch Pipeline for Phase 2 AWS Integration	$8,433,000
Storage	
Hawkins Hill Reservoir Improvements	$1,927,000
Construct 5 MG Reservoir at College Hill	9,370,000
Construct 5 MG Reservoir at AWS Plant	9,370,000
Construct Santa Clara Pump Station	3,072,000
Construct 5 MG Reservoir at Santa Clara	9,370,000
Construct 5 MG Elliott Reservoir	9,370,000
Construct 5 MG Elliott Reservoir- Phase 2	9,370,000
TOTAL	70,516,000

CHAPTER 9
Upper Level System

9.1 INTRODUCTION

EWEB's water distribution system is comprised of the Base Level, which contains the majority of the water demands and water storage within the water distribution system, and the Upper Level System that serves the higher elevations of the distribution system. The Upper level contains service levels (vertical levels based on elevation) and 31 separate service areas (horizontal zones within the service level) that provide water at hydraulic grade lines ranging from 703 to 1325 feet. Chapter 3 "Existing System" provides a summary of the Upper Level System hydraulic grade lines and facilities. The demands for the area are provided in Chapter 4 "Water Demands".

The Upper Level service areas are horizontally separated and are arranged in "ladders", which allows water to be pumped from the Base Level to reservoirs or pump stations at progressively higher service levels. This vertical operation scheme was developed to help operators maintain chlorine residuals in the higher level service areas. However, this operating scheme requires a large number of reservoirs and pump stations because storage is not shared between service areas. Figure 9-1 shows the existing Upper service areas and facilities. Chapter 9 provides a summary of the Technical Memorandum prepared to document the Upper Level System Evaluation, which is included in Appendix 3 of the Master Plan.

9.2 ISSUES WITH THE EXISTING SYSTEM

There are several issues with the existing Upper Level System that include the following:

- A lack of interconnection among service levels limits operational flexibility and can leave a large number of customers without water service if one facility is out of service for either planned or unplanned reasons.
- The operation of the system is complex and requires manipulation by the operators to deliver water from the base level to higher service levels.
- Under the existing configuration of the Upper Level service areas, very little redundancy is included since each service area and each pressure ladder operates independently.
- The Fairmount 850 PS experiences low suction pressures because it is located at too high of an elevation. The entire base level system operation is manipulated to mitigate these low pressures.
- The City View 800 and Summit Terrace 1150 pump stations have an existing pumping capacity deficit.
- The Crest 975 Reservoir has a storage deficit.

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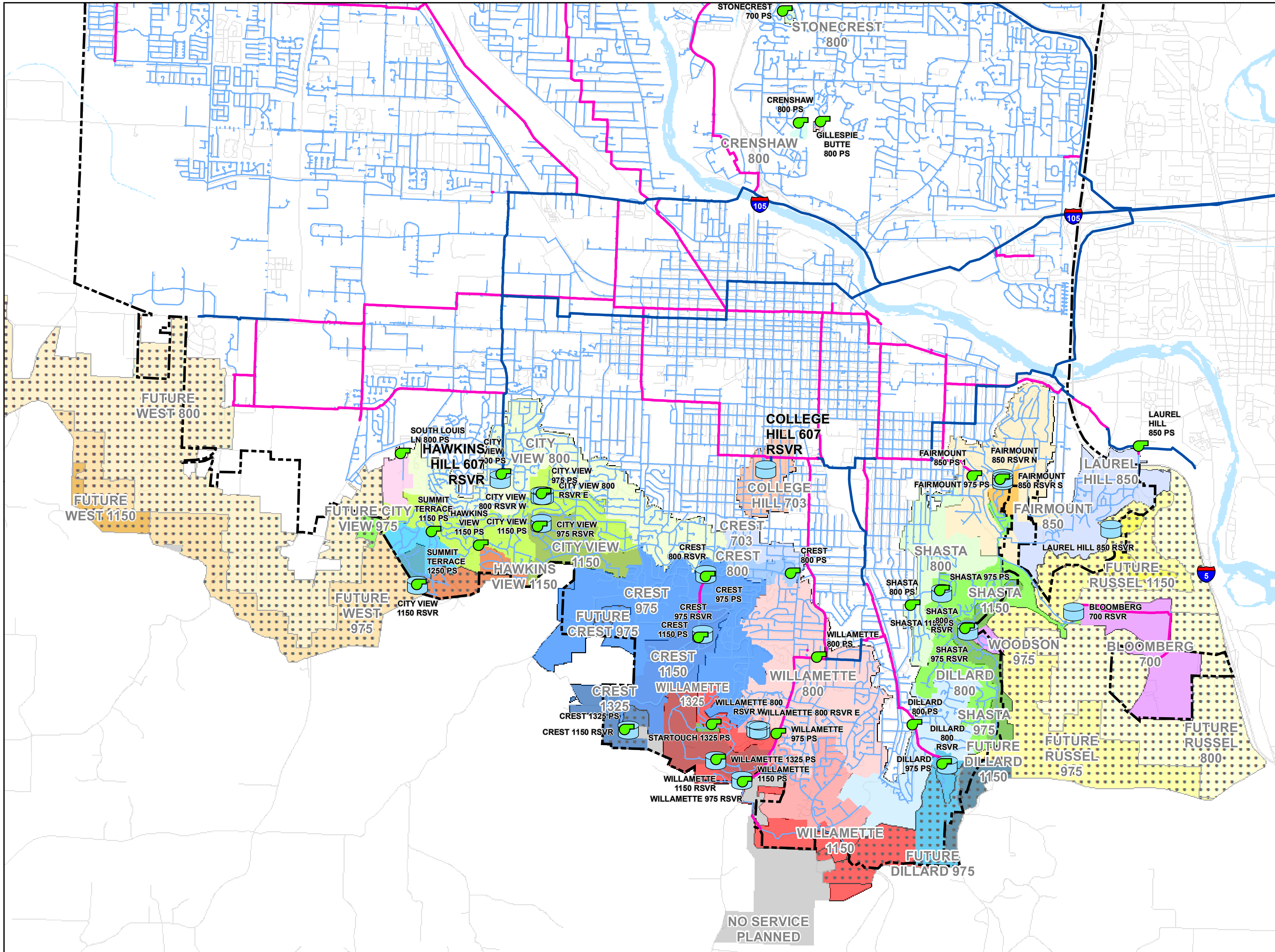

FIGURE 9-1

EWEB
2015 Water Master Plan

UPPER SERVICE AREAS AND FACILITIES

N

0 2,000 4,000
Feet

LEGEND
- Pump Station
- Reservoir
- Distribution Main (Less Than 16")
- Major Distribution Main (16" - 24")
- Transmission Main (24" and Greater)
- Upper Service Areas (Various Colors)
- EWEB Service Area

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- There is no flexibility to provide water to new development above an elevation of 800 without installing large and expensive infrastructure at a high cost to developers.
- The pump stations are all aging and in need of electrical, control, communication, mechanical and structural upgrades.

9.3 UPPER LEVEL SYSTEM OPTIMIZATION OBJECTIVES

The following objectives are the basis for the evaluation that is summarized in this chapter:

- Consolidate service areas to simplify operations, improve system resiliency of the Upper Level so that reservoirs and pump stations that are capable of withstanding an earthquake can serve the maximum area possible.
- The condition of the system must be maintained for reliable service;
- For efficient operation, opportunities to forgo new facilities or abandon existing facilities need to be explored;
- Redundancy and backup between service area and service levels is needed both for unplanned outages and for planned maintenance activities;
- Extension of service to future areas in the Upper Level identified in the Envision Eugene planning process needs to be assessed.
- Provide vertical redundancy between service levels.

Only improvements necessary to accomplish the above objectives are included in the optimization sections. Improvements to harden the second priority backbone facilities and complete condition improvements, discussed later in the chapter, are assumed to be the same for all alternatives and are therefore are include in subsequent sections.

9.4 CONSOLIDATING SERVICE AREAS

The largest service areas provide the best opportunity for horizontal interconnection (connecting areas with the same hydraulic grade line). The largest service areas are the 800, 850, and the 975 service Levels. The evaluation took into account resiliency requirements from the EWEB Resiliency Plan and included evaluating future infrastructure needs.

In addition to the larger service areas, smaller areas were evaluated to determine if improvements in operations could be achieved through connections with other service areas or with improvements within the service areas.

9.4.1 800 Service Level Consolidation

A comprehensive assessment of the 800 service level was completed. Two alternatives were evaluated, consolidating the City View, Crest, Willamette, Dillard, and Shasta 800 service areas, and maintaining the status quo (all systems operated independently). The results are summarized in the following sections.

9.4.1.1 Alternative 1: Consolidating City View, Crest, Willamette, Dillard, and Shasta 800 Service Areas

The first step in determining if the 800 level service areas can be consolidated was to look at the City View, Crest and Willamette 800 Level consolidation. These service areas can be consolidated by opening existing system separation valves between them. A step-by-step analysis for integrating the City View, Crest and Willamette 800 service areas was completed using EWEB's hydraulic model to evaluate operational performance including maintaining appropriate system pressure, water turnover in reservoirs, water balance between reservoirs, and system redundancy. The capacity to provide service to future growth areas was also included in the evaluation. By combining the systems the:

- Pressures in the City View and western parts of the Crest service areas will increase up to 3 psi;
- Water turnover in the Crest Reservoir will improve.

Redundancy and reliability within the 800 service levels can be further increased by connecting the Dillard and Shasta 800 service areas to the combined City View, Crest and Willamette 800 service area, which will allow water to move east and west from the Willamette System to provide service during normal and emergency operations. The following improvements are required for the effective consolidation of these service areas, which are shown on Figure 9-2.

- Installation of 600 feet of 12-inch diameter pipeline at the discharge of the Willamette 800 PS to better connect the discharge to eastern Willamette 800 service area;
- Installation of 4,300 feet of 12-inch diameter pipeline that runs through the Base Level to connect the Willamette and Dillard 800 service areas;
- Installation of 900 feet of 12-inch diameter pipeline to connect the Shasta 800 service area to the Willamette and Dillard 800 service areas,
- Modifications to the operations at the Willamette 800 Pump Station.
- Installation of new level control valves at the Willamette 800 Reservoirs.

9.4.1.2 Alternative 2 Maintain Separate 800 Service Areas

This alternative evaluated the infrastructure improvements required to maintain the status quo. The only changes that will be required are related to both existing and future deficiencies in storage and pumping capacity. The following improvements will be needed to maintain the status quo.

- The Dillard 800 PS will need to be replaced;
- A new Warren 800 Pump Station and Reservoir will be required when the area develops; and
- Implementation of resiliency recommendations will need to be accelerated.

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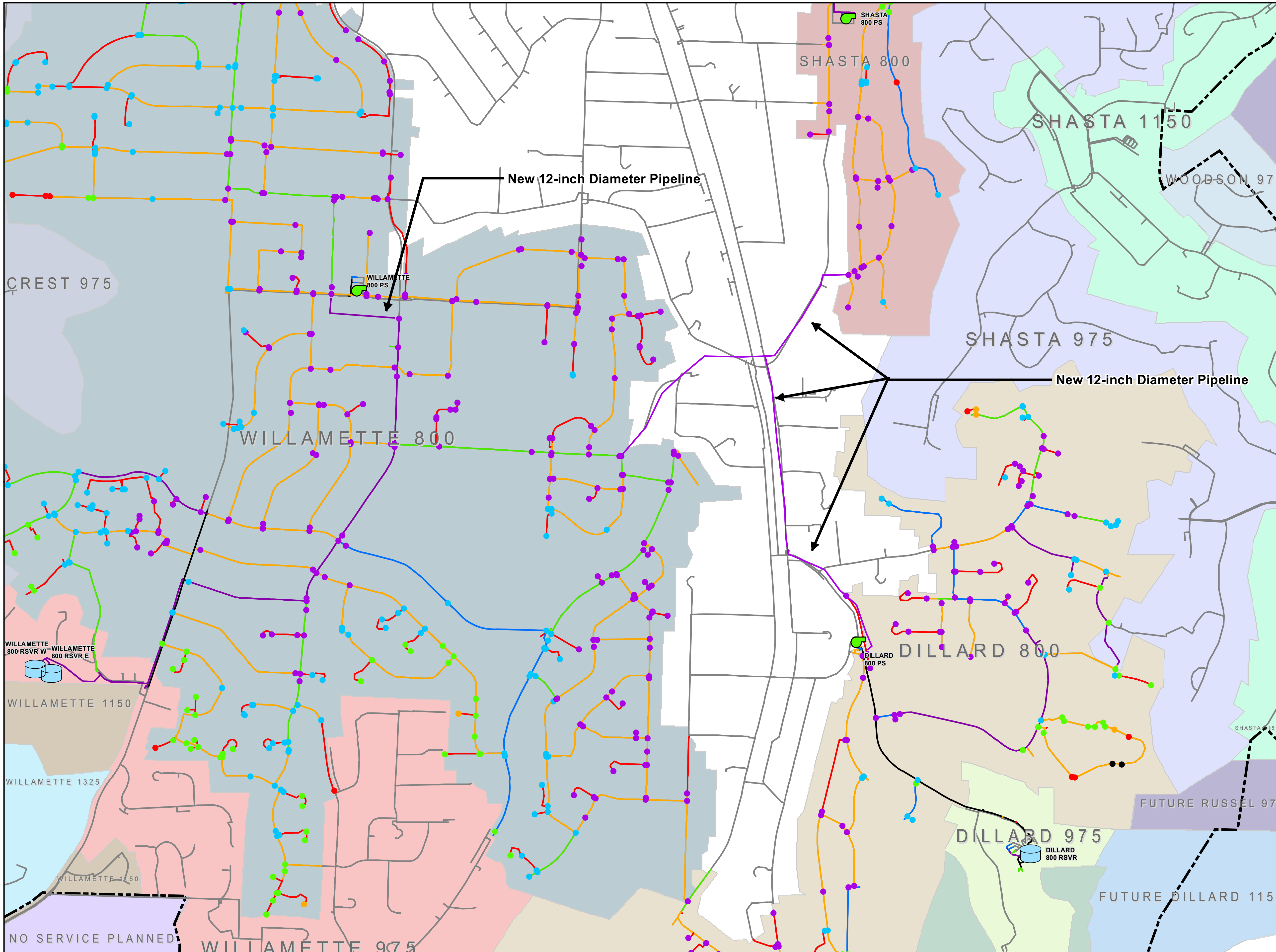

FIGURE 9-2

EWEB
2015 Water Master Plan

WILLAMETTE 800, DILLARD 800, AND SHASTA 800 SERVICE AREAS UNDER FUTURE COMBINED MDD OF 2.17 MGD

N

0 375 750
Feet

LEGEND

- Active Pump Station
- Existing Reservoir
- Less than 20 psi
- 20 - 35 psi
- 35 - 40 psi
- 40 - 60 psi
- 60 - 85 psi
- Greater than 85 psi
- Diameter < 4-inch
- 6-inch
- 8-inch
- 10-inch
- 12-inch
- 16-inch
- EWEB Service Area

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9.4.1.3 Evaluation of Alternatives 1 and 2

The capital cost for Alternative 1, the consolidation of the 800 service level, is shown in Table 9-1.

Table 9-1. Capital Cost for Alternative 1 – 800 Service Area Consolidation

Cost Component	Percent	Cost	Total Cost
600 feet of 12-inch diameter pipeline to connect Willamette 800 BPS to eastern Willamette 800 service area		$139,000	
4,300 feet of 12-inch diameter pipeline to connect Willamette 800 and Dillard 800 service area		$993,000	
900 feet of 12-inch diameter pipeline to connect Shasta 800 and Willamette/Dillard 800 service area		$208,000	
Install level control valve at Willamette 800 Reservoir		98,000	
Construction Contingency Costs	20%	$288,000	
Estimated Construction Cost with Contingencies			*$1,726,000*
Other Project Cost Allowances:			
Design	10%	$173,000	
Construction Management	10%	$173,000	
Administration	8%	$138,000	
Total Project Cost Allowances			$484,000
Estimated Total Capital Cost			**$2,210,000**

The cost for Alternative 2, which maintains the status quo, is shown in Table 9-2.

Table 9-2. Capital Cost for Alternative 2 - Maintain Separate 800 Service Areas

Cost Component	Percent	Cost	Total Cost
Construct 411 gpm Dillard Booster Pump Station		$612,000	
Expand City View BPS		$360,000	
Warren 800 PS and Reservoir		$2,517,000	
Construction Contingency Costs	20%	$194,000	
Estimated Construction Cost with Contingencies			*$3,683,000*
Other Project Cost Allowances:			
Design	10%	$368,000	
Construction Management	10%	$368,000	
Administration	8%	$295,000	
Total Project Cost Allowances			$1,031,000
Estimated Total Capital Cost			**$4,714,000**

The advantages and disadvantages, which include both economic and noneconomic factors, are summarized in Table 9-3 below.

Table 9-3. Summary of Advantages and Disadvantages of Alternative 1 and 2

	Advantages	Disadvantages
Alternative 1 Consolidation of the 800 Level Service Areas	• Alternative is the lowest cost alternative • Improves the ability to take reservoirs and pump stations out of service for maintenance • Eliminates the need for operation of the Dillard 800 PS • Water turnover improves in the reservoirs • Allows for more effective enhancement of system resiliency. If one reservoir is upgraded to meet seismic requirements, a larger service area benefits from the improvement • Allows for extension of service to the Bailey Hill/Gimpl Hill area service area without adding a new pump station reservoir • Improved reliability because service is provided by multiple sources • The existing pump station capacity deficit at the City View 800 PS would be eliminated with the consolidation • Future development on the western edge of the system can be served from the City View Reservoir • The Crest 800 Reservoir can be taken out of service for maintenance and demand and emergency storage can be provided by the City View and Willamette 800 Reservoirs	• Secondary construction impacts associated with pipeline construction • Pump station operations will need to change
Alternative 2 Maintain Separate 800 Service Areas	• No major pipeline construction impacts	• Highest cost alternative. • Requires upgrades of City View PS • Requires replacement and long term operation of the Dillard 800 PS • Requires a new reservoir and pump station when service is expanded to the Bailey Hill/Gimpl Hill areas

9.4.1.4 Recommended Improvements

It is recommended that the 800 level service areas be consolidated.

9.4.2 Evaluation of the 850 service Level

The 850 service level includes the Fairmount 850 and Laurel Hill 850 service areas which are located in the eastern portion of the South Hills. The two systems are currently combined and operate together. In addition, they serve as the main source of supply for the Bloomberg 700 Reservoir.

The Laurel Hill 850 and Fairmount 850 Reservoirs are currently filled by utilizing a combination of the Fairmount 850 and Laurel Hill 850 Pump Stations. Fairmount 850 PS is located at an elevation of 583 feet and consistently operates with low suction pressures. To avoid negative system pressure and pump cavitation, base level operations are managed to maintain at least one psi of suction pressure at the Fairmont 850 PS. The Laurel Hill 850 PS is in good condition and has capacity for future expansion. The 850 Service Level and facilities can be seen on Figure 9-3.

9.4.2.1 Alternative 1 – Fairmount 850 PS Decommissioning

Based on an extended period model run of the two service areas, the Fairmount 850 PS can be decommissioned and the Laurel Hill 850 PS can supply both the Laurel Hill and the Fairmount 850 Reservoirs, while maintaining adequate pressures. However, this would leave a large area with only a single source of supply. To create a redundant source of supply for the reservoirs, a connection to the Shasta 975 service area would be required. The required improvements for Alternative 1 are summarized below.

- Modification of controls at the Laurel Hill PS,
- Installation of level control valves at the Laurel Hill Reservoir;
- Installation of an additional pump at the Laurel Hill PS; and
- Construction of a PRV station to connect the Shasta 975 service area to the combined Fairmont and Laurel Hill 850 service areas.

9.4.2.2 Alternative 2 –Rebuild the Fairmount 850 PS

To maintain the existing operation of the Laurel Hill 850 and Fairmont 850 service areas, the Fairmont 850 PS will need to be replaced. A new site at a lower elevation along with the connecting pipeline would be required. Operation of the two service areas could then continue as with current operations.

9.4.2.3 Evaluation of Alternatives 1 and 2

The capital cost for Alternative 1, decommissioning the Fairmont 850 PS, is shown in Table 9-4.

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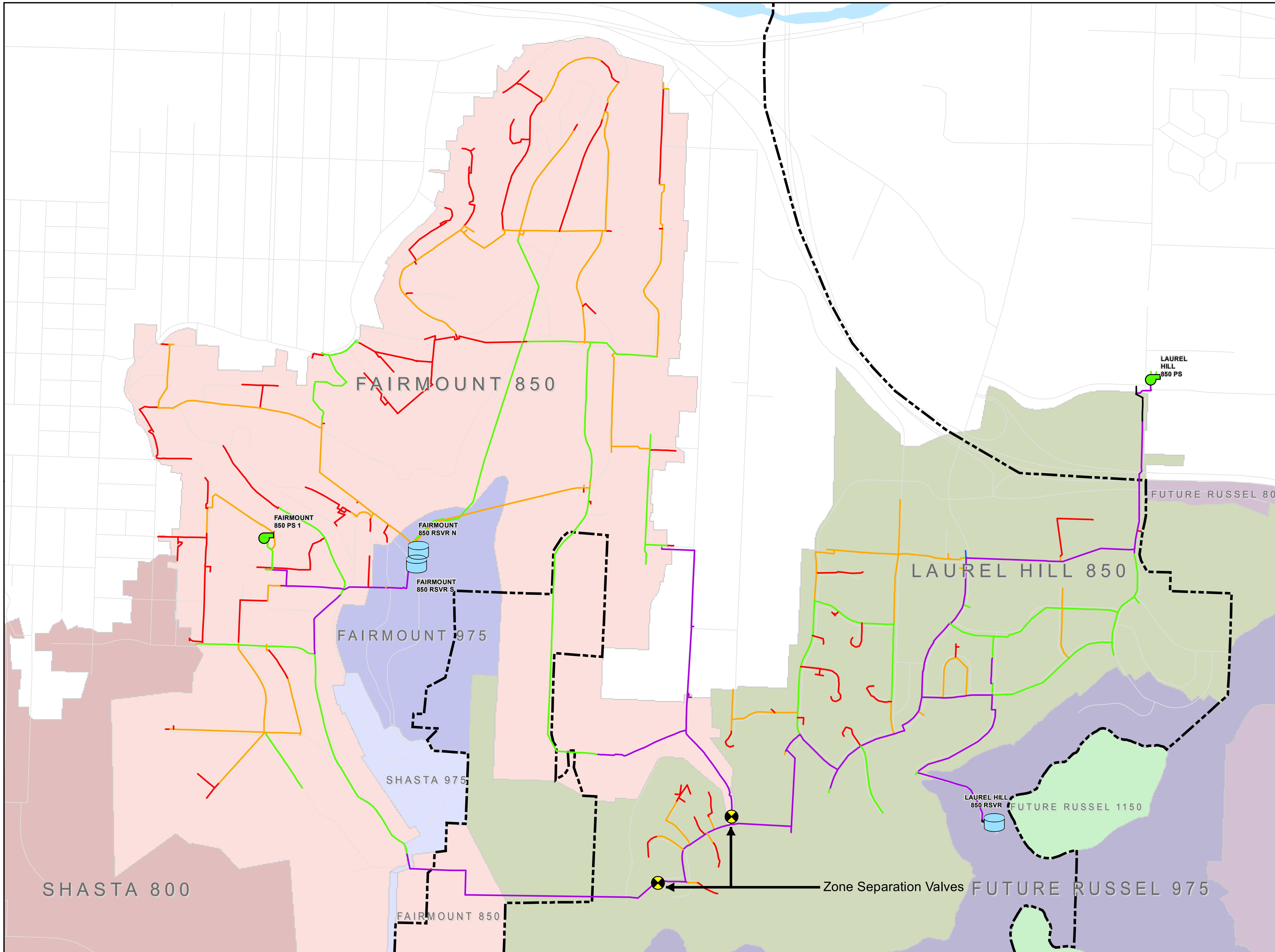

FIGURE 9-3

EWEB
2015 Water Master Plan

FAIRMOUNT AND LAUREL HILL 850 SERVICE AREAS

0 375 750
Feet

LEGEND

- Active Pump Station
- Existing Reservoir
- Diameter < 4-inches
- 6-inch
- 8-inch
- 10-inch
- 12-inch
- 16-inch
- EWEB Service Area

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Table 9-4. Capital Cost for Alternative 1 – Consolidate Fairmount and Laurel Hill 850 Service Areas			
Cost Component	Percent	Cost	Total Cost
New PRV station to Connect Shasta 975 to Laurel Hill/Fairmount 850 for supply redundancy		$98,000	
Additional Pump at the Laurel Hill BPS		$150,000	
Laurel Hill 850 Reservoir Shut-off Valve		$50,000	
SCADA and Telemetry Improvements		$50,000	
Construction Contingency Costs	20%	$70,000	
Estimated Construction Cost with Contingencies			*$418,000*
Other Project Cost Allowances:			
Design	10%	$42,000	
Construction Management	10%	$42,000	
Administration	8%	$33,000	
Total Project Cost Allowances			$117,000
Estimated Total Capital Cost			**$535,000**

The capital cost for Alternative 2, rebuilding the Fairmount 850 PS, is shown in Table 9-5.

Table 9-5. Capital Cost for Alternative 2 – Rebuild the Fairmount 850 PS			
Cost Component	Percent	Cost	Total Cost
Replace Fairmont 850 BPS		$660,000	
Construction Contingency Costs	20%	$132,000	
Estimated Construction Cost with Contingencies			*$792,000*
Other Project Cost Allowances:			
Design	10%	$79,000	
Construction Management	10%	$79,000	
Administration	8%	$63,000	
Total Project Cost Allowances			$221,000
Estimated Total Capital Cost			**$1,013,000**

Table 9-6 summarizes the advantages and disadvantages of the two alternatives.

Table 9-6. Summary of Advantage and Disadvantages for Alternatives 1 and 2

	Advantages	Disadvantages
Alternative 1 Decommission the Fairmount 850 PS	• Eliminates the need for operation of the Fairmont 850 PS • Eliminates a serious operational limitation in the Base Level	• Only one pump station serves both service areas. Backup supply will be provided with a PRV connection to the Shasta 975 service area
Alternative 2 Rebuild the Fairmount 850 PS	• New pump station would meet seismic codes • New Fairmount 850 Pump Station would eliminate a serious operational limitation in the base level	• New Fairmont PS would need to be constructed • EWEB does not own land for a new PS

9.4.2.4 Recommended Improvements

It is recommended that Alternative 1, decommissioning the Fairmount 850 PS be implemented.

9.4.3 Evaluation of the 975 Service Level

There are currently five service areas in the 975 service level including City View, Crest, Willamette, Dillard and Shasta 975. The 975 service areas are shown on Figure 9-4.

Connecting the Dillard and Shasta 975 services areas was determined to be too difficult due to the terrain and the considerable cost for the required pipeline improvements. Therefore the analysis only includes the City View, Crest and Willamette 975 service area integration.

9.4.3.1 Alternative 1 – Consolidation of the City View, Crest, and Willamette 975 Service Area

The City View, Crest and Willamette 975 service areas are adjacent service areas in the south hills that serve customers above the 800 level. The three service areas are separated by existing isolation valves which could be opened to operate these three service areas as a single service area.

Combining the service areas has the following operational results:

- The City View 975, Crest 975, and Willamette 975 PS will all need to be maintained to allow for filling of the reservoirs.
- Consolidation will allow individual reservoirs or pump stations to be taken out of service for short term maintenance activities.
- Minimum pressures decrease slightly in the area with the valves open.

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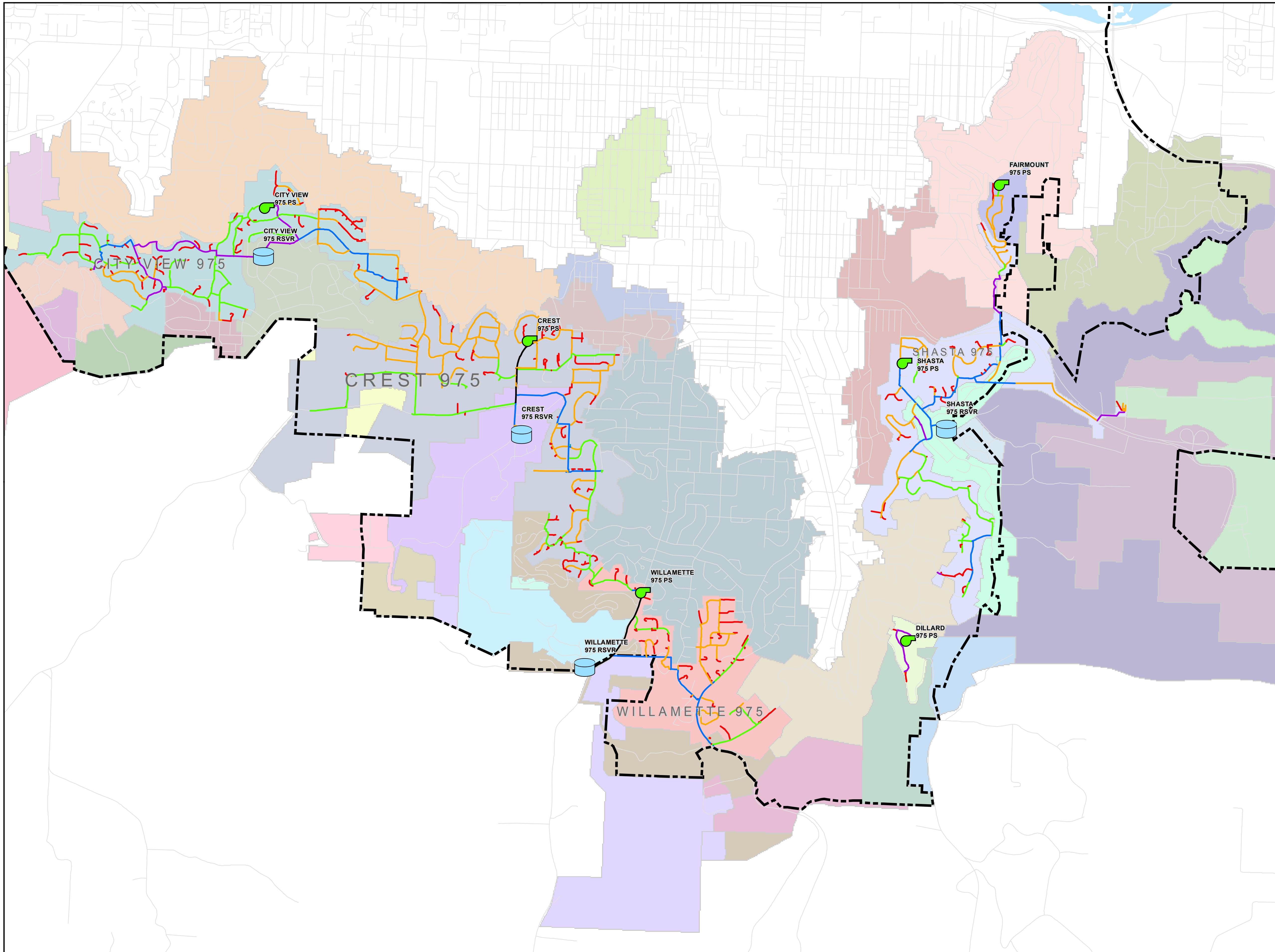

FIGURE 9-4

EWEB
2015 Water Master Plan

975 SERVICE AREAS AND FACILITIES

N

0 625 1,250
Feet

LEGEND

- Active Pump Station
- Existing Reservoir
- Diameter < 4-inches
- 6-inch
- 8-inch
- 10-inch
- 12-inch
- 16-inch
- EWEB Service Area

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- Reservoir operating levels decreases slightly.
- Provides increased reliability and redundancy.

9.4.3.2 Alternative 2 – Maintain Separate 975 Service Areas

Operating the 975 service areas as separate systems, the status quo, does not require any improvements except for upgrades necessary for seismic considerations. Redundancy in the service areas can obtained by manually opening the separation valves following a catastrophic event or when maintenance of a facility is required.

In addition, a modified scenario was evaluated, which included upsizing about 4 miles of 6-10 inch pipelines to new 12-inch pipelines to evaluate if improving transmission would improve zone connectivity. However, the results of the analysis were similar to those discussed above and did not provide any added benefits.

9.4.3.3 Evaluation of Alternatives 1 and 2

No capital improvements are required for either Alternative 1, consolidation of service areas, or for Alternative 2, maintain separate service areas...

The advantages and disadvantages of the two alternatives are summarized in Table 9-7 below.

Table 9-7. Summary of the Advantages and Disadvantages for Alternative 1 and 2

	Advantages	Disadvantages
Alternative 1 Consolidation of 975 Service Areas	• Provides additional redundancy	• There are no performance or operational improvements • Managing water levels and turnover in reservoirs would become more complicated • All 975 level pump stations need to be maintained • Pressures decrease slightly
Alternative 2 Maintain Separate Service Areas	• There is some level of redundancy provided by manually opening valves in an emergency	• Operation needs to be manually manipulated by operators • Valves need to be manually opened during an emergency

9.4.3.4 Recommended Improvements

It is recommended that 975 service areas not be consolidated and operations continue using the existing operating strategy.

9.4.4 Consolidation of the 1150 Service Level

The only service areas that make geographical sense to combine are the Crest 1150 and Willamette 1150 service areas. The remaining 1150 service areas would be difficult because of their location and the terrain. The Crest 1150 and Willamette 1150 Service Areas are shown on Figure 9-5.

Currently the facilities in the Crest and Willamette 1150 service area cannot be taken out of service. If a reservoir is taken offline, the pump stations are converted to a constant run pump station which requires operating the pumps against a throttled butterfly valve. To increase of the ease of performing maintenance and to provide a redundant feed to the service areas, combining the pressure zones was evaluated.

9.4.4.1 Alternative 1 – Crest and Willamette 1150 Service Area Consolidation

Analysis of the two service areas shows that the Crest 1150 service area could be connected to the Willamette 1150 service area and the Crest 1150 PS could then be abandoned. Because this would result in a single source of supply for both the Willamette and the Crest 1150 reservoirs a PRV station would need to be installed between the Willamette 1325 service area and the Crest 1150 service area. The following improvements are required to consolidate these areas:

- 2,000 feet of 12-inch diameter pipeline to connect the two service areas; and
- A PRV station connecting the combined service area with the Willamette 1325 service area as a backup supply.

9.4.4.2 Alternative 2 – Maintain Separate Willamette and Crest 1150 Service Areas

Operation with separate systems could be continued but the Crest 1150 PS will need to be replaced. To accommodate replacement, a PRV connection to the Willamette 1325 service area would be necessary for an alternative supply when facilities are out of service.

9.4.4.3 Evaluation of Alternative 1 and 2

The costs for Alternative 1 and 2 are summarized in Tables 9-8 and 9-9.

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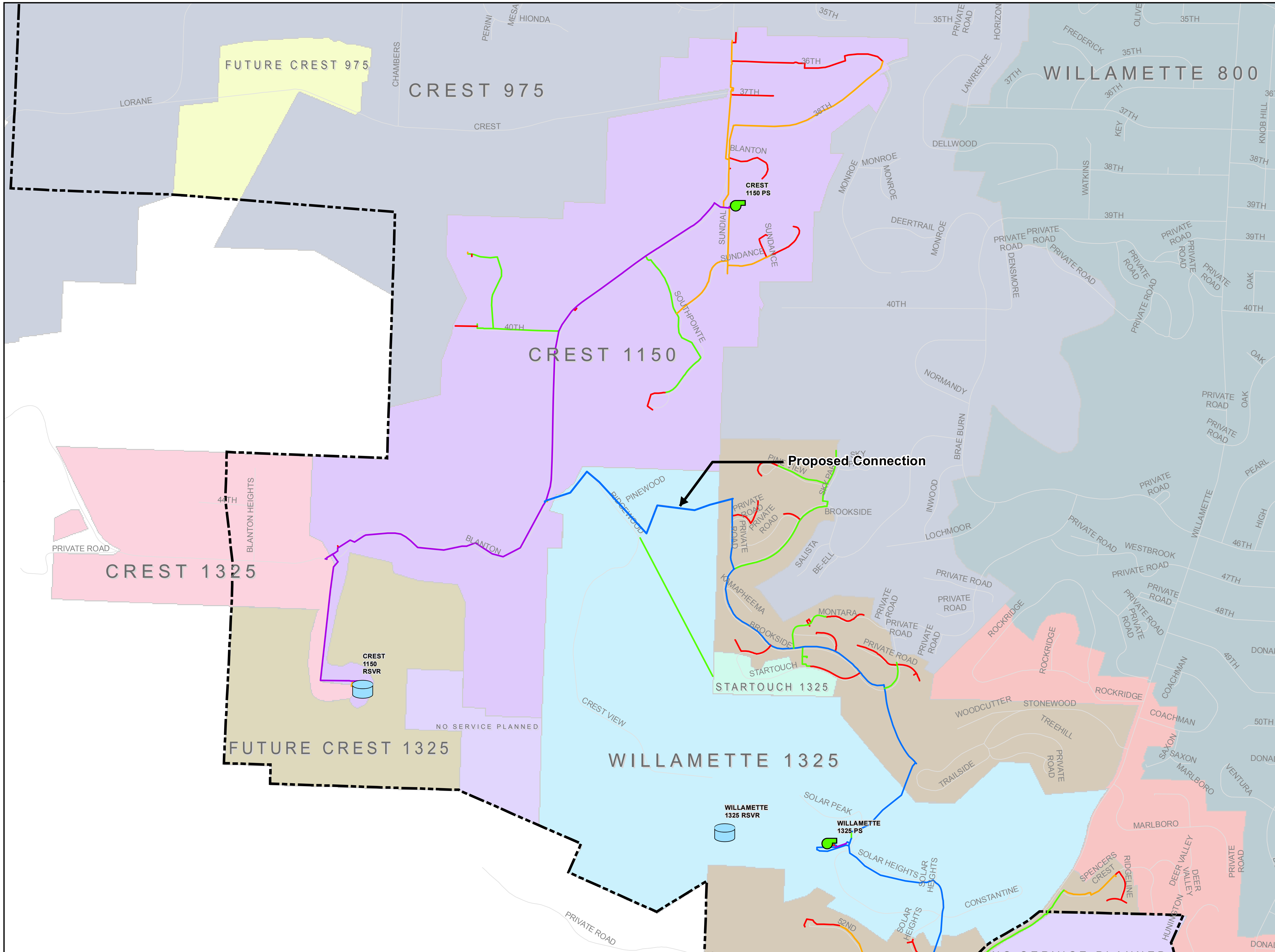

FIGURE 9-5

EWEB
2015 Water Master Plan

WILLAMETTE 1150 AND CREST 1150 SERVICE AREAS

0 375 750
Feet

LEGEND

- Active Pump Station
- Existing Reservoir
- Diameter < 4-inches
- 6-inch
- 8-inch
- 10-inch
- 12-inch
- EWEB Service Area

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Table 9-8. Capital Cost for Alternative 1 – Willamette and Crest 1150 Service Area Consolidation			
Cost Component	Percent	Cost	Total Cost
2000 feet of 12-inch Diameter Pipeline Connecting the Crest 1150 and Willamette 1150		$386,000	
New PRV Connection to Willamette 1325		$98,000	
Construction Contingency Costs	20%	$97,000	
Estimated Construction Cost with Contingencies			*$581,000*
Other Project Cost Allowances:			
Design	10%	$58,000	
Construction Management	10%	$58,000	
Administration	8%	$46,000	
Total Project Cost Allowances			$162,000
Estimated Total Capital Cost			**$743,000**

Table 9-9. Capital Cost for Alternative 2 – Maintain Separate Willamette and Crest 1150 Service Areas			
Cost Component	Percent	Cost	Total Cost
136 gpm Crest 1150 PS		$300,000	
Construction Contingency Costs	20%	$60,000	
Estimated Construction Cost with Contingencies			*$360,000*
Other Project Cost Allowances:			
Design	10%	$36,000	
Construction Management	10%	$36,000	
Administration	8%	$29,000	
Total Project Cost Allowances			$101,000
Estimated Total Capital Cost			**$461,000**

Since the cost for the two alternatives are comparable, non-economic factors are key for selection of the recommended approach. Table 9-10 summarizes the advantages and disadvantages for the alternatives.

Table 9-10. Summary of the Alternatives and Disadvantages for Combining the 1150 Service Area		
	Advantages	Disadvantages
Alternative 1 Consolidation	• Eliminates the need for operation of the Crest 1150 PS • Avoids constructing a new pump station	• Only one pump station serves both service areas. Backup supply will be provided with a PRV connection to the Willamette 1325 service area • Obtaining right-of-way for the new 10-inch diameter pipeline could be difficult
Alternative 2 Maintain Separate Crest and Willamette 1150 Service Areas	• New pump station would meet seismic code	• New Crest 1150 PS would need to be constructed

9.4.4.4 Recommended Improvements

It is recommended that Alternative 2 be implemented.

9.4.5 Willamette 1325 Service Area Improvements

Under current demands, the 350,000 gallon Willamette 1325 Reservoir, which serves the Willamette 1325 service area, does not turn over adequately. The Willamette 1325 service area is adjacent to the Crest 1150 service area and could be connected with a PRV station, at the intersection of Blanton Road and Ridgewood Drive, see discussion above. The Willamette 1325 Service Area can be seen on Figure 9-6.

Installing a PRV station for the purposes of increasing turnover under normal operations in the Willamette 1325 reservoir will result in a decrease in turnover in the Crest 1150 reservoir. However, installing a PRV station for emergency situations (*i.e.* fire flow), would provide additional redundancy and help supplement Crest 1150 under emergency conditions. The estimated capital cost for the PRV station is $151,000.

9.4.5.1 Recommended Improvements

It is recommended that a PRV station be installed to connect the Willamette 1325 and Crest 1150 service areas.

9.5 EXPANSION TO FUTURE AREAS

Several areas for expanding the UGB are being considered by the City of Eugene. The capability to serve these areas has been evaluated. In the Upper Level, two areas have been identified, the Russel basin on the eastern side and the Bailey Hill/Gimpl Hill area to the west.

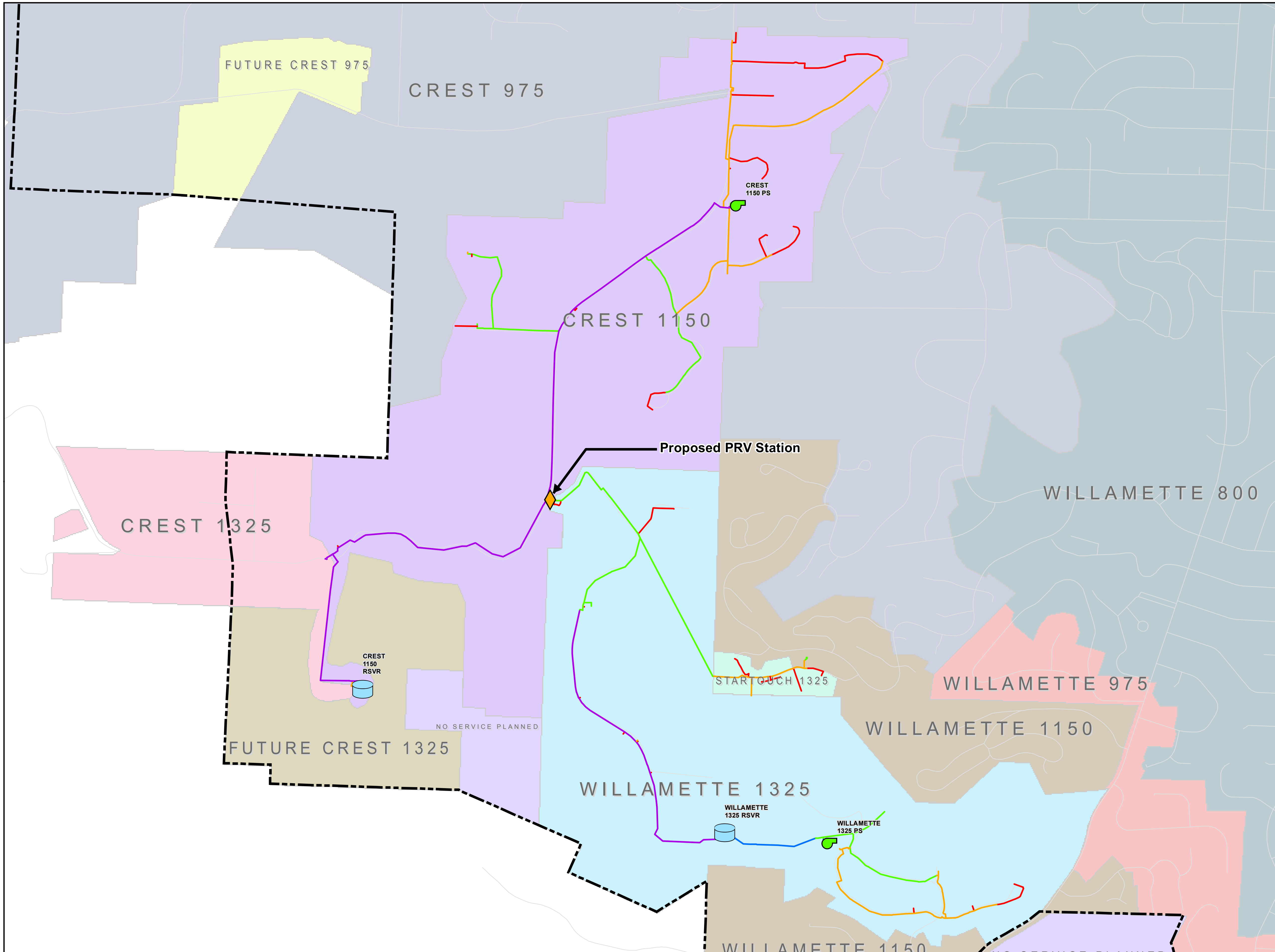

FIGURE 9-6

EWEB
2015 Water Master Plan

WILLAMETTE 1325 AND CREST 1150 SERVICE AREAS

N

0 375 750
Feet

LEGEND
- Active Pump Station
- Existing Reservoir
- Diameter < 4-inches
- 6-inch
- 8-inch
- 10-inch
- 12-inch
- EWEB Service Area

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9.5.1 Russel Basin

The lower elevation areas of the basin can be readily served by the Bloomberg 700 service area facilities if the Bloomberg 700 Reservoir is supplied from the Base Level. The Bloomberg 700 Reservoir will be the base facility for extending service to the higher elevations including the Russel 800 and Russel 975 service areas. When development in the Russel 800 and Russel 975 service areas happens the following infrastructure will need to be constructed:

- 9,850 ft of 24-inch pipe to supply the Bloomberg 700 Reservoir from the base level;
- A new 1,250 gpm Russel 800 Pump Station, 1.25 MG Russel 800 Reservoir and associated piping; and
- A new 500 gpm Russel 975 Pump Station, a 0.50 MG Reservoir and associated piping.

After the Russel 975 service area is developed and the infrastructure to serve it is in place, a connection could be made from this service area to the Shasta 975 service area to provide a second feed. Tables 9-11, 9-12, and 9-13 summarize the estimated cost to improve the Bloomberg 700, Future Russel 800, and Future Russel 975 service levels, respectively. The infrastructure is presented on Figure 9-7.

Table 9-11. Capital Cost for Improvements to Bloomberg 700 Service Area

Cost Component	Percent	Cost	Total Cost
1,250 gpm (1.8 mgd) PS		$900,000	
9,850 feet of 20-inch pipeline, 500 LF assumed to be installed by Jack and Bore		$3,676,000	
Level Shut-off Valve		$50,000	
Construction Contingency Costs	20%	$925,000	
Estimated Construction Cost with Contingencies			*$5,551,000*
Other Project Cost Allowances:			
Design	10%	$555,000	
Construction Management	10%	$555,000	
Administration	8%	$444,000	
Total Project Cost Allowances			$1,554,000
Estimated Total Capital Cost			**$7,105,000**

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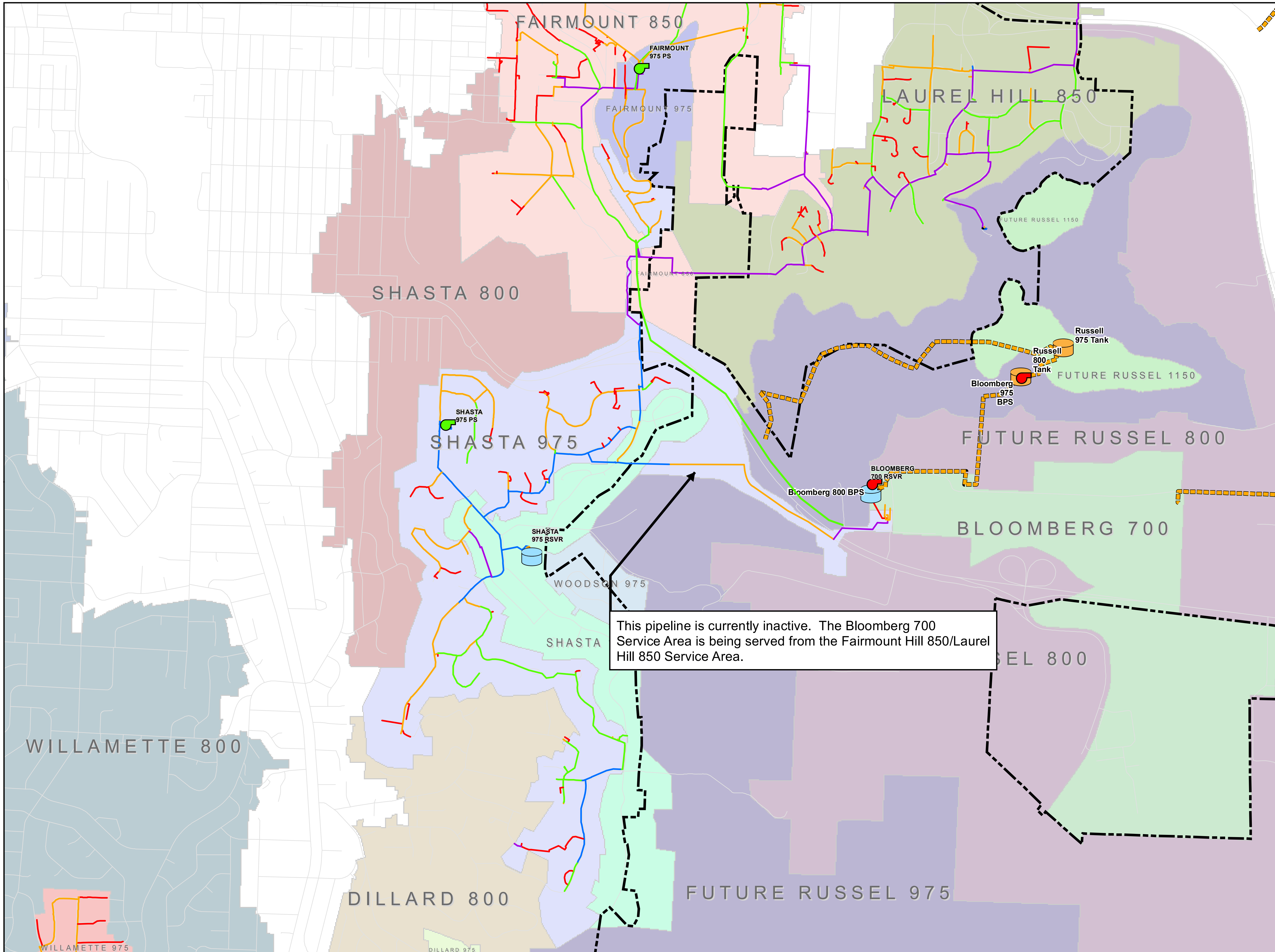
FIGURE 9-7

EWEB
2015 Water Master Plan

RUSSEL AND SURROUNDING 975 LEVEL SERVICE AREAS



N

0 625 1,250
Feet

LEGEND

- Active Pump Station
- Existing Reservoir
- Future Pump Station
- Future Storage Reservoir
- Future Pipeline
- Diameter < 4-inches
- 6-inch
- 8-inch
- 10-inch
- 12-inch
- 16-inch
- EWEB Service Area

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Table 9-12. Capital Cost for New Russel 800 Service Area Facilities			
Cost Component	Percent	Cost	Total Cost
1,250 gpm (1.8 mgd) PS		$900,000	
3,600 feet of 16-inch pipeline		$1,062,000	
1.5 MG Welded Steel Reservoir		$1,700,000	
Construction Contingency Costs	20%	$732,000	
Estimated Construction Cost with Contingencies			*$4,394,000*
Other Project Cost Allowances:			
Design	10%	$439,000	
Construction Management	10%	$439,000	
Administration	8%	$352,000	
Total Project Cost Allowances			$1,230,000
Estimated Total Capital Cost			**$5,624,000**

Table 9-13. Capital Cost for New Russel 975 Service Area Facilities			
Cost Component	Percent	Cost	Total Cost
500 gpm (0.72 mgd) PS		$720,000	
1,000 feet of 12-inch pipeline		$231,000	
0.50 MG Reservoir		$1,500,000	
Construction Contingency Costs	20%	$490,000	
Estimated Construction Cost with Contingencies			*$2,941,000*
Other Project Cost Allowances:			
Design	10%	$294,000	
Construction Management	10%	$294,000	
Administration	8%	$235,000	
Total Project Cost Allowances			$823,000
Estimated Total Capital Cost			**$3,764,000**

9.5.2 Bailey Hill/Gimpl Hill 800 Service Area

Service to this expansion area can be provided by extending the City View 800 service area to the west or by providing a separate service area that is served off the Base Level. These two alternatives are presented in the following sections. The future service area can be seen on Figure 9-8.

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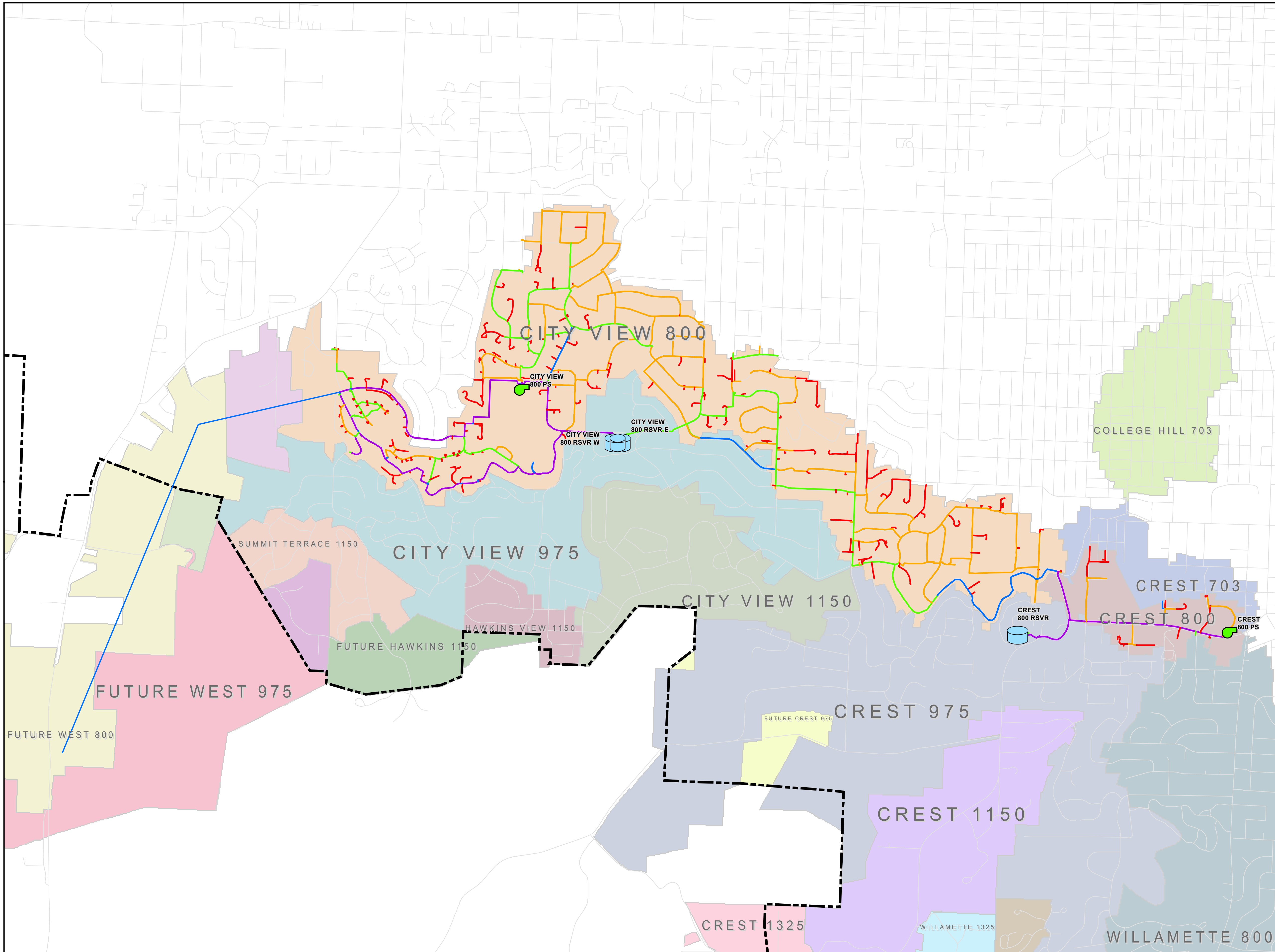

FIGURE 9-8

EWEB
2015 Water Master Plan

FUTURE BAILEY HILL/ GIMPL HILL AREA AND SURROUNDING SERVICE AREAS

LEGEND
- Active Pump Station
- Existing Reservoir
- Diameter < 4-inches
- 6-inch
- 8-inch
- 10-inch
- 12-inch
- 16-inch
- EWEB Service Area

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9.5.2.1 Alternative 1 – Extend 800 Service Level

To extend the consolidated 800 service area to the west, some existing pipelines will need to be replaced with larger diameter pipelines to strengthen and connect the City View 800 service area to the Bailey Hill/Gimpl Hill service area. In addition, a pipeline that extends to the Bailey Hill/Gimpl Hill service area is necessary and the City View 800 PS will need to be expanded. These improvements can be seen on Figure 9-3. The estimated capital cost for the improvements are shown in Table 9-14.

9.5.2.2 Alternative 2 – Separate Bailey Hill/Gimpl Hill 800 Service Area

The Bailey Hill/Gimpl Hill 800 service area could be served off the Base Level with construction of a new Warren 800 reservoir, Warren 800 pump station and connecting pipeline. The capital cost for this alternative is shown in Table 9-11.

9.5.2.3 Evaluation of Alternatives

The estimated capital costs for Alternative 1 and Alternative 2 are shown in Table 9-14 and Table 9-15.

Table 9-14. Capital Cost for Alternative 1 - Extend City View 800 Service Area to Bailey Hill/Gimpl Hill 800 Service Area

Cost Component	Percent	Cost	Total Cost
10,220 feet of 12-inch diameter pipeline		$2,361,000	
2,500 feet of 16-inch diameter pipeline to the Gimpl Hill Area		$738,000	
Expand City View 800 PS		$642,000	
Construction Contingency Costs	20%	$748,000	
Estimated Construction Cost with Contingencies			*$4,489,000*
Other Project Cost Allowances:			
Design	10%	$449,000	
Construction Management	10%	$449,000	
Administration	8%	$359,000	
Total Project Cost Allowances			$1,257,000
Estimated Total Capital Cost			**$5,746,000**

Table 9-15. Alternative 2 – Separate Bailey Hill/Gimpl Hill 800 Service Area			
Cost Component	Percent	Cost	Total Cost
450 gpm PS		$467,000	
1.25 MG Storage Reservoir		$2,050,000	
8,200 feet of 16-inch Pipeline New PS to the Reservoir		$2,419,000	
Construction Contingency Costs	20%	$987,000	
Estimated Construction Cost with Contingencies			*$5,923,000*
Other Project Cost Allowances:			
Design	10%	$592,000	
Construction Management	10%	$592,000	
Administration	8%	$474,000	
Total Project Cost Allowances			$1,658,000
Estimated Total Capital Cost			**$7,581,000**

Table 9-16 summarizes the advantages and disadvantages for each alternative.

Table 9-16. Summary of Advantages and Disadvantages for Bailey Hill/Gimpl Hill Service Area		
	Advantages	Disadvantages
Alternative 1 Serve Bailey Hill/Gimpl Hill from the City View 800 service area	• Lowest cost option • Less infrastructure to construct and maintain • Provides redundancy	• Creates a large service area
Alternative 2 Construct new Reservoir to serve Bailey Hill/Gimpl Hill	• Fits with the status quo	• Highest cost option • Constructs a new large reservoir on the fringes of the system which could cause water quality issues

9.5.2.4 Bailey Hill/Gimpl Hill Service Recommendations

Service to the Bailey Hill/Gimpl Hill area can be provided more economically by extending the 800 service level to the west from the City View 800 service area. This approach will also avoid the need for a new pump station and reservoir.

9.6 CONDITION IMPROVEMENTS FOR UPPER LEVEL SYSTEMS

In addition to improvements for optimized operation and enhanced reliability, EWEB completed a comprehensive evaluation of all 25 pump stations and has completed inspections on the majority of the reservoirs. The following sections summarize the recommendations from the evaluations.

9.6.1 Pump Station Evaluations and Recommendations

In 2013, EWEB completed a seismic evaluation of all of the pump stations. In 2014, EWEB Engineering and Operations personnel conducted field visits to each of the 25 pump stations. The visual inspections documented the condition of the site, mechanical equipment, control equipment, communication and electrical equipment condition. From these inspections it was determined that the following pump stations need to be replaced to remedy mechanical, structural, and electrical issues.

- Willamette 975 PS is an open ended below grade pump station that is prone to flooding. The pump station has significant communication, control system, and electrical issues. In addition, the mechanical equipment is oversized for the demands and has reached the end of its useful life. EWEB owns land behind the pump station for replacement.
- Crest 1150 PS is an open ended below grade pump station that has significant structural issues. Currently the roof rests on a row of cinder blocks and is not tied to the wall. The electrical equipment has reached the end of its useful life. EWEB has sufficient land onsite to construct a new pump station while the old station remains in service.
- Hawkins View 1150 PS is a constant run pump station that works in parallel with the City View 1150 PS. The pumps are undersized for the demands; the station does not have fire flow capacity; and does not include standby power. In addition, it is constructed in a customer's yard. EWEB is obtaining land from a developer to construct a new station that will have capacity to serve both the City View 1150 and the Hawkins View 1150 demands and include full standby power.
- The Crenshaw PS is a constant run pump station that has reached its capacity. New development in the area requires a new Crenshaw PS be constructed with fire flow capability and standby power.

The remaining stations need structural improvements and significant communication, electrical and mechanical upgrades. EWEB has developed a prioritized plan for upgrading these systems. It is recommended that funds be provided in the capital plan on an annual basis to complete these upgrades.

In addition to the above mentioned improvements, work upgrading RTUs with PLCs ahead of the SCADA system upgrade should be continued. This work should include investigating new communication methods between stations and from stations to headquarters. In addition, the SCADA upgrade should be completed to allow for simplified operations.

9.6.2 Reservoir Upgrades

EWEB has been upgrading or building new reservoirs over the last fifteen years. The following reservoirs are new or have been rehabilitated to meet current seismic codes.

- City View 975 Reservoir is a prestressed concrete reservoir has been rehabilitated. The work that was done included removing all the shotcrete and prestressing wires and replacing with new prestressing wires and shotcrete, new inlet/outlet piping was installed and miscellaneous structural upgrades were completed.
- City View 800 Reservoir West is a new prestessed reservoir was constructed in 2001.
- Laurel Hill Reservoir is a new 1.0 MG conventionally reinforced reservoir constructed in 2008. The reservoir meets all current seismic codes.
- Willamette 975 Reservoir is a 1.25 MG prestressed reservoir. A full rehabilitation project was completed in 2009. New prestressing bands were installed around the reservoir, miscellaneous structural improvements were completed, and new inlet/outlet piping was installed.
- Willamette 800 Reservoir West is a prestressed reservoir that is in need to being replaced. In 2015 construction will begin on a new 1.25 MG Willamette 800 Reservoir to bring the site up to current seismic codes in compliance with the recommendations of the resiliency plan.
- Shasta 800 Reservoir: a rehabilitation project for the Shasta 800 Reservoir to fix site issues and complete required seismic upgrades in compliance with the EWEB Resiliency Plan has been budgeted.

It is recommended that the reservoirs be drained and inspected by a civil/mechanical and structural engineer every 5 years. At this time all hatches and ladders should be replaced as required and any minor repairs should be made. If more extensive work is required these projects should be planned for on an as needed basis in the capital improvements plan.

9.7 RECOMMENDED IMPROVEMENTS

The following section summarizes the recommended improvements for the Upper Level System.

9.7.1 Optimization Improvements

Based on the evaluation of alternatives, it is recommended that the 800 and 850 service areas be fully consolidated. In addition, consolidation of the Crest and Willamette 1150 service areas is recommended. The required improvements are summarized in Table 9-17.

Description	Capital Cost
Table 9-17. Recommended Improvements	
600 feet of 12-inch diameter pipeline to connect Willamette 800 BPS to eastern Willamette 800 service area	$214,000
4,300 feet of 12-inch diameter pipeline to connect Willamette 800 and Dillard 800 service area	$1,525,000
900 feet of 12-inch diameter pipeline to connect Shasta 800 and Willamette/Dillard 800 service area	$319,000
Install level control valve at Willamette 800 Reservoir	$151,000
New PRV station to Connect Shasta 975 to Laurel Hill/Fairmount 850 service area	$151,000
Additional Pump at the Laurel Hill BPS	$230,000
Laurel Hill 850 Level Shut-off Valve	$77,000
SCADA and Telemetry Improvements at Laurel Hill 850 BPS	$77,000
2000 feet of 10-inch diameter pipeline connecting the Crest 1150 and Willamette 1150	$461,000
New PRV Connection to Willamette 1325	$151,000
Total Capital Cost	**$3,356,000**

When the UGB is expanded and development in either the Russell or the Bailey Hill/Gimpl Hill areas is initiated, service to those areas will require construction of improvements. For the Russell basin, it is recommended that service be provided off the Bloomberg system which would eventually trigger the projects shown in Tables 9-7 through 9-9. Because the City indicated that this area will not be part of the current expansion, these projects will likely not be needed in the near term.

For the Bailey Hill/Gimpl Hill development, the improvements shown in Table 9-10 are recommended when development of the area begins.

9.7.2 Pump Station Improvement Recommendations

It is recommended that the Willamette 975, Crest 1150, Crenshaw and Gillespie Butte Pump Stations be replaced. It is estimated that each pump station replacement will cost approximately $800,000 including overhead and contingencies.

RTU/PLC upgrades should continue following the plan that was developed. It is estimated that each replacement will cost approximately $100,000.

A new SCADA system should be implemented.

9.7.3 Reservoir Improvement Recommendations

Work should continue upgrade or replacing reservoirs per the list above. Each upgrade is estimated to cost approximately $1,000,000. Specific costs are included in Chapter 11 "Capital Improvements Plan". Inspections and repairs should continue to help maintain the reservoirs and delay large rehabilitation projects.