3. SYSTEMS ANALYSIS

The objective of this chapter is to determine if the existing system facilities are capable of supplying sufficient quality and quantity of water to meet the existing and projected demands identified in Chapter 2. This chapter covers the following water system elements:

- System Design Standards
- Water Quality Analysis
- System Description and Analysis
- Summary of System Deficiencies and Recommended Improvements.

3.1 System Design Standards

The City's water system is a "Group A" public water system because it serves more than 15 residential connections. The City has adopted system design, water quality, and construction standards to ensure that basic public health is protected. These standards are summarized in the following sections.

The City's design and construction standards are described in Chapter 7. A summary of system capacity criteria established and adopted by the City are summarized in Table 3-1. Table 3-2 details the City's facility design standards.

3.2 Water Quality Analysis

The City currently meets all water quality requirements of the Safe Drinking Water Act and its amendments and WAC 246-290 (Appendix 3A).

Initial lead and copper monitoring in the distribution system was conducted in 1993. The monitoring results showed that the 90th percentile copper level exceeded the 1.3 ppm action level. Initial level recording showed that the 90th percentile reading was 2.4 ppm. In 2000 the City installed a new caustic soda injection system at the site of Wells 1 and 2 to raise the water system's pH to a level of 7.2. Initial sampling in September 2000 showed a dramatic decrease in copper levels but the 90th percentile concentration (the concentration for which was exceeded by 10 percent of the samples) still exceeded the 1.3 ppm action level. The amount of caustic soda injected into the system was increased so that the pH level of the water was raised to 7.8. In December 2000, the 90th percentile copper concentration dropped below the 1.3 ppm EPA action level. The City is now in compliance with the lead and copper levels.

The City is required to test its raw water for radionuclides and inorganic, volatile organic and synthetic organic compounds. The City's raw water currently is in compliance with state and federal water quality standards. Copies of the latest test results, as summarized in the City's annual water Consumer Confidence Reports, are included in Appendix 3B of this WSP. Water quality test data for the past 6 years are summarized in Table 3-3. The City has not received any water quality complaints in the past 6 years.

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Table 3-1. System Capacity Analysis Criteria		
Criteria	DOH Water System Design Manual Standards	City of Yelm Standards/Comments
Water quality parameters	Compliance with Safe Drinking Water Act standards and Chapter 246-290 WAC (see Appendix 3A).	Same as DOH.
ADD and MDD	ADD is determined from monthly water use records and indicates the amount of water used in a typical day. MDD represents the highest actual or estimated quantity of water that is, or is expected to be, used over a 24-hour period, excluding unusual events or emergencies.	Same as DOH. Future MDD is estimated as 2.41 times ADD, based on past water production records.
PHD	PHD represents the maximum rate of water use, excluding fire flow, which can be expected to occur within a defined service area over a continuous 60-minute time period. PHD=(MDD/1440)[(C)(N) +F]+ 18, where N= Number of ERUs, C=Coefficient as a function of ERU ranges (=1.6 for water systems of >500 ERUs, such as Yelm) and F= Factor associated with specific ERU range (=225 for water systems > 500 ERUs).	Same as DOH.
Minimum pressure requirement at PHD	Distribution pipelines must be able to deliver water to meet PHD at 30 psi during normal conditions and at least 20 psi during fire flow conditions.	Same as DOH.
Calibrated model results compared to actual field measurements	Variation in pressure should be no more than 10% when comparing the model's calculated results to the actual field measurement.	Same as DOH.
Maximum pipe velocities	DOH recommends that design of distribution mains not exceed a maximum velocity of 8 fps at PHD. Maximum velocities of greater than 8 fps may occur under fire flow conditions, for short sections of mains, or for piping within pump and valve station facilities.	Same as DOH.
Storage	The sum of operational storage, equalizing storage, standby storage, and fire flow storage requirements as per equations listed in the DOH manual.	Same as DOH, with provisions for nesting fire flow and standby storage.

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Table 3-2. Facility Design Standards		
Standard	DOH Water System Design Manual Standards	City of Yelm Standards/Comments
Minimum pipe diameter	Any pipeline designed to provide fire flow must be at least 6" diameter. The minimum size for a transmission or distribution main must be determined by hydraulic analysis.	Same as DOH plus: For all new mains over 50' long, (1) all hydrants in single-family areas shall be supplied by not less than 6" looped water mains or have dead-end water mains of at least 8" diameter; (2) in areas other than single family, 8" looped mains are required.
Backup power	Onsite backup power equipment or gravity standby storage is highly recommended.	The City currently has a generator that is capable of simultaneously operating the pumps in Wells 1 and 2. New sources in the southwest Yelm wellfield will have dedicated backup generators. Future booster pump stations will be required to have backup generators.
Fire hydrant spacing	Not specific.	Set by the City's Development Guidelines (see Chapter 7), sound engineering judgment, and as directed by the City's Public Works Director and local Fire Marshal.
Water valve spacing	As a general rule, valves on distribution mains of 12" and smaller should be located such that a water main length of not more than 1,000' can be isolated by valve closure.	Minimum requirements per DOH and as deemed necessary by City's Development Guidelines, sound engineering judgment, and as directed by the City's Public Works Director and local Fire Marshal. In no case shall there be less than one valve every 1,000'.
Depth of bury	Pipes shall be buried deep enough to be below the frost line event in the hardiest of winters. At a minimum, 36" is required unless justified otherwise by design engineer	The minimum cover for all water mains from top of pipe to finish grade shall be 42" unless otherwise approved.
Separation from non-potable conveyance systems	Water mains should maintain 10' horizontal and 18" vertical separation above sanitary sewers. Design engineer shall refer to Ecology Manual "Criteria for Sewage Works Design" for design variances. Water mains should maintain 5' horizontal and 6" vertical separation above other types of non-potable systems.	Same as DOH.
Telemetry systems	No defined standard.	The City currently uses a "hard-wired" telemetry system. The equipment was industry standard when installed.

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Table 3-3. Consumer Confidence Report- Water Quality Summary										
Contaminant of Concern		Frequency	Results							Maximum Limits
			2002	2003	2004	2005	2006	2007	2008	
Copper		Continuous	2 exceedances	5 exceedances	5 exceedances	One detection at 0.90 mg/L	Not required	Met health standards	Met health standards	MCL: 1.3 mg/L
Lead		Continuous	4 exceedances	2 exceedances	Met health standards	Met health standards	Not required	Met health standards	Met health standards	N/A
Micro-Biological/Bacteriological contaminants		3–6 samples/month at various monitoring points from 2002-2008. In 2009, increased to 10 samples/month.	Met health standards	Met health standards	Met health standards	Met health standards	Met health standards	One unsatisfactory sample. Five repeat samples were satisfactory.	Met health standards	N/A
Nitrates		Annually	Well 1: 1.3	Well 1: 1.8	Well 1: 3.7	Well 1: 4.7	Well 1: N/A	Well 1: 2.4	Well 1: 2.2	MCL: 10 mg/L
			Well 1A: N/A	Well 1A: N/A	Well 1A: N/A	Well 1A: 4.2	Well 1A: 2.8	Well 1A: 2.6	Well 1A: 2.3	
			Well 2: 1.0	Well 2: 1.8	Well 2: 3.7	Well 2: 4.3	Well 2: 2.3	Well 2: 2.3	Well 2: 2.1	
			Well 3: 2.0	Well 3: N/A	Well 3: n/A	Well 3: N/A	Well 3: N/A	Well 3: N/A	Well 3: N/A	
Inorganic full contaminants (IOC)		Minimum of every 3 years	Well 3: < RL	Not required	Not required	Not required	Not required	Well 1A: <MCL Well 2: < MCL	Not required	Well 1: < MCL
Synthetic organic contaminants		Minimum of every 3 years	Not required	Not required	Not required	Not required	Well 1A: ND	Not detected	Well 1A: <MCL	N/A
Radionuclide (Radium 228)	Gross Alpha	Minimum of every 3 years	Well 1&2: ND	Wells 1&2: ND	Results not available	Results not available	Wells 1&2: ND	Well 1A: ND	Results not available	N/A
Radionuclide (Radium 228)	Gross Beta		Well 1&2: ND	Wells 1&2: ND	Results not available	Results not available	Wells 1&2: ND	Well 1A: ND	Results not available	
Volatile organic contaminants (VOCs)	VOCs	Minimum of every 3 years	Well 1: ND Well 2: ND Well 3: ND	Not required	Not required	Not required	Well 1A: ND Well 2: ND	Not required	Well 1A: ND Well 2: ND	N/A
	HAAs		Not required	Not required	6.3 µg/L	8.8 µg/L	Not required	Not required	3.0 µg/L	
	TTHM		Not required	Not required	31.5 µg/L	36.1 µg/L	Not required	Not required	27.1 µg/L	
Chlorine residual		Annual average	Not required	Not required	1.5 mg/L	0.14 mg/L	0.29 mg/L	0.30 mg/L	.32 mg/L	MRDL/MRDLG: 4.0 ppm

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3.3 System Description and Analysis

Figure 1-3 presents a map of the existing water system. This section describes each component of the City water system, including sources, treatment and storage facilities, and the transmission and distribution system. An analysis of the condition and capacity of each component is presented along with an identification of system deficiencies. This section concludes with a description of proposed improvement projects to address these deficiencies. These improvements will be incorporated into the Capital Improvement Program developed in Chapter 8.

3.3.1 Sources

The following section provides a description of the existing conditions, capacities, deficiencies, and proposed improvements for the current water system's sources.

3.3.1.1 Existing Conditions

The City currently owns two groundwater sources that are used to supply the City with potable water. Wells 1A and 2 are located on Second Avenue between Washington and McKenzie Streets. The wells are approximately 30 feet apart and have an average depth of 65 feet. Each well has a 12-inch-diameter well casing and each is protected in an individual well house. Each well has a capacity of 1,200 gpm. The well pumps discharge directly into the Baker Hill tank through a dedicated 8-inch line. Hydraulic conditions in the piping from the wells to the Baker Hill tank limit pumping from the wells so that only one well can operate at any one time when operating at full capacity of 1,200 gpm. The system pressure depends on the water level within the tanks.

Well 2 was drilled to a depth of 61 feet in 1958. The well is constructed with a 12-inch casing and 9 feet of 80-slot, Armco iron well screen. Well testing in 1959 at 1,250 gpm showed 6 inches of drawdown. The pump installed at the time of construction was a 20-horsepower (hp) submersible pump set at a depth of 55 feet below the surface that delivered 255 gpm. In 1987 the original pump was replaced with a Jacuzzi pump and a 25-hp, five-stage Hitachi motor capable of pumping 400 gpm. Well 2 was pump tested on August 14, 2000, at a rate of approximately 1,514 gpm with a measured drawdown of 0.85 foot below the static water level. A letter report summarizing the testing of Well 2 is provided in Appendix 3C. Well 2 was upgraded in 2002 and a new Goulds deep well turbine pump, which has a capacity of 1,200 gpm, was installed.

Well 1A was drilled in 2005. The well is constructed with a 12-inch casing and has 10 feet of 50-slot Johnson screening. The pump is a Goulds model 10DHHC turbine pump with a four-stage pump motor that can pump 1,200 gpm. The well depth is 68.7 feet. A well drawdown test was performed for Well 1A on May 6, 2005, and showed a pumping rate of 1,200 gpm for 90 minutes resulting in a drawdown of only 0.15 foot (see Appendix 3C). Well logs for Well 1 (old source currently used for monitoring adjacent to Well 1A) and Well 2 are also included in Appendix 3C.

Wells 1A and 2 operate on an "on-call" basis using a pressure transducer located at the Public Works reservoir. The telemetry system allows the wells to operate in either auto or manual mode. In auto mode, alternating operation is provided along with simultaneous operation of the wells if the reservoir levels drop to a predetermined level. The well pump operational procedures require alternating operation of Wells 1A and 2 when the tank level of the Public Works reservoir falls to a set point. The Public Works reservoir and the Baker Hill tank are connected by a bypass valve system and piping to the distribution system. A pressure transducer in the Baker Hill tank controls the bypass valve between the two reservoirs. When the water level in the Baker Hill tank is low, the transducer trips the bypass valve, which directs the flow to the Baker Hill tank. Once the Baker Hill tank is full, the bypass valve directs the flow to the Public Works tank through the distribution system piping. The Public Works tank transducer then shuts off the pumps when the tank is full.

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The wells are set to run so that the wells have a resting period between uses on an average day. A control valve installed near the wells allows water to be pumped directly from the wells into the distribution system if pressure at the valve drops below 30 pounds per square inch (psi) if a fire or other event causes low pressure in the system. The valve allows water to be discharged directly into the system, bypassing the storage tank, until the pressure increases to 45 psi.

No evidence has shown that the capacity of the existing sources has decreased with time. Well tests from 1959, 2000, and 2005 all show that pumping capacities of at least 1,250 gpm can be supported in the downtown wellfield with little drawdown. As described below, the City plans to take Wells 1A and 2 out of service over approximately the next 10 years as the southwest Yelm wellfield is developed. The existing wells will still be maintained to allow them to be placed back in service in an emergency. The existing wells are in good condition, with Well 2 having been reconstructed in 2002 and Well 1A having been constructed and placed into service in 2005. No significant work on either of these sources beyond routine maintenance is expected to be necessary over the next 10 years.

3.3.1.2 Capacity Analysis

Currently, Wells 1A and 2 are capable of supplying a combined flow rate of 1,200 gpm. In 2007, per Table 2-6, the MDD was 1.53 million gallons per day (mgd) (1,091 gpm), or 109 gpm less than the existing source capacity on an MDD basis.

Tables 3-4 and 3-5 present calculations of the projected water demands for the next 20 years and the corresponding source capacities for the two development scenarios described in Chapter 2—with and without the development of the MPCs, as described below.

With MPCs

Tables 2-20 and 2-22 show the projected ADD, MDD, and PHD for this scenario and also the estimate of the number of connected ERUs. Table 3-4 converts the projected ADD and MDD to gpm (columns 3 and 4 in the table). This table shows that in 2015 (6-year planning horizon) the projected ADD and MDD are 1,010 gpm and 2,433 gpm, respectively.

Without MPCs

Tables 2-21 and 2-22 show the projected ADD, MDD, and PHD for this scenario and also the estimate of the number of connected ERUs. Table 3-5 converts the projected ADD and MDD to gpm (columns 3 and 4 in the table). This table shows that in 2015 the projected ADD and MDD are 669 gpm and 1,612 gpm, respectively.

3.3.1.3 Source Deficiencies and Proposed Improvements

As long as there is adequate source capacity to meet MDD requirements, there will also be adequate capacity to satisfy ADD. For example, the 2008 ADD requirement of 469 gpm can be satisfied by the existing sources with one well operating for about 9 hours per day.

Tables 3-4 and 3-5 show that the actual MDD for 2009 was 1,214 gpm. The existing MDD source capacity is only 1,200 gpm. Consequently, additional source capacity will need to be constructed as soon as possible, regardless of whether or not the MPCs are developed. The initial increase in source capacity will be provided by completing improvements at the downtown wells. Preliminary estimates are that completion of these improvements will increase the source MDD capacity from 1,200 gpm to 1,700 gpm. This project is expected to be completed in 2010 or early 2011. In the interim, the City has adopted a conservation program for 2010

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Table 3-4. Projected Demands and Source Capacity - (with MPCs)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Projected Demands				Available Source Capacity				
	Projected Annual Demand		Projected ADD	Projected MDD	ADD		MDD		
Year	ac-ft	ERU	gpm	gpm	gpm	ERU	gpm	ERU	Wells in Service
2007	731	3,033	453	1,091	600	4,019	1,200	3,335	2 downtown wells
2008	756	3,140	469	1,130	600	4,019	1,200	3,335	2 downtown wells
2009	812	3,373	504	1,214	600	4,019	1,200	3,335	2 downtown wells
2010	1,085	4,505	673	1,621	975	6,530	1,950	5,419	2 downtown wells+ 1 SW Yelm well
2011	1,187	4,930	736	1,774	1,225	8,205	2,450	6,809	2 downtown wells with improvements+ 1 SW Yelm well
2012	1,301	5,402	807	1,944	1,225	8,205	2,450	6,809	2 downtown wells with improvements+ 1 SW Yelm well
2013	1,410	5,853	874	2,106	1,225	8,205	2,450	6,809	2 downtown wells with improvements+ 1 SW Yelm well
2014	1,519	6,307	942	2,269	1,975	13,228	3,950	10,978	1 downtown well with improvements + 3 SW Yelm wells
2015	1,629	6,762	1,010	2,433	1,975	13,228	3,950	10,978	1 downtown well with improvements + 3 SW Yelm wells
2016	1,747	7,255	1,083	2,611	1,975	13,228	3,950	10,978	1 downtown well with improvements + 3 SW Yelm wells
2017	1,867	7,751	1,157	2,789	1,500	10,047	3,000	8,337	4 SW Yelm well
2018	1,987	8,249	1,232	2,968	1,875	12,558	3,750	10,422	5 SW Yelm well
2019	2,107	8,749	1,306	3,148	1,875	12,558	3,750	10,422	5 SW Yelm well
2020	2,228	9,252	1,381	3,329	1,875	12,558	3,750	10,422	5 SW Yelm well
2021	2,329	9,671	1,444	3,480	1,875	12,558	3,750	10,422	5 SW Yelm well
2022	2,430	10,092	1,507	3,631	1,875	12,558	3,750	10,422	5 SW Yelm well
2023	2,532	10,515	1,570	3,784	2,250	15,070	4,500	12,506	6 SW Yelm well
2024	2,635	10,940	1,633	3,936	2,250	15,070	4,500	12,506	6 SW Yelm well
2025	2,737	11,367	1,697	4,090	2,250	15,070	4,500	12,506	6 SW Yelm well
2026	2,855	11,855	1,770	4,266	2,250	15,070	4,500	12,506	6 SW Yelm well
2027	2,994	12,433	1,856	4,474	2,250	15,070	4,500	12,506	6 SW Yelm well
2028	3,112	12,923	1,930	4,650	2,625	17,581	5,250	14,590	7 SW Yelm well
2029	3,231	13,416	2,003	4,827	2,625	17,581	5,250	14,590	7 SW Yelm well
2030	3,350	13,911	2,077	5,006	2,625	17,581	5,250	14,590	7 SW Yelm well

(1) See Table 2-20. Projected demands for 2008 and 2009 were prepared during initial drafting of this WSP and estimated demands of 819 and 843 ac-ft, respectively. Actual demand measured at the well was 756 ac-ft in 2008 and 812 ac-ft in 2009. Actual data was used when evaluating system capacity from 2007-2009. Projected demands shown in Table 2-20 were used to evaluate capacity from 2010-2030 for the with-MPC scenario.
(2) See Table 2-20. Projected demands for 2008 and 2009 prepared during initial drafting of this WSP estimated demands of 3,400 and 3,502 ERUs, respectively.
(3) Projected annual demand (acre-feet/year) converted to gallons per minute
(4) Projected ADD multiplied by a peaking factor of 2.41
(5) Based on MDD source capacity, assuming available sources pump for 12 hours per day (equivalent to 50% of MDD source capacity)
(6) Calculated total ERUs at 215 gpd/ERU that could be served at corresponding ADD source capacity
(7) Total capacity of all sources
(8) Calculated total ERUs at 215 gpd and a peaking factor of 2.41 that could be served at corresponding MDD source capacity
(9) Downtown well capacity = 1,200 gpm before improvements and 1,700 after improvements, SW Yelm well capacity = 750 gpm (assumed). Source capacity schedule will change depending on actual development patterns.

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Table 3-5. Projected Demands and Source Capacity - (without MPCs)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Projected Demands				Available Source Capacity				
	Projected Annual Demand		Projected ADD	Projected MDD	ADD		MDD		
Year	ac-ft	ERU	gpm	gpm	gpm	ERU	gpm	ERU	Wells in Service
2007	731	3,033	453	1,091	600	4,019	1,200	3,335	2 downtown wells
2008	756	3,140	469	1,130	600	4,019	1,200	3,335	2 downtown wells
2009	812	3,373	504	1,214	600	4,019	1,200	3,335	2 downtown wells
2010	796.66	3,308	494	1,190	600	4,019	1,200	3,335	2 downtown wells
2011	904	3,754	561	1,351	850	5,693	1,700	4,725	2 downtown wells with improvements
2012	952	3,951	590	1,422	1,225	8,205	2,450	6,809	2 downtown wells with improvements+ 1 SW Yelm well
2013	994	4,126	616	1,485	1,225	8,205	2,450	6,809	2 downtown wells with improvements+ 1 SW Yelm well
2014	1,036	4,302	642	1,548	1,225	8,205	2,450	6,809	2 downtown wells with improvements+ 1 SW Yelm well
2015	1,079	4,479	669	1,612	1,225	8,205	2,450	6,809	2 downtown wells with improvements+ 1 SW Yelm well
2016	1,134	4,709	703	1,694	1,600	10,716	3,200	8,893	1 downtown wells with improvements+ 2 SW Yelm well
2017	1,190	4,940	738	1,777	1,600	10,716	3,200	8,893	1 downtown wells with improvements+ 2 SW Yelm well
2018	1,245	5,172	772	1,861	1,125	7,535	2,250	6,253	3 SW Yelm well
2019	1,302	5,405	807	1,945	1,125	7,535	2,250	6,253	3 SW Yelm well
2020	1,358	5,639	842	2,029	1,125	7,535	2,250	6,253	3 SW Yelm well
2021	1,406	5,839	872	2,101	1,125	7,535	2,250	6,253	3 SW Yelm well
2022	1,455	6,040	902	2,173	1,125	7,535	2,250	6,253	3 SW Yelm well
2023	1,503	6,242	932	2,246	1,125	7,535	2,250	6,253	3 SW Yelm well
2024	1,552	6,445	962	2,319	1,500	10,047	3,000	8,337	4 SW Yelm well
2025	1,601	6,649	993	2,393	1,500	10,047	3,000	8,337	4 SW Yelm well
2026	1,666	6,918	1,033	2,489	1,500	10,047	3,000	8,337	4 SW Yelm well
2027	1,752	7,274	1,086	2,617	1,500	10,047	3,000	8,337	4 SW Yelm well
2028	1,816	7,542	1,126	2,714	1,500	10,047	3,000	8,337	4 SW Yelm well
2029	1,881	7,812	1,166	2,811	1,500	10,047	3,000	8,337	4 SW Yelm well
2030	1,947	8,083	1,207	2,908	1,875	12,558	3,750	10,422	5 SW Yelm well

(1) See Table 2-21. Projected demands for 2008, 2009, and 2010 were prepared during initial drafting of this WSP and were estimated to be 819, 843, and 868 ac-ft, respectively. Actual demand was 756 ac-ft in 2008 and 812 ac-ft in 2009. In 2010, a conservation program was developed with a projected demand of 796.66 ac-ft for 2010. Actual data and the revised 2010 projection were used when evaluating system capacity from 2007-2010; demand projections shown in Table 2-21 were used to evaluate capacity from 2011-2030.
(2) See Table 2-21. Projected demands for 2008, 2009, and 2010 prepared during initial drafting of this WSP estimated demands of 3,400, 3,502, and 3,603 ERUs, respectively.
(3) Projected annual demand (acre-feet/year) converted to gallons per minute
(4) Projected ADD multiplied by a peaking factor of 2.41
(5) Based on MDD source capacity, assuming available sources pump for 12 hours per day (equivalent to 50% of MDD)
(6) Calculated total ERUs at 215 gpd/ERU that could be served at corresponding ADD source capacity
(7) Total capacity of all sources
(8) Calculated total ERUs at 215 gpd and a peaking factor of 2.41 that could be served at corresponding MDD source capacity
(9) Downtown well capacity = 1,200 gpm, SW Yelm well capacity = 750 gpm (assumed)

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which limits irrigation usage and reduces demand on the water system. A complete description of this conservation program is provided in Appendix 4H. The charts and tables in this chapter show the revised anticipated demand for 2010 is 1,190 gpm for the without-MPCs scenario, just below the source capacity of 1,200 gpm.

As water demands continue to increase, additional capacity will be provided through the development of sources in the southwest Yelm wellfield. The timeline for the development of these new wells and the concurrent transfer of water rights from the existing wells to meet these demands and provide sufficient source capacity was initially described in the City's Water Right Mitigation Plan (see Chapter 4 and Appendix 4E). The timeline in the Mitigation Plan has been further developed in this WSP so that the construction of new wells will be timed to provide adequate source capacity for the without-MPCs scenario. For the "with MPCs" scenario, the schedule for source capacity development will change depending on actual development patterns.

Tables 3-4 and 3-5 (columns 5–8) show the available source capacity that would be achieved as the wells are developed according to the following schedules and the corresponding number of ERUs that could be served with this capacity. The schedules for the construction of these improvements were developed so that there would always be adequate source capacity available. Before development begins in the MPCs, the "with MPCs" scenario and development schedule will be re-evaluated through an update to this WSP. As described in the Mitigation Plan, it is assumed that the wells in southwest Yelm will each have a capacity of 750 gpm.

Figures 3-1 and 3-2 present the information from Tables 3-4 and 3-5 as graphs of projected demand, in terms of connected ERUs, and the MDD source capacity that will be achieved as new sources are constructed. These graphs show that the schedule for development of new sources will result in adequate source capacity being achieved if demand does not exceed the conservative projections developed as part of this WSP.

3.3.1.4 Schedule for Well Development and Water Rights Actions (with MPCs)

Year[1]	Well Development and Water Rights Actions	Projected MDD (gpm)	Source MDD Capacity (gpm)
2010	Projected annual demand is 1,085 ac-ft, exceeding the available water rights of 796.66 ac-ft. Completion of the construction of Southwest Yelm Well 1A is assumed, along with securing Phase 1 water right of 554 ac-ft. The sequence for securing new water rights and transferring existing water rights is presented in Section 4.3.	1,621	1,950
2011	Projected annual demand is 1,187 ac-ft (4,930 ERUs). The downtown well improvement project is completed and an additional 152.59 ac-ft of water rights are acquired.	1,774	2,450
2014	Projected demand of 1,519 ac-ft (6,307 ERU) exceeds water rights. Construction of two new wells (SW Yelm Wells 2 and 3) would be required to make up for one downtown well being taken out of service as part of mitigation plan. Resulting source capacity = 3 x 750 gpm + 1700 gpm = 3,950 gpm. Water rights consist of 554 ac-ft transferred from downtown wells for SW Yelm 2 and 554 ac-ft in new water rights secured for SW Yelm 3.	2,269	3,950
2015	Last year of the 6-year planning horizon.	2,433	3,950
2017	Construction of the next Southwest Yelm well (Well 4) is required to provide adequate source capacity after remaining downtown well is taken out of service. Water rights come from transferring balance of downtown well water right of 395.25 ac-ft and securing 158.75 ac-ft in new water rights.	2,789	3,000
2018	Southwest Yelm Well 5 is required to provide adequate source capacity. An additional new water right of 554 ac-ft is secured.	2,968	3,750
2023	Southwest Yelm Well 6 is required to be put into service to meet MDD. An additional new water right of 554 ac-ft is secured.	3,784	4,500
2028	Southwest Yelm Well 7 is required to be put into service to meet MDD. An additional new water right of 554 ac-ft is secured.	4,650	5,250
2030	Remainder of pending Water Right application G2-29084 is secured as part of Phase 4 water right. Total available water rights equal 3,949.25 ac-ft.	5,006	5,250

[1] *This schedule assumes the development of the MPCs beginning in 2010. The schedule will change depending on actual development patterns and demands.*

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Figure 3-1
Source Capacity in ERUs (with MPCs)

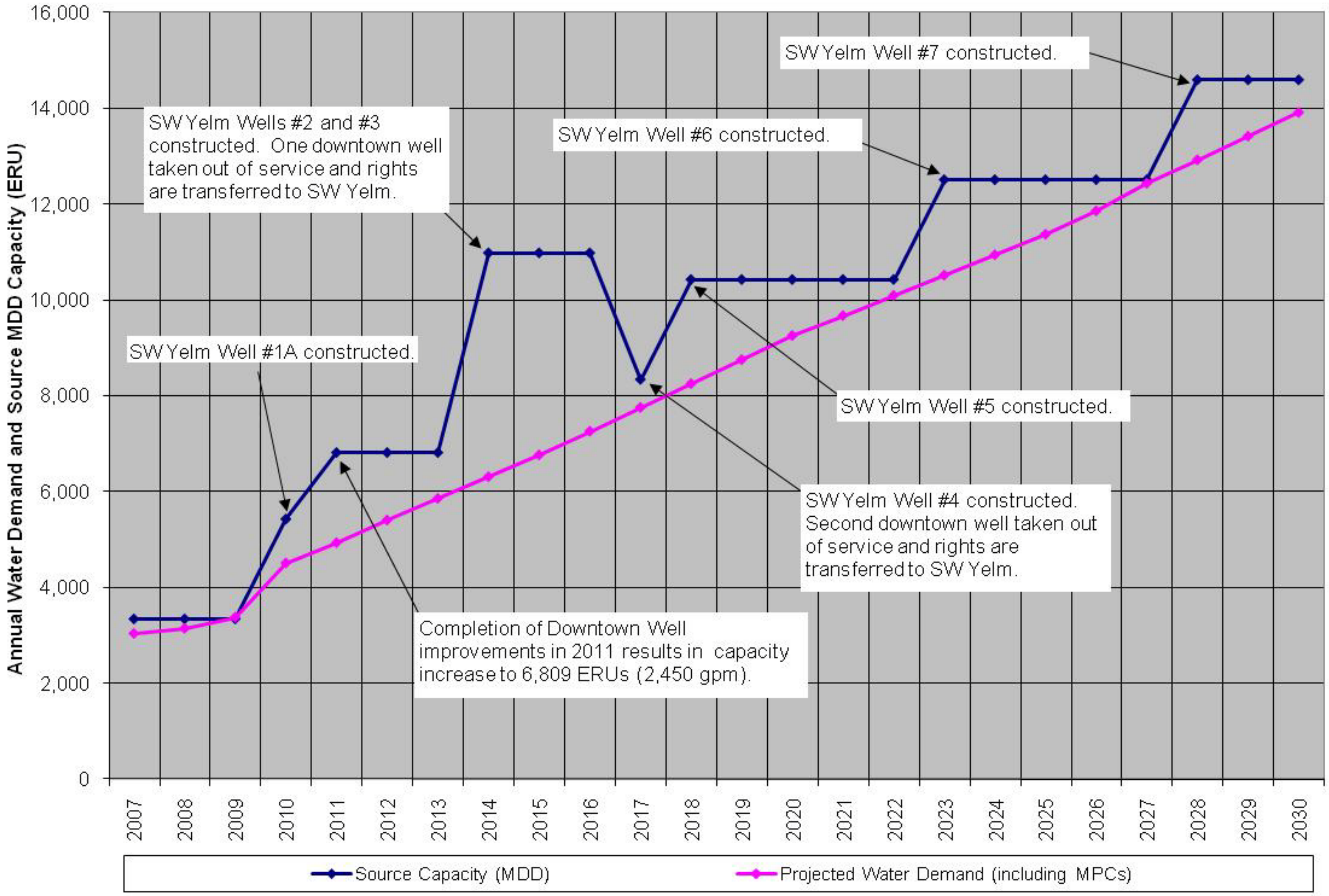

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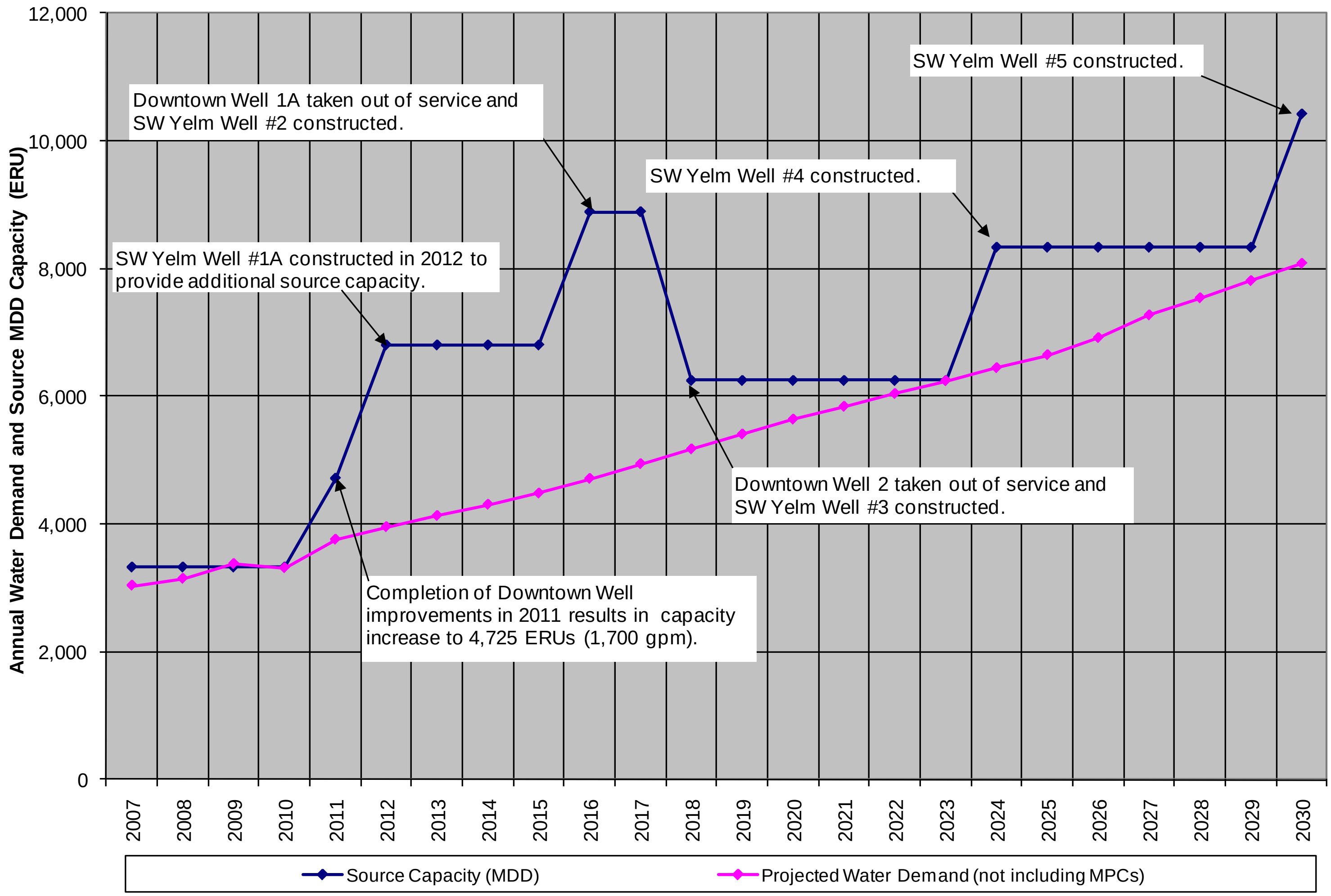
Figure 3-2
Source Capacity in ERUs (without MPCs)



3.3.1.5 Schedule for Well Development and Water Rights Actions (without MPCs)

Year	Well Development and Water Rights Actions	Projected MDD (gpm)	Source MDD Capacity (gpm)
2011	Projected annual demand is 904 ac-ft (3,754 ERUs). The downtown well improvement project is completed and an additional 152.59 ac-ft of water rights are acquired.	1,351	1,700
2012	Projected annual demand is 952 ac-ft, which matches the existing available water right (assuming water rights of 152.59 ac-ft for decommissioned wells and McMonigle transfer are secured in 2011). Completion of the construction of Southwest Yelm Well 1A is assumed, along with securing the Phase 1 water right for 554 ac-ft.	1,422	2,450
2015	Last year of the 6-year planning horizon. Adequate capacity remaining for both water rights and source capacity.	1,612	2,450
2016	Mitigation plan identifies Downtown Well 1A being transferred to southwest Yelm. Southwest Yelm Well 2 is constructed and put into service. Water Rights are transferred from Downtown Well 1A.	1,694	3,200
2018	Mitigation plan identifies Downtown Well 2 being transferred to southwest Yelm. Well 3 put into service in southwest Yelm. Water right transfer to southwest Yelm from downtown wells is completed, along with securing a portion of the Phase 2 water right for 158.75 ac-ft.	1,861	2,250
2024	Another Southwest Yelm well (Well 4) needs to be added to provide adequate source capacity. The remaining portion of the Phase 2 water right is secured, along with a portion of the Phase 3 water right. Total water acquisition is equal to 554 ac-ft.	2,319	3,000
2030	Following 20-year planning horizon, the Phase 4 water right of 1,733.25 acre-feet is secured to complete the water rights application G2-29084. Total available water rights equal 3,949.25 ac-ft. Another Southwest Yelm well (Well 5) is constructed to increase source capacity.	2,908	3,750

Note: Water right quantities shown above correspond with well development schedules developed for this WSP. Actual water right quantities approved by Ecology may be higher per the City of Yelm's Mitigation Plan.

3.3.2 Water Treatment

The following section provides a description of the existing conditions, capacities, deficiencies, and proposed improvements for the current water system's water treatment facilities.

3.3.2.1 Existing Conditions

Disinfection. The City system uses chlorine gas to disinfect the raw water from Wells 1A and 2. The dedicated transmission main from Wells 1A and 2 to the Baker Hill reservoir has no service connections to it and provides chlorine contact for the full distance between the wells and the reservoir. The chlorine contact time at a pumping rate of 1,200 gpm is approximately 30 minutes. Construction drawings for this line are provided in Appendix 3D. The City does not allow connections to this line. Additional contact time is provided in the reservoir prior to introduction into the distribution system. According to the requirements described in WAC 246-290-451, water systems are required to have a target chlorine residual concentration that, when multiplied by the contact time at peak flow, is equal to a value of 6. For Yelm, this equates to a target chlorine residual concentration of 0.2 mg/L at or before the first service connection. Additionally, the distribution system is monitored to ensure that detectable residual disinfectant concentrations are present in all active parts of the distribution system.

The City is currently completing a project at the downtown wells which will change the configuration of the system before the first service connection. As part of this project, chlorine contact time will be re-evaluated and a new target residual will be established. The project will be constructed to include a sampling location

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after the designated contact time has been met. In the future, the City will conduct monitoring at this point to verify that CT6 requirements are met. This project is described further at the end of this document.

The City monitors residual disinfectant concentrations at the same locations as routine and repeat coliform sample locations. A map of these sample sites is included in the Coliform Monitoring Plan in Appendix 6D. The use of gas chlorination in highly populated areas where a leak may affect a population is a concern. The City will review disinfection alternatives to existing chlorination, including liquid sodium hypochlorite.

Corrosion Control. The pH adjustment system installed in 2000 consists of a 2,000-gallon polyethylene caustic soda tank. Caustic soda is injected directly into the dedicated chlorine line that goes to the Baker Hill reservoir. The injection pump is a Wallace & Tiernan Encore 700 mechanical diaphragm pump that is speed controlled using a variable frequency drive paced by a 6-inch magnetic flow meter on the contact line. The facility's life expectancy is 50 years. The injection pump can handle flows up to 1,400 gpm although the maximum continuous design flow is 1,200 gpm. Tests of various wells throughout the area have indicated that the water within the aquifer tends to have low pH. It is to be expected that any new sources would mostly likely require a pH adjustment prior to distribution by the City.

3.3.2.2 Capacity Analysis

The existing disinfection and corrosion control systems have adequate capacity to treat water from the existing sources. Chlorine contact time is sufficient and the mechanical equipment is in good working order.

3.3.2.3 Treatment System Deficiencies and Proposed Improvements

No deficiencies have been identified in the existing treatment systems. As new sources are developed at the southwest Yelm wellfield, additional treatment systems will need to be designed and constructed. Disinfection and corrosion control treatment facilities will be constructed for the southwest Yelm wells. The description of improvements presented in Chapter 8 shows that treatment facilities in southwest Yelm will be constructed so that the water from multiple wells can be treated at a single treatment facility. As discussed in Chapter 8, additional treatment for manganese may be required for the southwest Yelm sources depending on the results of water testing that is performed as part of the development of those sources.

The Downtown Well project will include improvements to the disinfection and corrosion control systems. A 24-inch pipe, approximately 600 feet long, will be installed to provide additional chlorine contact time for that portion of the water from the wells that is pumped directly to the distribution system rather than to the dedicated line that is connected to the Baker Hill tank. In addition, chlorine and caustic soda feed system controls will be modified to provide variable dosages based on variable flow rates from the wells.

3.3.3 Storage

The following section provides a description of the existing conditions, capacities, deficiencies, and proposed improvements for the current water system's storage facilities.

3.3.3.1 Existing Conditions

Yelm currently has two storage tanks in operation: the Baker Hill and Public Works tanks. These tanks each provide 500,000 gallons of system storage. The Downtown Tower tank, which provided 50,000 gallons of storage, was taken offline in 2006.

In 1976, Reliable Steel Fabricators, Inc., constructed the Baker Hill tank, a 500,000-gallon steel standpipe. The tank has a diameter of 36.3 feet and is 64.7 feet high. It is located south of Baker Road between Mill and Clark Roads. The high water elevation in the tank is 477 feet. A pressure transducer is installed in the tank's discharge line. In 2006, the tank's interior was recoated. Other than the coating, the tank has not undergone

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any internal maintenance since it was commissioned in 1976. The tank's anchorage straps also were recently repaired. Over time the reservoir's anchor straps had suffered damage and the concrete surrounding some of the anchor straps has broken away.

Construction of the Public Works tank was completed in 2005. The tank has a diameter of 50 feet and is 148 feet tall. It is located next to the Public Works facility on Rhoton Road SE.

Figure 3-3 presents a schematic drawing and elevations of the existing storage facilities. Both of the existing tanks operate at a hydraulic grade line elevation of 477 feet. This 477 pressure zone can serve the existing service area and some of the proposed MPC to the southwest. The development of a new 630 pressure zone will be required as development begins to develop in the higher elevations of the MPC. Figure 3-4 shows the boundaries and areas served by each pressure zone. These boundaries are determined by the ground elevations and a minimum system pressure requirement of 30 psi (69 feet of head) at the meter of the served property.

3.3.3.2 Storage Capacity Analysis

Storage requirements are based on four components: operational, equalizing, standby, and fire suppression. The following section describes how these volumes were calculated.

Operational Storage. The operational storage volume is the volume that typically supplies water to the distribution system under normal operating conditions when the source(s) are not in operation. The Baker Hill tank has a top height of 63.33 feet. When this elevation is reached, the wells are turned off. The tank operates down to a height of 56.56 feet before a well pump is turned back on. The Public Works tank has a top height of 145 feet and if the level drops to a height of 140 feet a well is turned back on. The total operational storage calculated for these operating conditions is approximately 126,000 gallons.

Future operational storage cannot be calculated exactly without knowing the tank dimensions and operational strategies. For the purposes of estimating operational storage volumes of future reservoirs, a ratio similar to what currently exists (126,000 gallons of operational storage as part of 1 MG of existing storage) is assumed.

Equalizing Storage. Equalizing storage is used when the PHD exceeds the capacity of the sources. Equalizing storage is calculated using the following equation:

V_{ES} = $(Q_{PH} - Q_S)$(150 minutes)

V_{ES} = Equalizing storage volume (gallons)

Q_{PH} = PHD (gpm)

Q_S = Total source of supply capacity, excluding the capacity of emergency sources

This equation uses the difference between the PHD and the well source capacity for a period of 150 minutes to determine the required equalizing storage volume. If the source capacity exceeds the PHD, the required equalizing storage is zero.

The PHD, Q_{PH}, is determined using the following equation:

PHD = (MDD/1440)[(C)(N) + F] + 18

PHD = Peak hourly demand, gpm

MDD = Maximum day demand per ERU, gpd

C = Coefficient that depends on the size of the water system. C = 1.6 for Yelm

N = Number of connections, ERUs

F = Coefficient that depends on the size of the water system. F = 225 for Yelm

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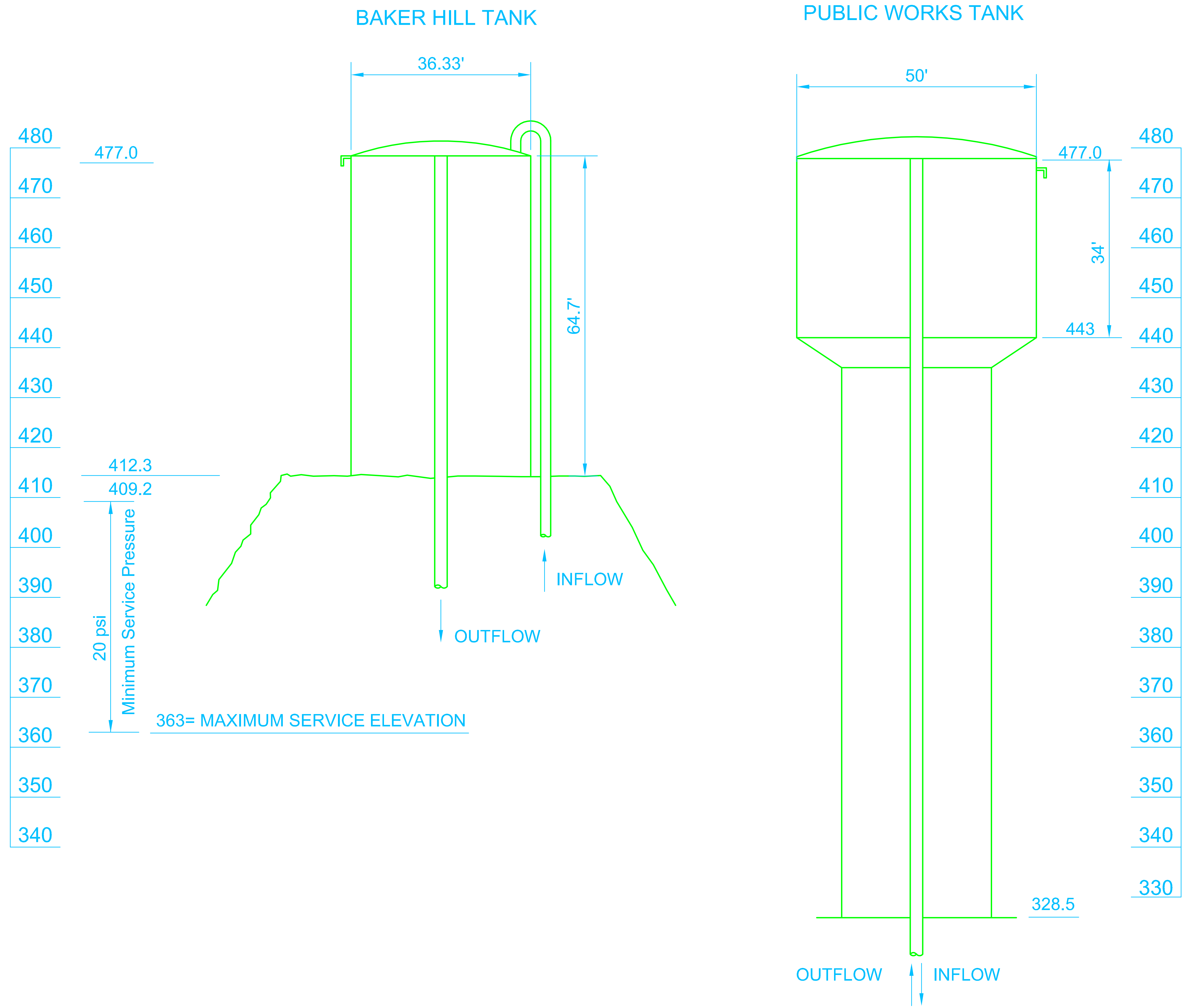

Figure 3-3
City of Yelm
Existing Storage Facility Elevations

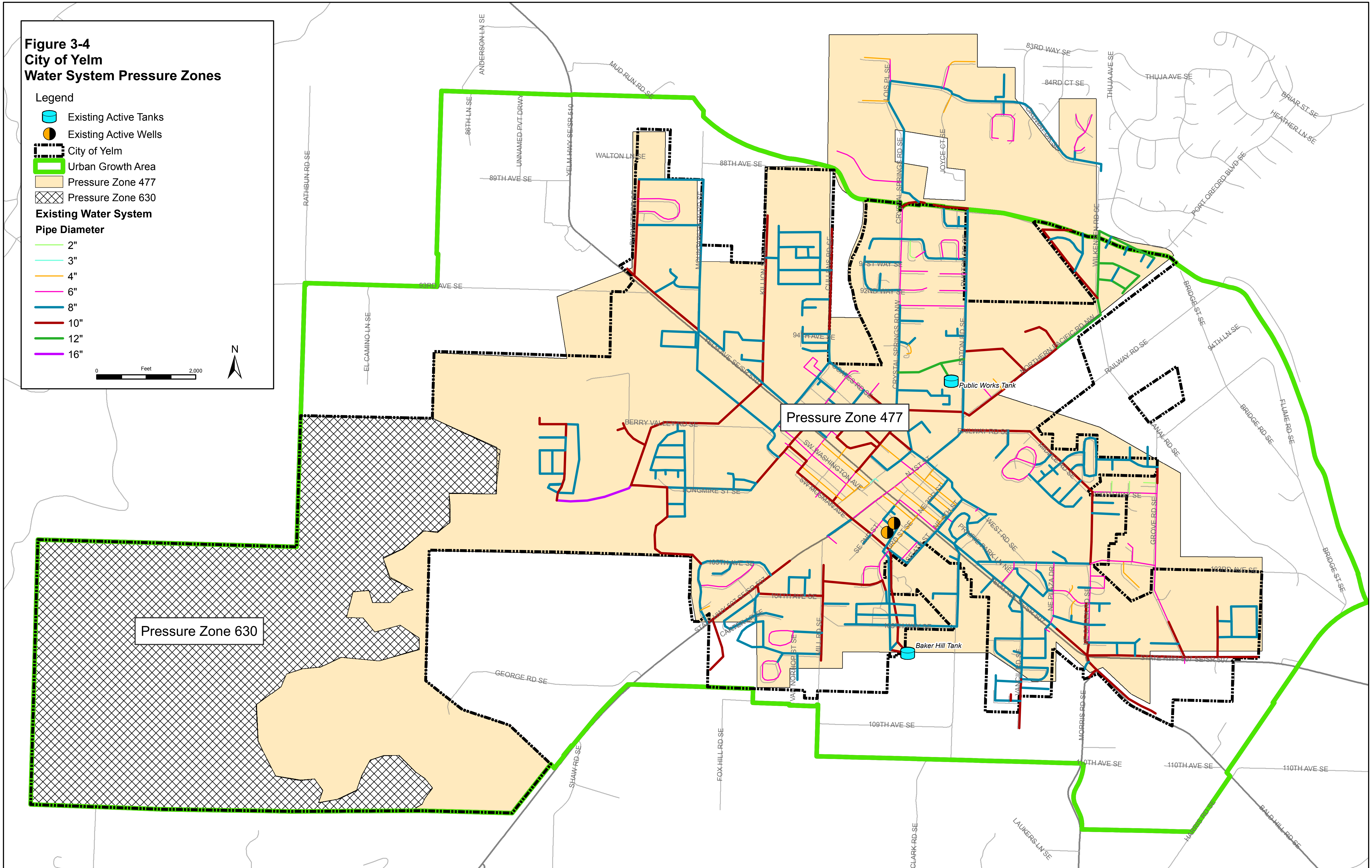

Figure 3-4
City of Yelm
Water System Pressure Zones
Legend
Existing Active Tanks
Existing Active Wells
City of Yelm
Urban Growth Area
Pressure Zone 477
Pressure Zone 630
Existing Water System
Pipe Diameter
2"
3"
4"
6"
8"
10"
12"
16"
0
Feet
2,000
N
Pressure Zone 477
Pressure Zone 630
Public Works Tank
Baker Hill Tank
93RD AVE SE
BERRY VALLEY RD SE
LONGMIRE ST SE
GEORGE RD SE
SHAW RD SE
FOX HILL RD SE
109TH AVE SE
110TH AVE SE
CLARK RD SE
LAUKERS LN SE
HARRIS RD SE
BALD HILL RD SE
BRIDGE ST SE
FLUME RD SE
BRIDGE RD SE
CANAL RD SE
RAILWAY RD SE
94TH LN SE
NORTHERN PACIFIC RD NW
PORT ORFORD BLVD SE
THUJA AVE SE
BRIAR ST SE
HEATHER LN SE
83RD WAY SE
84RD CT SE
JOYCE CT SE
LOIS PL SE
CRYSTAL SPRINGS RD SE
88TH AVE SE
WALTON LN SE
89TH AVE SE
YELM HWY SE/SR 510
UNNAMED PVT DRWY
86TH LN SE
ANDERSON LN SE
MUD RUN RD SE
RATHBUN RD SE
EL CAMINO LN SE
KILLION RD SE
SW WASHINGTON AVE
SW MOSMAN AVE
WEST RD SE
PRAIRIE PARK LN NE
GROVE RD SE
103RD AVE SE
104TH AVE SE
105TH AVE SE
MILL RD SE
VANCIL RD SE
MORRIS RD SE
WILKENSEN RD SE
SOLBERG ST SE

The required equalizing storage volume is not a fixed quantity but varies as the number of connections increases (PHD increases) and the number of sources increases (source capacity increases).

Standby Storage. Standby storage is provided in order to meet demands in the event of a system failure such as a power outage, an interruption of supply, or a break in a major transmission line. The amount of emergency storage should be based on the reliability of supply and pumping equipment, standby power sources, and the anticipated length of time the system could be out of service.

Standby storage is calculated using the following equation:

SB_{TMS} = $(2\ days)(ADD)(N) - t_m(Q_S - Q_L)$

SB_{TMS} = Standby storage volume for a water system with multiple sources (gallons)

ADD = Average day demand for the system (gpd/ERU)

N = Number of ERUs

Q_S = Sum of all installed and continuously available sources of supply, except emergency sources (gpm)

Q_L = Largest capacity source available to the system (gpm)

t_m = Time that remaining sources are pumped on the day when the largest source is not available (minutes). For Yelm, the well pumps can run continuously and this value is 1,440 minutes.

At a minimum, the standby storage volume should be equal to 200 gallons per connected ERU. If the connected source capacity was to pump continuously for 24 hours, the calculated value of SB_{TMS} would be negative. Consequently, the required volume is calculated based on 200 gallons per connected ERU.

Fire Suppression Storage. This is volume required to provide for fire suppression. Either the local Fire Marshal requirements or the Public Water System Coordination Act of 1977 determines the volume and duration of water required for fire suppression. Fire flow criteria are listed in Table 3-11. The City adopted the 1997 Uniform Fire Code (UFC) requirements. The UFC Table A III-A-1 establishes the minimum flow requirements. The storage analysis uses a minimum volume of 360,000 gallons based on a 3,000 gpm fire for the duration of 120 minutes. The required standby volume is larger than the volume required for fire suppression in all conditions. Therefore, the fire suppression storage has been "nested" with the standby storage and is not considered as additional volume to be provided.

City policy is to provide up to 3,000 gpm of fire flow. If greater fire flows are required by code for larger structures, sprinklers or other enhanced fire protection measures are required.

3.3.3.3 Storage Deficiencies and Proposed Improvements

Tables 3-6 and 3-7 present the calculations used to determine the required storage volume for the two development scenarios described in Chapter 2: with and without the development of the MPCs, respectively.

The system's storage analysis shows that the 1,000,000 gallons of storage currently available is enough to meet the minimum volume currently required for the Yelm system according to DOH standards. In 2007, the required storage volume was calculated to be approximately 830,000 gallons (see Column 8 in the capacity tables). Based on the population and water demand projections developed in Chapter 2 and included in Tables 3-6 and 3-7, the available storage volume is only adequate until 2010 in the "with MPCs" scenario. In the "without MPCs" scenario the available storage volume would be adequate through 2012.

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As the population in the service area and the associated water demands increase, additional storage capacity will be provided through the construction of new reservoirs. Construction of these reservoirs will be timed to coincide with the development of the southwest Yelm wellfield and the need for additional storage in other parts of the system based on these calculations of the required storage volume.

Tables 3-6 and 3-7 (column 11 in each) show the storage capacity in ERUs that would be realized as the new reservoirs are constructed according to the following schedules. The schedules for the construction of these improvements were developed so that there would always be adequate storage capacity available.

Figures 3-5 and 3-6 present the information from Tables 3-6 and 3-7 as graphs of projected demand, in terms of connected ERUs, and the storage capacity that will be achieved as the new reservoirs are constructed. These graphs show that the schedule for development of new reservoirs will result in adequate storage capacity being achieved if demand does not exceed the conservative projections developed as part of this WSP.

A new pressure zone at elevation 630 feet will be required to supply water to outlying portions of the Thurston Highlands MPC. It is not anticipated that development will happen in this area in the 6-year planning period.

The storage analysis figures show the minimum reservoir sizes required to meet demand. Because of the uncertainty of when, how, and to what extent the Thurston Highlands MPC will develop, this WSP will need to be updated as a condition of approval of the MPC.

3.3.3.4 Schedule for Reservoir Construction Projects (with MPCs)

Year[1]	Reservoir Construction Projects	Storage Capacity Required (gallons)	Storage Capacity Available (gallons)
2010	Complete construction of 500,000-gallon reservoir in southwest Yelm as part of development of Southwest Yelm Well 1A. Reservoir would be built to operate in the new 630 pressure zone, with a pressure-reducing valve provided to control flows back to the existing distribution system in the 477 pressure zone.	1,201,400	1,500,000
2013	Complete construction of 500,000-gallon reservoir in southeast Yelm in the vicinity of Wal-Mart to address fire flow issues in this area of the system. Reservoir would be built in the 477 pressure zone.	1,575,000	2,000,000
2017	Complete construction of 750,000-gallon reservoir in southwest Yelm in the 630 pressure zone as part of development of Southwest Yelm Well 4. Reservoir will provide storage and flow in the new pressure zone and will assist in development of looped system along SR 507.	2,131,000	2,750,000
2024	Complete construction of a 1,000,000-gallon reservoir in southwest Yelm in the 630 pressure zone. Reservoir will provide additional capacity necessary to serve Thurston Highlands MPC until at least 2030.	2,945,000	3,750,000

[1] This schedule assumes the development of the MPCs beginning in 2010. The schedule will change depending on actual development patterns and demands.

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Table 3-6. Projected Demands and Storage Capacity (with MPCs)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Projected ERUs	Projected MDD	Calculated PHD	Required Storage Volume (gal)									
Year	ERU	MGD	gpm	Operational	Equalizing	Standby	Fire Flow	Total	Gal Req'd/ ERU	Available Storage (gal)	Available Storage (ERU)	Capacity Remaining (ERUs)	Reservoirs in Service
2007				126,000	96,899	606,681	360,000	829,581	273	1,000,000	3,657	623	Baker Hill/Public Works
2008				126,000	106,049	628,092	360,000	860,141	274	1,000,000	3,651	511	Same as above
2009				126,000	126,123	700,486	360,000	952,609	272	1,000,000	3,677	174	Same as above
2010	4,505	2.33	2,693	189,000	111,400	901,027	360,000	1,201,427	267	1,500,000	5,625	1,120	Same as above + SW Yelm #1
2011	4,930	2.55	2,937	189,000	73,054	985,916	360,000	1,247,970	253	1,500,000	5,925	996	Same as above
2012	5,402	2.80	3,209	189,000	113,829	1,080,346	360,000	1,383,175	256	1,500,000	5,858	456	Same as above
2013	5,853	3.03	3,469	252,000	152,790	1,170,577	360,000	1,575,367	269	2,000,000	7,431	1,578	Same as above + SE Yelm
2014	6,307	3.27	3,730	252,000	0	1,261,372	360,000	1,513,372	240	2,000,000	8,335	2,028	Same as above
2015	6,762	3.50	3,992	252,000	6,319	1,352,446	360,000	1,610,764	238	2,000,000	8,396	1,634	Same as above
2016	7,255	3.76	4,276	252,000	48,913	1,451,092	360,000	1,752,005	241	2,000,000	8,282	1,027	Same as above
2017	7,751	4.02	4,561	346,500	234,212	1,550,210	360,000	2,130,922	275	2,750,000	10,003	2,252	Same as above + SW Yelm #2
2018	8,249	4.27	4,848	346,500	164,716	1,649,805	360,000	2,161,021	262	2,750,000	10,497	2,248	Same as above
2019	8,749	4.53	5,136	346,500	207,928	1,749,881	360,000	2,304,309	263	2,750,000	10,442	1,692	Same as above
2020	9,252	4.79	5,426	346,500	251,349	1,850,441	360,000	2,448,291	265	2,750,000	10,392	1,140	Same as above
2021	9,671	5.01	5,667	346,500	287,525	1,934,223	360,000	2,568,248	266	2,750,000	10,356	684	Same as above
2022	10,092	5.23	5,909	346,500	323,872	2,018,399	360,000	2,688,771	266	2,750,000	10,322	230	Same as above
2023	10,515	5.45	6,153	346,500	247,891	2,102,974	360,000	2,697,365	257	2,750,000	10,720	205	Same as above
2024	10,940	5.67	6,397	472,500	284,583	2,187,951	360,000	2,945,035	269	3,750,000	13,930	2,990	Same as above + SW Yelm #3
2025	11,367	5.89	6,643	472,500	321,451	2,273,334	360,000	3,067,285	270	3,750,000	13,897	2,530	Same as above
2026	11,855	6.14	6,924	472,500	363,663	2,371,095	360,000	3,207,258	271	3,750,000	13,862	2,006	Same as above
2027	12,433	6.44	7,257	472,500	413,538	2,486,602	360,000	3,372,640	271	3,750,000	13,824	1,391	Same as above
2028	12,923	6.70	7,539	472,500	343,380	2,584,664	360,000	3,400,544	263	3,750,000	14,251	1,328	Same as above
2029	13,416	6.95	7,823	472,500	385,934	2,683,214	360,000	3,541,648	264	3,750,000	14,205	789	Same as above
2030	13,911	7.21	8,108	472,500	428,700	2,782,258	360,000	3,683,458	265	3,750,000	14,163	251	Same as above

(1) See Table 2-20. Projected demands for 2008 and 2009 were prepared during initial drafting of this WSP and estimated demands of 819 and 843 ac-ft, respectively. Actual demand measured at the well was 756 ac-ft in 2008 and 812 ac-ft in 2009. Actual data was used when evaluating system capacity from 2007-2009. Projected demands shown in Table 2-20 were used to evaluate capacity from 2010-2030 for the with-MPC scenario.
(2) See Table 2-22
(3) See Table 2-22
(4) Estimated assuming approximatley 63,000 gallons per 500,000 gallons of reservoir volume, similar to existing reservoirs
(5) Calculated based on MDD and number of ERUs connected, see text.
(6) Calculated based on 200 gal required/ERU
(7) Calculated assuming 3,000 gpm for 2 hours. Fire flow is nested with standby storage volume
(8) Totals columns (4), (5), (6)
(9) Calculated by (8)/(1)
(10) SW Yelm #1 - 500K gallons, SE Yelm - 500K gallons, SW Yelm #2 - 750K gallons, SW Yelm #3 - 1 million gallons
(11) Calculated by (10)/(9)
(12) Calculated by (11) - (1)
(13) See anticipated schedule in Section 3.3.3.3
Note: This schedule assumes the development of the MPCs beginning in 2010. The schedule will change depending on actual development patterns and demands.

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Table 3-7. Projected Demands and Storage Capacity (without MPCs)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Projected ERUs	Projected MDD	Calculated PHD	Required Storage Volume (gal)									
Year	ERU	MGD	gpm	Operational	Equalizing	Standby	Fire Flow	Total	Gal Req'd/ ERU	Available Storage (gal)	Available Storage (ERU)	Capacity Remaining (ERUs)	Reservoirs in Service
2007	3,033			126,000	96,899	606,681	360,000	829,581	273	1,000,000	3,657	623	Baker Hill/Public Works
2008	3,140			126,000	106,049	628,092	360,000	860,141	274	1,000,000	3,651	511	Same as above
2009	3,373			126,000	126,123	674,581	360,000	926,704	275	1,000,000	3,640	267	Same as above
2010	3,308	1.71	2,174	126,000	120,514	661,593	360,000	908,107	275	1,000,000	3,643	335	Same as above
2011	3,754	1.95	2,260	126,000	84,046	750,830	360,000	960,876	256	1,000,000	3,907	153	Same as above
2012	3,951	2.05	2,374	189,000	0	790,249	360,000	979,249	248	1,500,000	6,052	2,101	Same as above + SW Yelm #1
2013	4,126	2.14	2,474	189,000	3,660	825,203	360,000	1,017,863	247	1,500,000	6,080	1,954	Same as above
2014	4,302	2.23	2,576	189,000	18,880	860,453	360,000	1,068,333	248	1,500,000	6,041	1,738	Same as above
2015	4,479	2.32	2,677	189,000	34,105	895,712	360,000	1,118,818	250	1,500,000	6,004	1,526	Same as above
2016	4,709	2.44	2,810	189,000	0	941,710	360,000	1,130,710	240	1,500,000	6,246	1,538	Same as above
2017	4,940	2.56	2,943	189,000	0	987,909	360,000	1,176,909	238	1,500,000	6,296	1,356	Same as above
2018	5,172	2.68	3,076	189,000	123,952	1,034,312	360,000	1,347,264	261	1,500,000	5,758	586	Same as above
2019	5,405	2.80	3,211	189,000	144,077	1,080,922	360,000	1,413,999	262	1,500,000	5,733	329	Same as above
2020	5,639	2.92	3,345	189,000	164,292	1,127,738	360,000	1,481,030	263	1,500,000	5,711	72	Same as above
2021	5,839	3.03	3,461	252,000	181,596	1,167,812	360,000	1,601,407	274	2,000,000	7,292	1,453	Same as above + SE Yelm
2022	6,040	3.13	3,576	252,000	198,973	1,208,058	360,000	1,659,031	275	2,000,000	7,282	1,241	Same as above
2023	6,242	3.23	3,693	252,000	216,426	1,248,478	360,000	1,716,904	275	2,000,000	7,272	1,029	Same as above
2024	6,445	3.34	3,810	315,000	121,455	1,289,073	360,000	1,725,528	268	2,500,000	9,338	2,893	Same as above + SW Yelm #2
2025	6,649	3.45	3,927	315,000	139,060	1,329,845	360,000	1,783,905	268	2,500,000	9,318	2,669	Same as above
2026	6,918	3.58	4,082	315,000	162,239	1,383,525	360,000	1,860,763	269	2,500,000	9,294	2,376	Same as above
2027	7,274	3.77	4,287	315,000	192,981	1,454,723	360,000	1,962,704	270	2,500,000	9,265	1,991	Same as above
2028	7,542	3.91	4,441	315,000	216,157	1,508,396	360,000	2,039,553	270	2,500,000	9,245	1,703	Same as above
2029	7,812	4.05	4,596	315,000	239,444	1,562,326	360,000	2,116,770	271	2,500,000	9,226	1,414	Same as above
2030	8,083	4.19	4,752	315,000	150,342	1,616,515	360,000	2,081,857	258	2,500,000	9,706	1,623	Same as above

(1) See Table 2-21. Projected demands for 2008, 2009, and 2010 were prepared during initial drafting of this WSP and were estimated to be 819, 843, and 868 ac-ft, respectively. Actual demand was 756 ac-ft in 2008 and 812 ac-ft in 2009. In 2010, a conservation program was developed with a projected demand of 796.66 ac-ft for 2010. Actual data and the revised 2010 projection were used when evaluating system capacity from 2007-2010; demand projections shown in Table 2-21 were used to evaluate capacity from 2011-2030.
(2) See Table 2-22
(3) See Table 2-22
(4) Estimated assuming approximately 63,000 gallons per 500,000 gallons of reservoir volume, similar to existing reservoirs
(5) Calculated based on MDD and number of ERUs connected, see text.
(6) Calculated based on 200 gal required/ERU
(7) Calculated assuming 3,000 gpm for 2 hours. Fire flow is nested with standby storage volume
(8) Totals columns (4), (5), (6)
(9) Calculated by (8)/(1)
(10) Assuming each reservoir, new and existing, is 500,000 gallons with no dead storage
(11) Calculated by (10)/(9)
(12) Calculated by (11) - (1)
(13) See anticipated schedule in Section 3.3.3.3

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Figure 3-5
Storage Capacity in ERUs (with MPCs)

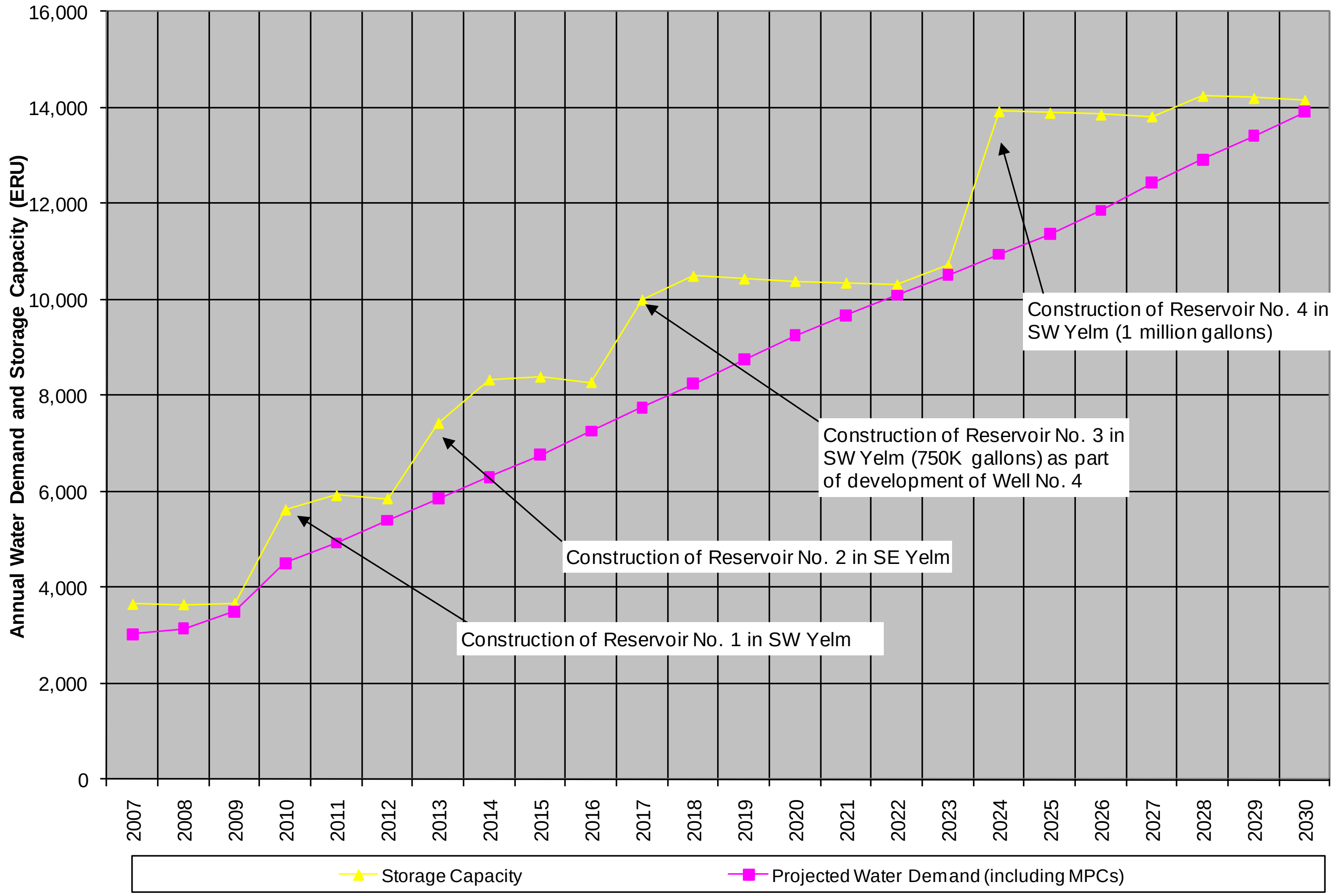

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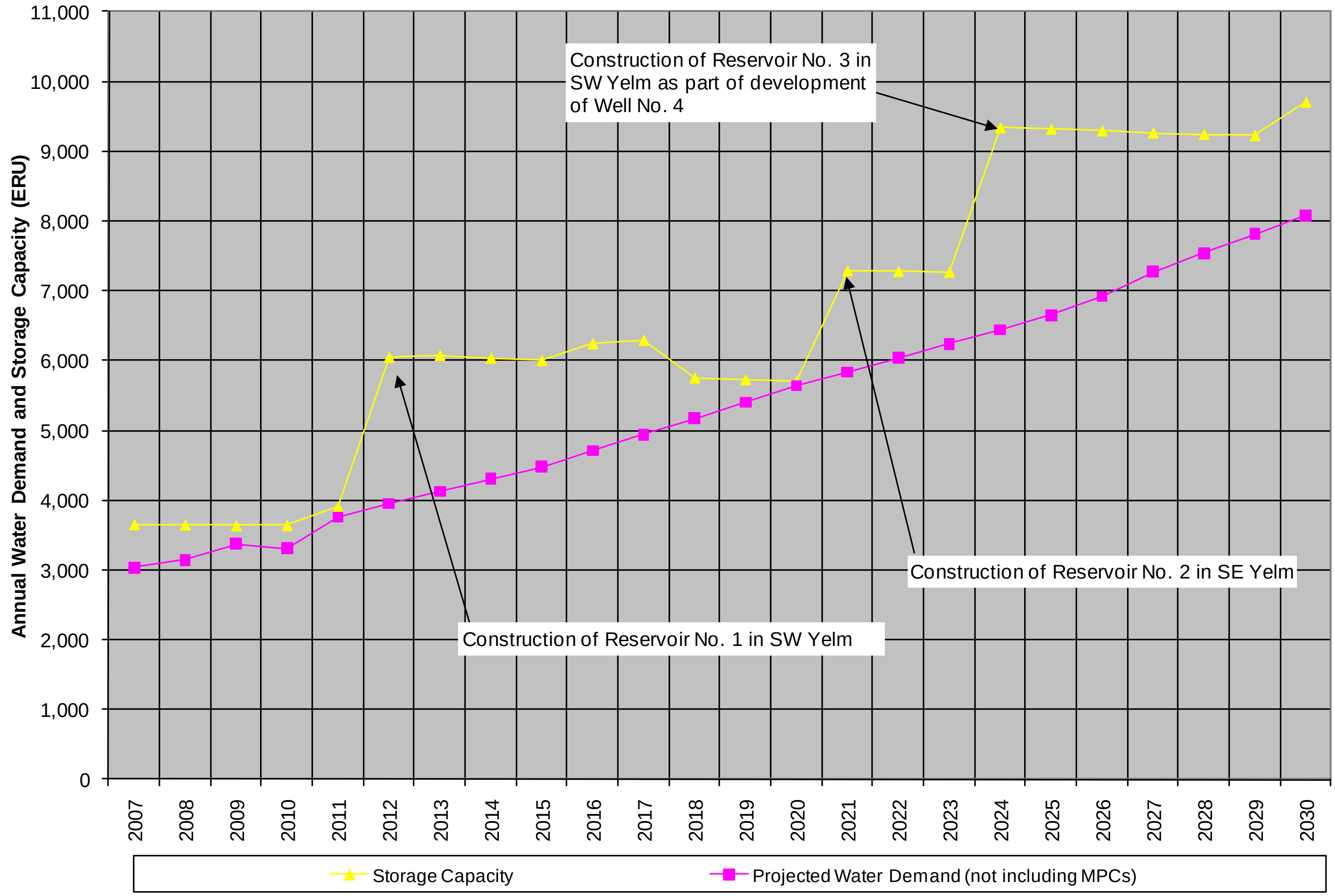
Figure 3-6
Storage Capacity in ERUs (without MPCs)



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3.3.3.5 Schedule for Reservoir Construction Projects (without MPCs)

Year	Reservoir Construction Projects	Storage Capacity Required (gallons)	Storage Capacity Available (gallons)
2012	Complete construction of 500,000-gallon reservoir in southwest Yelm as part of development of Southwest Yelm Well 1A. Reservoir would be built to operate in the new 630 pressure zone, with a pressure-reducing valve provided to control flows back to the existing distribution system in the 477 pressure zone.	979,000	1,500,000
2021	Complete construction of 500,000-gallon reservoir in southeast Yelm in the vicinity of Wal-Mart to address fire flow issues in this area of the system. Reservoir would be built in the 477 pressure zone.	1,601,000	2,000,000
2024	Complete construction of 500,000-gallon reservoir in southwest Yelm in the 630 pressure zone as part of development of Southwest Yelm Well 4. Construction of reservoir provides additional capacity over what is immediately necessary but is necessary to provide storage and flow in the new pressure zone and will assist in development of looped system along SR 507.	1,726,000	2,500,000

3.3.4 Distribution System

The following section provides a description of the existing conditions, design standards, and hydraulic capacity of the current water system's water distribution system.

3.3.4.1 Existing Conditions

The existing Yelm distribution system consists primarily of 4- to 10-inch-diameter pipe. The pipes in the downtown area are the oldest in the system and are generally 4- to 6-inch asbestos cement (AC). Figure 3-7 presents a map of the existing system, color-coded by line size. Figure 3-8 presents the same map color-coded by pipe material. Figure 3-9 presents a chart depicting the age of the Yelm water system. Approximately 72 percent of the existing pipeline inventory is less than 30 years old, and 10 percent is at least 50 years old. Figure 3-10 presents a chart depicting the existing distribution system inventory by line size; Figure 3-11 presents a chart showing the existing system by material type.

The AC pipe in the system is generally in good condition. The majority of the AC pipe is located in the downtown area and consists of 4-inch-diameter lines. These lines have been in service for up to 50 years. The accumulation of deposits within the pipe significantly increases the roughness coefficient and affects the efficiency of the system. The small-diameter mains also restrict fire flow capacities. A citywide replacement program has been developed as part of the CIP included in this WSP to identify and replace pipes that do not provide adequate fire flow.

Currently the entire distribution system is located in the 477 pressure zone and operates within a pressure range of 30–70 pounds per square inch gauge (psig) under normal operating conditions. Overall, the distribution system is considered to be in adequate to good condition. The City's ongoing leak detection program will continue in the future and as AC pipe failures are detected they will be replaced with a minimum 6-inch-diameter line.

Table 3-8 details the length, size, and line types in the distribution system. Newer lines at the perimeter of the system are generally 6- to 10-inch PVC pipes. A 16-inch transmission main, constructed in 2007, provides the start of a transmission system from the existing water system toward the MPCs and the southwest Yelm wellfield.

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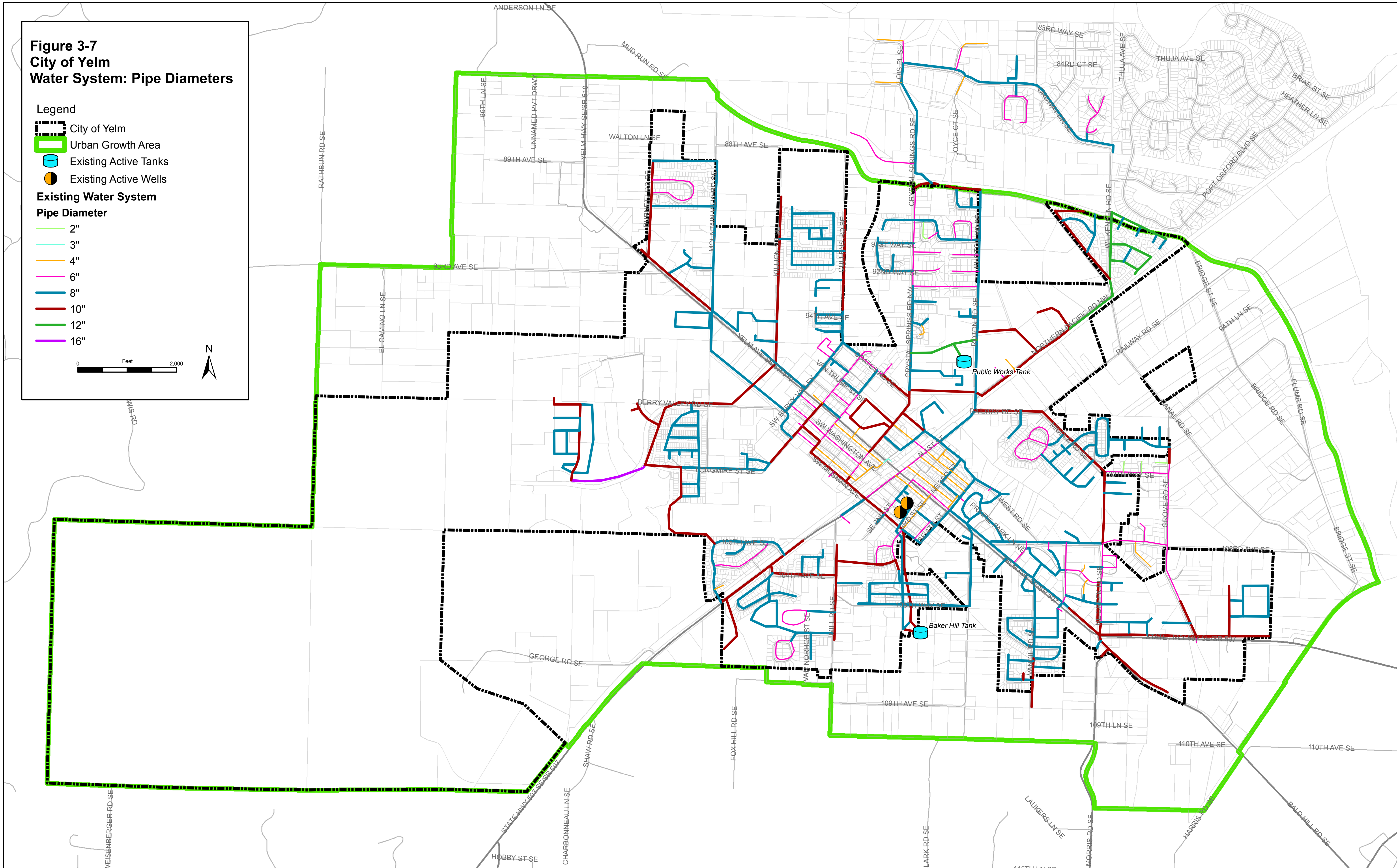


Figure 3-7
City of Yelm
Water System: Pipe Diameters
Legend
City of Yelm
Urban Growth Area
Existing Active Tanks
Existing Active Wells
Existing Water System
Pipe Diameter
2"
3"
4"
6"
8"
10"
12"
16"
0
Feet
2,000
N
Public Works Tank
Baker Hill Tank
ANDERSON LN SE
MUD RUN RD SE
WALTON LN SE
88TH AVE SE
89TH AVE SE
93RD AVE SE
86TH LN SE
RATHBUN RD SE
EL CAMINO LN SE
YELM AVE SE
BERRY VALLEY RD SE
LONGMIRE ST SE
SW WASHINGTON AVE
RAILWAY RD SE
NORTHERN PACIFIC RD NW
CRYSTAL SPRINGS RD NW
CANAL RD SE
BRIDGE RD SE
BRIDGE ST SE
FLUME RD SE
94TH LN SE
PORT ORFORD BLVD SE
THUJA AVE SE
THUJA AVE SE
HEATHER LN SE
BRIAR ST SE
84RD CT SE
83RD WAY SE
WEST RD SE
GROVE RD SE
103RD AVE SE
109TH AVE SE
109TH LN SE
110TH AVE SE
110TH AVE SE
GEORGE RD SE
SHAW RD SE
FOX HILL RD SE
STATE HWY 507 SE/SR 507
CHARBONNEAU LN SE
WEISENBERGER RD SE
HOBBY ST SE
CLARK RD SE
LAUKERS LN SE
MORRIS RD SE
115TH LN SE
HARRIS RD SE
BALD HILL RD SE
VAN NORHOF ST SE
MILL RD SE
KILLION RD SE
JOYCE CT SE
UNNAMED PVT DRWY
YELM HWY SE/SR 510
MOUNTAIN VIEW RD SE
94TH AVE SE
WILKENSEN RD SE
CULLENS RD SE
SW MCKENZIE AVE

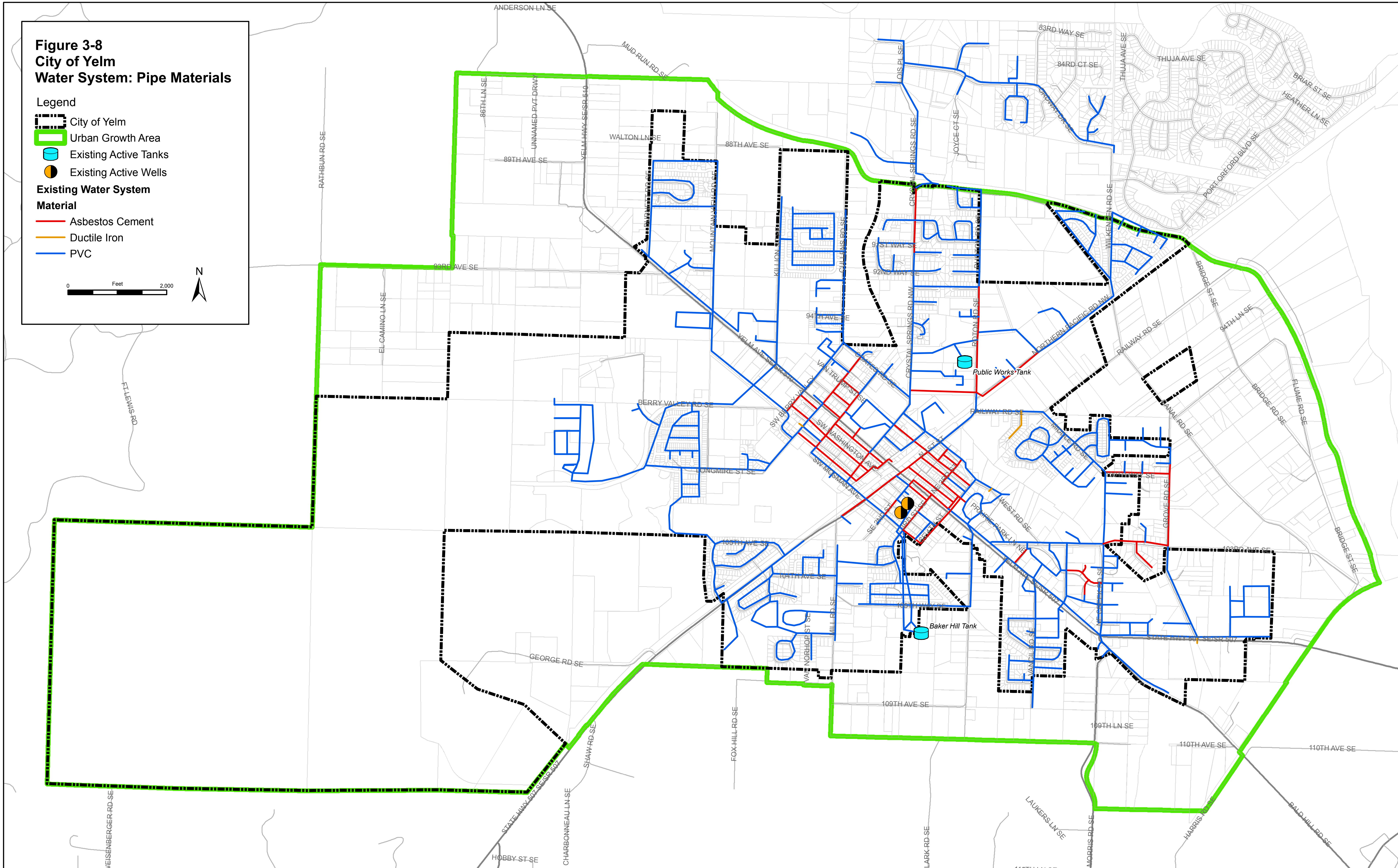


Figure 3-8
City of Yelm
Water System: Pipe Materials

Figure 3-9. City of Yelm Waterline Inventory by Age

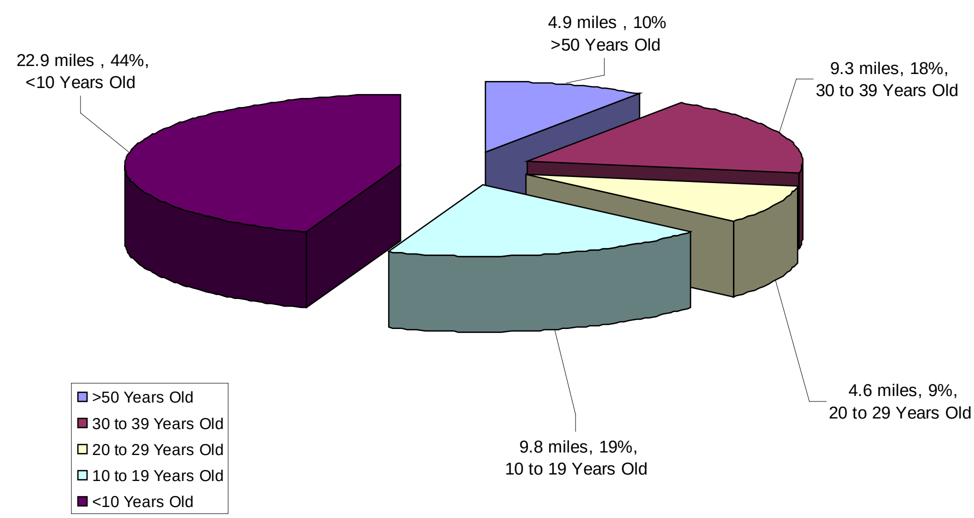
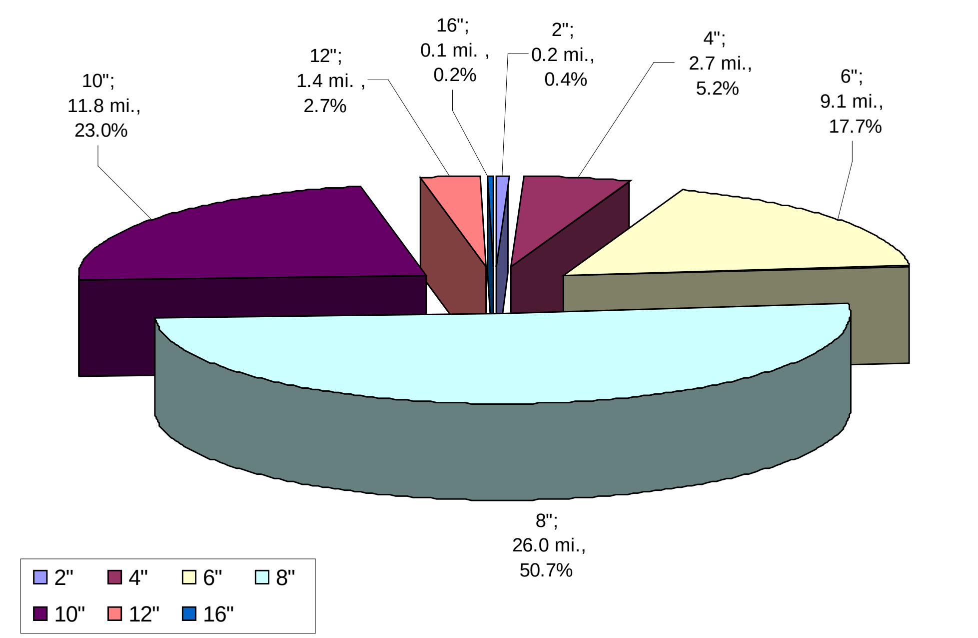


Figure 3-10. City of Yelm Water Main Inventory Installed Pipe by Size (Diameter)



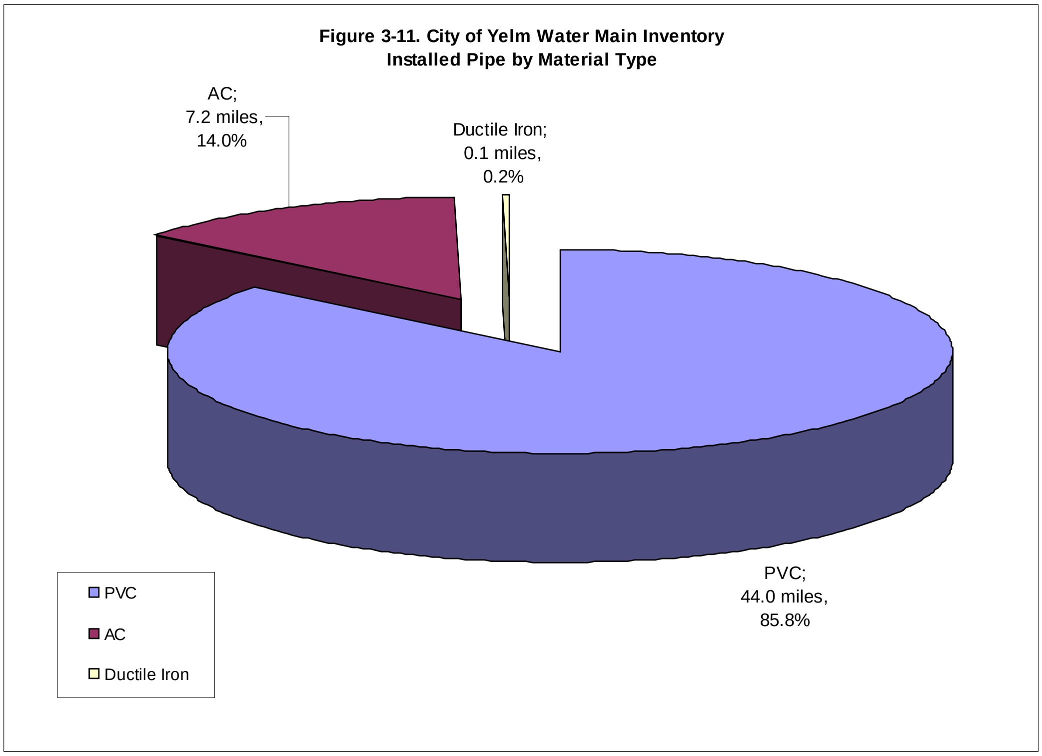


Table 3-8. 2008 Yelm Water Main Inventory (Lengths in Feet)						
Diameter (inches)	PVC	AC	Ductile Iron	Total System (feet)	Total System (miles)	Percent of Total Pipe
2	1,178			1,178	0.2	0.4%
3		226		226	0.0	0.1%
4	3,825	10,196		14,021	2.7	5.0%
6	30,727	17,348	30	48,105	9.1	17.2%
8	134,734	7,001	638	142,373	27.0	51.0%
10	61,414	3,086		64,500	12.2	23.1%
12	7,408			7,408	1.4	2.7%
16	1,571			1,571	0.3	0.6%
Total Feet	240,857	37,857	668	279,382		
Total Miles	45.62	7.17	0.13		52.9	
% of Total Pipe	86.2%	13.6%	0.2%			

3.3.4.2 Design Standards

The Yelm water system has been designed and constructed to provide adequate water supply and pressure at the extremities of the existing service area. This piping network has been configured to allow for growth beyond the existing service area limits. Distribution lines for individual development projects are extended off of the main distribution loop. Extensions are sized based on the specific demand for the number and type of units served.

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Yelm's standards require that system pressures remain above 30 psi when the PHD is applied to the system in order to provide users with adequate pressure throughout the system. These standards require that fire flow be considered in conjunction with the MDD applied to the system. Fire flows in the system must not cause any point in the system to have a pressure lower than 20 psi. Pipelines are sized such that when a PHD is applied to the system, velocities in distribution mains do not exceed 8 feet per second (fps). Short sections of mains and piping in valve and pump station facilities can have velocities greater than this maximum value. System pressures are limited to less than 100 psi. Pressures greater than 100 psi can encourage wasting of water and cause damage to piping materials that are unable to handle such pressures.

Water, sewer, and reuse line separation distances are required to meet the DOH and Ecology standards. Water lines must have 10 feet of horizontal separation from sanitary sewer and reclaimed water lines. Whether running parallel or crossing, reclaimed water and sewer lines are required to be 18 inches below any potable water lines. Where separations cannot be maintained, special construction requirements are provided such as providing a sleeve, encasing in concrete, or other methods approved by DOH and Ecology.

3.3.4.3 Hydraulic Capacity Analysis

The hydraulic capacity of the Yelm water system was evaluated by computer analysis. The computer model used in the analysis was Bentley WaterGEMS version 3.0 by Bentley Systems, Inc. The program calculates pressures and water flows in pipes throughout the system. Input data include pipe lengths, sizes, roughness coefficients, ground elevations, tank information, pump information, pressure-reducing valve parameters and system demand values.

The water system map has been reviewed in detail with water system staff to confirm that the system map is complete and accurate. Figure 3-12 presents the node map that is based on this water system map and is used in the modeling and shows both the existing system and the system improvements identified in the 6- and 20-year CIPs. Appendix 3E contains hydraulic model details including nodes, sample input and output files, and a node location map. The following demand sets were modeled as part of the WSP development:

- **2007 ADD.** This demand set was used for model calibration and for verification of existing conditions.
- **2007 PHD.** This demand set was used to verify adequate system pressure (30 psi minimum) at PHD.
- **2007 MDD with Fire Flow.** This demand set was used for the existing system analysis and to determine existing system deficiencies.
- **2015 PHD: without MPCs.** This demand set was used to verify adequate system pressure in the system (30 psi minimum) after completion of the 6-year CIP at peak demand for the "without MPCs" scenario.
- **2015 MDD with Fire Flow: without MPCs.** This demand set was used for system analysis and to identify the distribution system projects to be included in the 6-year CIP for the "without MPCs" scenario.
- **2029 MDD with Fire Flow: without MPCs.** This demand set was used for system analysis and to develop the 20-year CIP for the "without MPCs" scenario.

As described in Chapters 1 and 2, this WSP will be updated to develop an expanded CIP and revised rate structure if it becomes clear that the initial development of the Thurston Highlands MPC is likely to begin. Until that time, the City will plan for growth in its water system using the "without MPCs" scenario. Consequently, while initial model runs were performed for the 2015 and 2029 system configurations for the "with MPCs" scenario, those results are very preliminary. Results of the following model runs for the "with MPCs" scenario are provided in Appendix 3E for reference:

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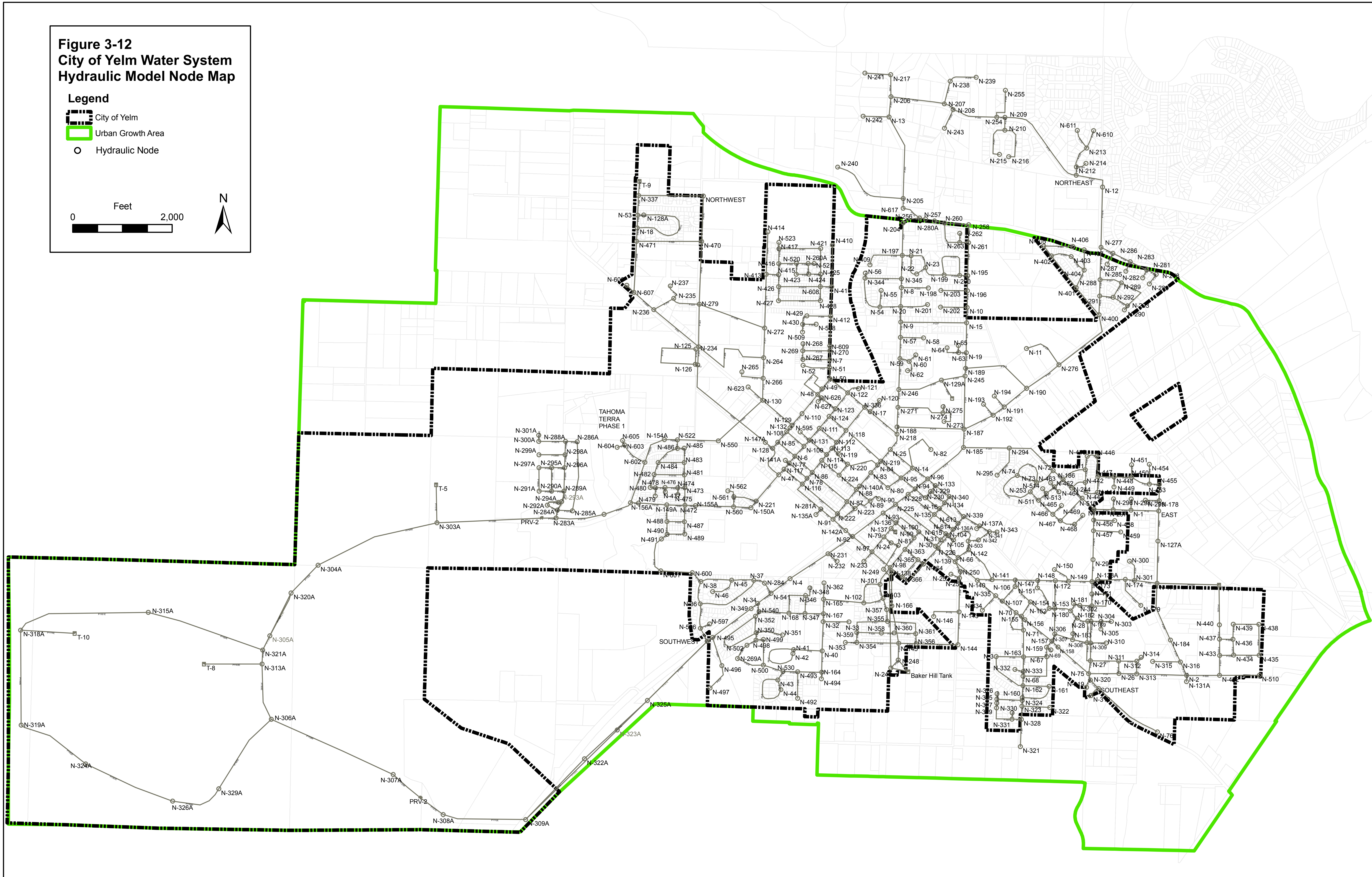

Figure 3-12
City of Yelm Water System
Hydraulic Model Node Map

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- **2015 PHD: with MPCs.** This demand set was used to verify adequate system pressure in the system (30 psi minimum) after completion of the 6-year CIP at peak demand with the inclusion of the proposed MPC.
- **2015 MDD with Fire Flow: with MPCs.** This demand set was used for system analysis and to identify the distribution system projects to be included in the 6-year CIP for the "with MPCs" scenario.
- **2029 MDD with Fire Flow: with MPCs.** This demand set was used for system analysis and to develop the 20-year CIP for the "with MPCs" scenario.

Table 3-9 presents the projected demands used for the various computer model scenarios; these data were previously presented in Table 2-22. For model runs at 2015 and 2029 demand conditions, the system configuration that is modeled incorporates the 6- and 20-year CIPs, respectively, as described in Chapter 8. The results of the individual model runs are then used to confirm that the identified deficiencies related to available system pressure and flow are addressed by the CIP projects. The following sections provide modeling results for the runs related to the existing system conditions and the "without MPCs" scenario. Additional modeling results for the "with MPCs" scenario are provided in Appendix 3E.

Table 3-9. Yelm Water System Plan Projected Demands for Modeling

		2007	2015	2029
Total system demand without MPCs	ADD (gpd)	652,182	962,891	1,679,501
	MDD (gpd)	1,525,172	2,320,567	4,047,597
	PHD (gpd)	2,579,323	3,855,411	6,618,659
	Model nodes	536	536	536
	ADD (gpm/node)	0.84	1.25	2.18
	MDD (gpm/node)	1.98	3.00	5.25
	PHD (gpm/node)	3.34	4.99	8.58
Total demand with MPCs	ADD (gpd)	652,182	1,453,879	2,884,455
	MDD (gpd)	1,525,172	3,503,848	6,951,537
	PHD (gpd)	2,579,323	5,748,661	11,264,963
Demand from MPCs only	ADD (gpd)	-	490,988	1,204,954
	MDD (gpd)	-	1,183,282	2,903,940
	PHD (gpd)	-	1,893,251	4,646,304
	MPC model nodes	0	5	17
	ADD (gpm/MPC node)	-	68.19	49.22
	MDD (gpm/MPC node)	-	164.34	118.63
	PHD (gpm/MPC node)	-	262.95	189.80

3.3.4.4 Calibration of Computer Model

The computer model of the Yelm water system was compared to actual field tests performed by the City's Public Works Department from 1998 to 2004. Appropriate adjustments and corrections were made with regard to roughness coefficients, source data, interties, pressure-reducing valves, etc., until a satisfactory model was achieved. The Hazen-Williams friction factor (C) assumptions used for pipes in all models are as follows:

- PVC: C = 140
- DIP (ductile iron pipe): C = 135

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- AC: C = 130.

The resultant model matched the field results well throughout the City. This calibration ensures that the model accurately represents the system. Calibration results are shown in Table 3-10.

3.3.4.5 Hydraulic Analysis Results

Hydraulic analysis results for the various scenarios are summarized below. The City has established minimum fire flow rates that are required for project approval and also meet the minimum flow requirement identified in the Water Coordination Act (WAC 246-293). The minimum fire flow rates established by the City and used in the hydraulic analysis are listed in Table 3-11.

3.3.4.5.1 2007 (Existing) Conditions

Model runs to determine existing system deficiencies were conducted using 2007 demands and the existing system configuration.

- **2007 PHD.** Model runs using 2007 PHD in the absence of fire flow were conducted in order to check the existing distribution system for low pressure and high pipe velocities. At 2007 PHDs, all pipe velocities were well below the design criteria of 8 fps. Model runs also indicated that pressure is 30 psi and above throughout the system at PHD, which satisfies DOH requirements. All pressures below 40 psi at PHD are detailed in Table 3-12.
- **2007 MDD with Fire Flow.** Fire flow demands in combination with 2007 MDD flows were modeled using the existing system configuration. The system is required to provide at least 20 psi during MDD with a fire flow. This model run incorporated a reservoir level elevation of 456.5 feet to account for the loss of equalizing storage prior to the fire flow event and the depletion of 360,000 gallons in the two existing reservoirs due to the fire flow event (3,000 gpm for 120 minutes). Significant deficiencies (greater than 300 gpm) are detailed in Table 3-13. Deficits of significance identified in this model run are depicted pictorially in Figure 3-13. The most significant deficiencies occur downtown, near City Hall, and at the edges of the system along Yelm Avenue and State Route (SR) 507 in the area around Wal-Mart.

3.3.4.5.2 2015 Conditions

The system configurations that were modeled for 2015 demands incorporated the 6-year CIP projects identified in Chapter 8 for the "with MPCs" and "without MPCs" scenarios with the exception of the Downtown Well project. Additional modeling will be performed during the design of that project and the results will be documented in the associated project report. These projects include source, treatment, storage, transmission, and distribution projects. The individual CIP projects incorporated into the expanded system model for the "without MPCs" scenario are as shown in Tables 3-14. Chapter 8 includes a description of these projects and Figure 8-1 shows the location of these improvements.

The source (W), storage (RES), treatment (WTS), and transmission (T) projects listed in Table 3-14 were identified and prioritized in order to provide the capacity required to meet future demands, as described in the previous sections of this chapter. Distribution (D) projects were identified and prioritized to address the most severe deficiencies that were identified in the modeling of the existing conditions.

Not all of the existing distribution system deficiencies will be addressed by the 6-year CIP. Additional projects have been identified to be constructed to address these deficiencies through the remainder of the 20-year planning horizon.

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Table 3-10. Calibration Information for Yelm 2009 Water System Model													
Computer Model Node #	Elev	Location of Test	Field Test Date	Field GPM Flow	Field Static Pressure (psi)	Field Residual Pressure (psi)	Computer Static Pressure (psi)	Computer Residual Pressure (psi)	Field Static - Residual	Computer Static - Residual	Static - Residual Difference	% Error Static Pressure	% Error Residual Pressure
N-92	355	1st & Mossman	9/17/2003	920	50	42	49	45	8	4	4	-2%	7%
N-90	350	Yelm Ave. City Hall	1/15/2002	400	50	9	51	9	41	42	-1	2%	0%
N-115	345	Yelm & Solberg	9/23/2003	935	54	45	53	47	9	6	3	-2%	4%
N-131	349	Yelm & Longmire	9/23/2003	980	54	44	52	45	10	7	3	-4%	2%
Tahoma Terra	340	Berry Valley & Longmire	9/23/2003	935	54	45	55	46	9	9	0	2%	2%
N-37	340	150th Ave. SE & Brighton N	9/23/2003	920	54	42	56	46	12	10	2	4%	10%
N-42	360	Mill Pond School	5/4/1999	840	46	34	47	36	12	11	1	2%	6%
N-102	350	Parkview Loop & Parkview Dr.	4/7/1999	975	52	46	52	47	6	5	1	0%	2%
N-30	340	4th & Yelm	5/4/1999	990	56	52	56	51	4	5	-1	0%	-2%
N-162	354	Vancil Loop & Vancil Rd.	4/9/1999	890	50	42	49	42	8	7	1	-2%	0%
N-352	350	Carter St. & Carter Loop	4/2/2004	1000	52	38	52	42	14	10	4	0%	11%
N-14	334	Railroad & Stevens	9/24/2003	975	58	50	58	53	8	5	3	0%	6%
N-122	347	Longmire & Coates	2/23/2004	935	52	44	53	46	8	7	1	2%	5%
N-51	348	9525 Cullens	2/24/2004	950	54	47	52	45	7	7	0	-4%	-4%
N-204	324	Crystal Springs & Canal Rd.	3/5/1998	840	62	34	62	34	28	28	0	0%	0%
N-187	335	NP Rd. & Rhoton	3/5/2004	975	60	50	58	52	10	6	4	-3%	4%
Northeast	300	Sweet Clover & Ordway	3/10/2004	750	70	20	73	18	50	55	-5	4%	-10%
N-210	295	William Pl. & 86th	4/3/1998	745	74	26	75	28	48	47	1	1%	8%
N-297	344	100th Way & Harold	3/30/2004	1060	52	40	54	38	12	16	-4	4%	-5%
N-72	340	Middle Rd. & Prairie Creek	3/16/2004	1130	54	45	56	47	9	9	0	4%	4%
										Average=	0.9	2%	5%

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Table 3-11. Fire Flow Criteria for Hydraulic Analysis	
Land Use/Zoning Classifications	Fire Flow Requirement at 20 psi
Existing Single Family Residential	750 gpm
New SFR Developments or System Modifications	1,500 gpm
Schools	1,500 gpm
Industrial	3,000 gpm
Commercial	3,000 gpm

Table 3-12. Existing Conditions (2007) Lowest System Pressures at Peak Hour Demands		
Computer Model Node	Location	Pressure (psi)
N-291A	100th Ave. SE & Dain St. SE	38
N-290A	100th Ave. SE & Justman St. SE	38
N-289A	100th Ave. SE & Dotson St. SE	38
N-496	600' SE of 105th Ave. & SR 507 SE	38
N-297A	99th Ave. SE & Dain St. SE	39
N-292A	Jensen Dr. SE, 150' west of Dotson	39
N-300A	98th Way SE & Dain St. SE	39
N-296A	99th Way SE & Dotson St. SE	39
N-299A	99th Ave. SE & Dotson St. SE	40
N-294A	Dotson St. SE, 100' north of Jensen	40

Table 3-13. Existing System Deficiencies of Significance Existing (2007) MDD with Fire Flows				
Node	Approximate Location	Total Flow Available at 20 psi (gpm)	Required Fire Flow (gpm) at 20 psi	Deficit (gpm)
N-2	Grove Rd. & SR 507	1,871	3,000	-1,129
N-11	Northern Pacific Rd.	2,458	3,000	-542
N-27	106th Ave. & Creek St.	2,626	3,000	-374
N-31	4th St. & Yelm Ave.	1,876	3,000	-1,124
N-75	Bald Hill Rd. & SR 507	2,606	3,000	-394
N-90	Yelm Ave. City Hall	312	3,000	-2,688
N-93	Washington Ave. SE & 1st St. S	2,639	3,000	-361
N-110	NW Cullens Rd. 300' NE of Yelm Ave.	2,681	3,000	-319
N-128	Berry Valley Dr. & Berry Valley Rd.	2,623	3,000	-377
N-129	NW Cullens Rd. & Yelm Ave.	2,658	3,000	-342
N-130	Killion & Yelm	2,453	3,000	-547
N-151	400' SW of Plaza Dr. & SE 103rd Ave.	2,610	3,000	-390
N-170	Creek St. & Creek Ln.	2,432	3,000	-568
N-171	Creek St. & Creek Ln.	2,498	3,000	-502

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Table 3-13. Existing System Deficiencies of Significance Existing (2007) MDD with Fire Flows (continued)				
Node	Approximate Location	Total Flow Available at 20 psi (gpm)	Required Fire Flow (gpm) at 20 psi	Deficit (gpm)
N-179	10400 Tranquility Ln. SE	364	750	-386
N-180	Algiers Ct. & Algiers Dr.	2,039	3,000	-961
N-182	Yelm View Ct. & Algiers Dr.	2,188	3,000	-812
N-223	McKenzie Ave. & Railroad Ave.	1,574	3,000	-1,426
N-224	Rice St. & Yelm Ave.	1,567	3,000	-1,433
N-225	Yelm Ave.& 1st St.	2,636	3,000	-364
N-230	Van Trump Ave. & 2nd St.	1,825	3,000	-1,175
N-234	Mountain View & SR 510	2,213	3,000	-787
N-236	1600 W Yelm Ave.	2,006	3,000	-994
N-264	Killion Rd. 850' north of SR 510	2,532	3,000	-468
N-266	Killion 440' north of SR 510	2,497	3,000	-503
N-304	Algiers Dr. east of Creek St.	2,439	3,000	-561
N-307	Yelm View Ct. NE	2,626	3,000	-374
N-311	16500 106th Ave. SE	2,417	3,000	-583
N-312	16600 106th Ave. SE	2,312	3,000	-688
N-313	16600 SR 507	2,269	3,000	-731
N-316	Grove Rd. North of SR 507	1,898	3,000	-1,102
N-432	Wal-Mart Area	1,659	3,000	-1,341
N-434	Wal-Mart Area	1,659	3,000	-1,341
N-435	Wal-Mart Area	1,539	3,000	-1,461
N-438	Wal-Mart Area	1,517	3,000	-1,483
N-439	Wal-Mart Area	1,568	3,000	-1,432
N-440	Wal-Mart Area	1,626	3,000	-1,374
N-471	Burnett Rd. & 91st Ave.	1,864	3,000	-1,136
N-607	Burnett Rd. & Yelm Ave.	1,915	3,000	-1,085

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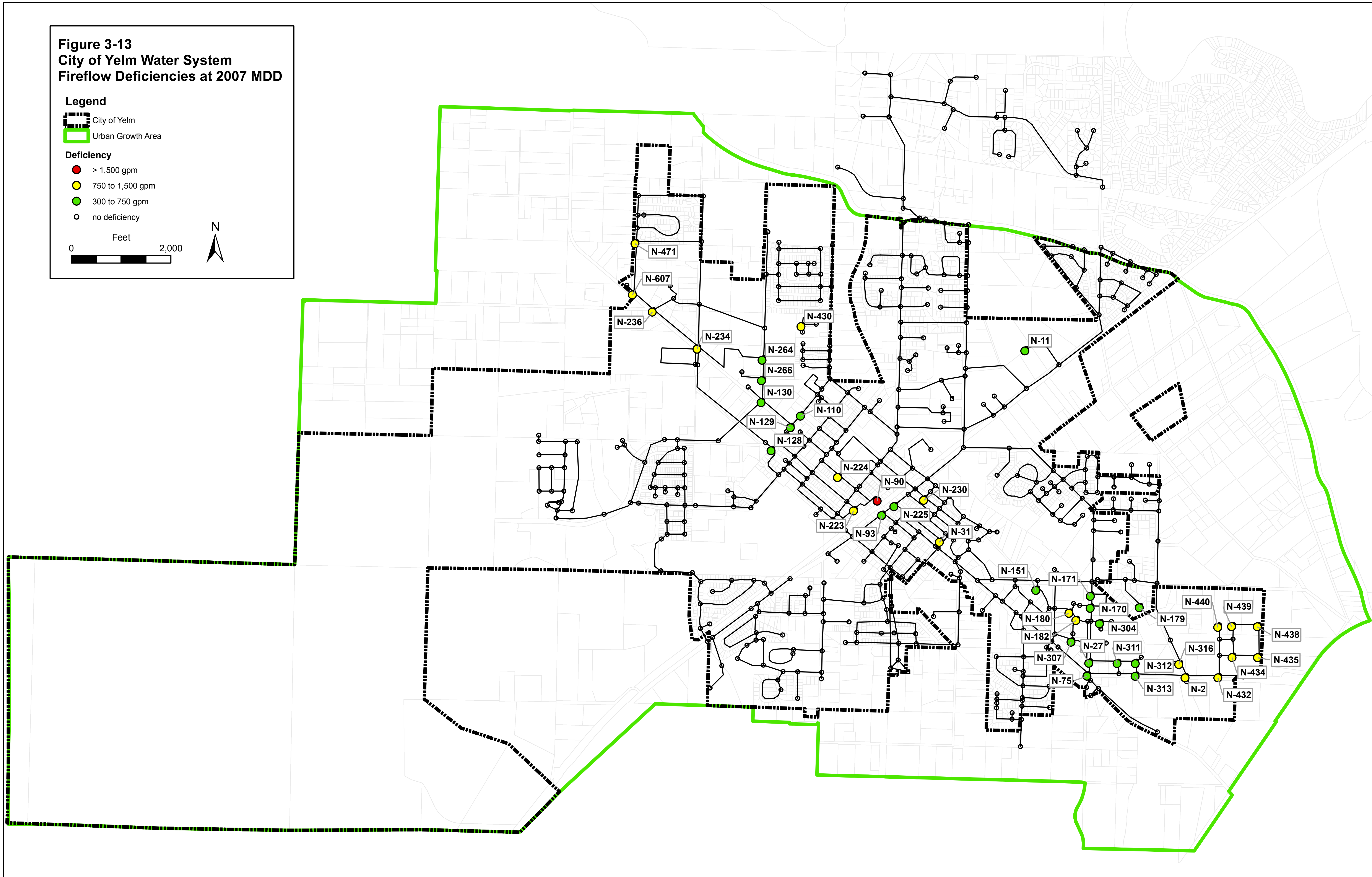

Figure 3-13
City of Yelm Water System
Fireflow Deficiencies at 2007 MDD

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Table 3-14. 6-Year CIP Projects: "without MPCs" Scenario		
Project ID[1]	Project Name	Year Online
W-DT[2]	Downtown Well Improvement Project Completed	2011
W-1	Southwest Yelm Well No. 1A	2012
RES-1	Southwest Yelm Reservoir No. 1	2012
WTS -1	Water Treatment System 1	2012
T-1	New Transmission Main 1	2011
D-1	Railroad St. Distribution Replacement	2010
D-2	SW Washington Ave. & Rice St. Dist. Replacement	2012
D-3	Van Trump Distribution Replacement	2014

[1] See Section 8.5 for project descriptions.

[2]Water system modeling incorporating this project will be included with the design.

- **2015 PHD: without MPCs.** Model runs using 2015 PHD in the absence of fire flow were conducted for the "without MPCs" scenario in order to check the system for low pressure and high pipe velocities. This model run included the system as it would be configured after completion of the 6-year CIP for the "without MPCs" scenario. At 2015 PHDs, all pipe velocities were well below the design criteria of 8 fps. Model runs also indicated that the pressure is 38 psi or greater throughout the system at PHD, which satisfies DOH requirements.
- **2015 MDD with Fire Flow: without MPCs.** Fire flow demands were modeled with 2015 MDD rates using the system configuration as it would exist after completion of the 6-year CIP improvements for the "without MPCs" scenario. The system is required to provide at least 20 psi during MDDs including fire flow. This model run incorporated a reservoir level elevation of 459.5 for the two existing reservoirs (Public Works and Baker Hill). In addition, the new reservoir, which will be located in the 630 pressure zone, was incorporated into the system by assuming the connection to the system provided a continuous pressure equivalent to an elevation of 477 feet downstream of the pressure-reducing valve. Deficiencies of significance are detailed in Table 3-15 and Figure 3-14. This table shows that the significant deficiencies identified in the model in the area around City Hall will be addressed by the distribution system projects D-1, D-2, and D-3 that are part of the 6-year CIP and the construction of the new reservoir (project RES-1 in the southwest Yelm wellfield) will address some additional deficiencies.

3.3.4.5.3 2029 Conditions

Section 8.5 includes a description of the 20-year CIPs for the "with MPCs" and "without MPCs" scenarios. The details and timing of the 20-year CIP will likely change depending on how fast Yelm grows and the extent to which the Thurston Highlands MPC is developed. This is especially true for the implementation of the source, treatment, transmission, and storage projects that are primarily driven by capacity requirements. Besides these capacity-related projects, the 20-year CIPs for both scenarios also include additional distribution system projects that are intended to address fire flow deficiencies identified in the modeling of the existing conditions. These projects, which are the same for both scenarios, are shown in Table 3-16.

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Table 3-15. Deficiencies of Significance 2015 MDD with Fire Flow without MPCs

Node	Approximate Location	Deficit at 2007 Conditions	Primary Improvements to Address 2007 Deficit	Surplus or Deficit at 2015 Conditions
N-2	Grove Rd. & SR 507	-1,129		-1,057
N-11	Northern Pacific Rd.	-542		-491
N-27	106th Ave. & Creek St.	-374		-241
N-31	4th St. & Yelm Ave.	-1,124		-942
N-75	Bald Hill Rd. & SR 507	-394		-3,000
N-90	Yelm Ave. City Hall	-2,688	D-1, RES-1	484
N-93	Washington Ave. SE & 1st St. S	-361		-196
N-110	NW Cullens Rd. 300' NE of Yelm Ave.	-319	RES-1	116
N-128	Berry Valley Dr. & Berry Valley Rd.	-377	RES-1	117
N-129	NW Cullens Rd. & Yelm Ave.	-342	RES-1	77
N-130	Killion & Yelm	-547	RES-1	-94
N-151	400' SW of Plaza Dr. & SE 103rd Ave.	-390		-257
N-170	Creek St. & Creek Ln.	-568		-482
N-171	Creek St. & Creek Ln.	-502		-412
N-179	10400 Tranquility Ln. SE	-386		-377
N-180	Algiers Ct. & Algiers Dr.	-961		-862
N-182	Yelm View Ct. & Algiers Dr.	-812		-702
N-223	McKenzie Ave. & Railroad Ave.	-1,426	D-1, RES-1	457
N-224	Rice St. & Yelm Ave.	-1,433	D-2, RES-1	555
N-225	Yelm Ave. & 1st St.	-364		-202
N-230	Van Trump Ave. & 2nd St.	-1,175	D-3, RES-1	567
N-234	Mountain View & SR 510	-787		-531
N-236	1600 W Yelm Ave.	-994		-786
N-264	Killion Rd. 850' north of SR 510	-468	RES-1	-24
N-266	Killion 440' north of SR 510	-503	RES-1	-53
N-304	Algiers Dr. east of Creek St.	-561		-476
N-307	Yelm View Ct. NE	-374		-247
N-311	16500 106th Ave. SE	-583		-480
N-312	16600 106th Ave. SE	-688		-594
N-313	16600 SR 507	-731		-631
N-316	Grove Rd. North of SR 507	-1,102		-1,028
N-432	Wal-Mart Area	-1,341		-1,281
N-434	Wal-Mart Area	-1,341		-1,293
N-435	Wal-Mart Area	-1,461		-1,417
N-438	Wal-Mart Area	-1,483		-1,440
N-439	Wal-Mart Area	-1,432		-1,387
N-440	Wal-Mart Area	-1,374		-1,327
N-471	Burnett Rd. & 91st Ave.	-1,136		-966
N-607	Burnett Rd. & Yelm Ave.	-1,085		-896

Highlighted cells indicate nodes with deficiencies that will be addressed with improvements as part of the 6-year CIP..

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Figure 3-14
City of Yelm Water System
Fireflow Deficiencies at 2015 MDD

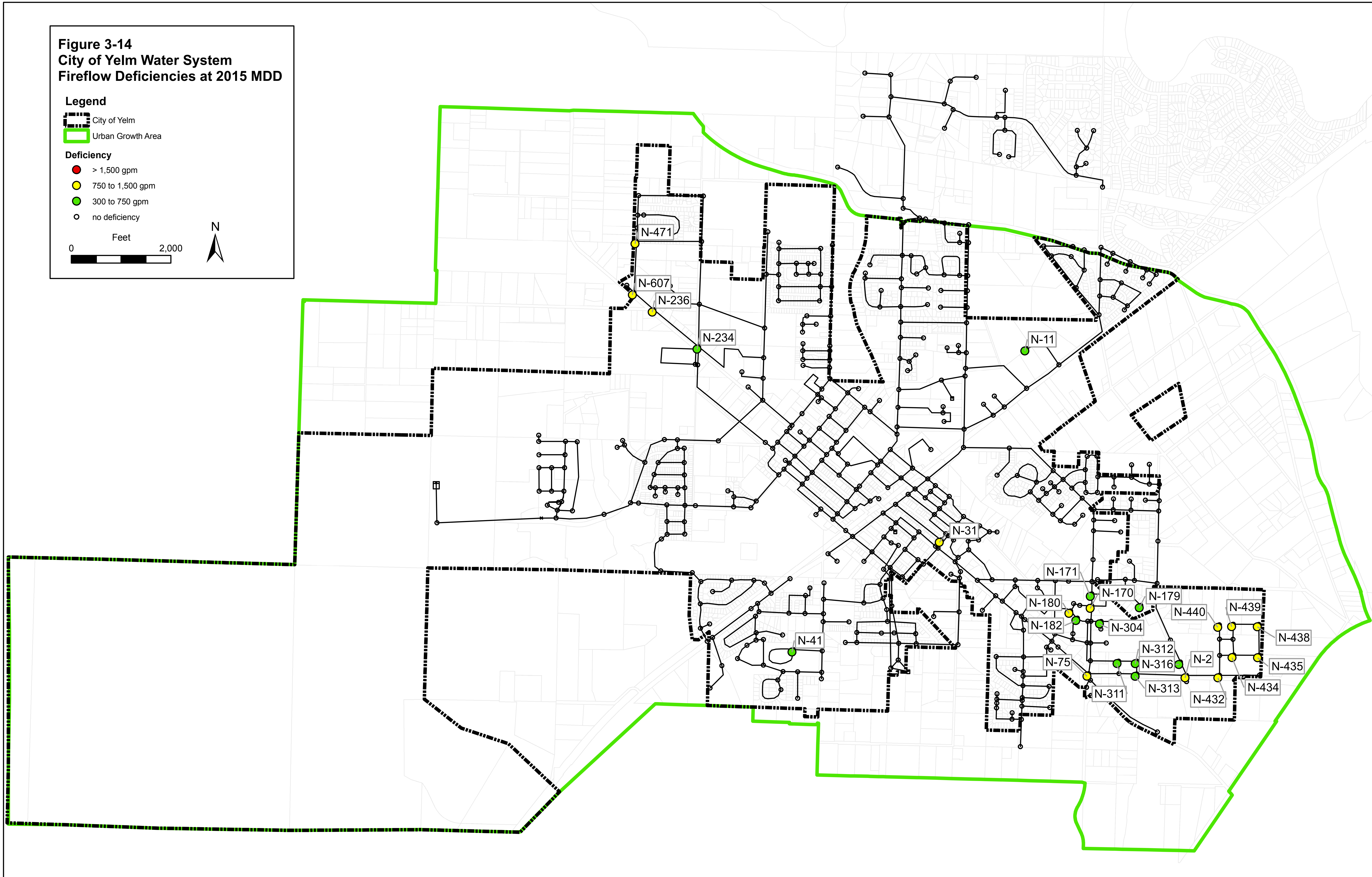

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Table 3-16. 20-Year CIP Distribution System Projects		
Project ID[1]	Project Name	Year Online
D-4	Replace 4" and smaller AC pipe with 10" PVC on 4th St. & Washington Ave. SE	2016
D-5	Replace 4" and 6" AC pipe with 8" PVC on Algiers Ct. & Dr. & Yelm View	2018
D-6 & D-7	Pipe Replacement on Tranquility & new 12" loop from Sprague St. to Killion Ct.	2022
D-8 & D-9	New 8" & 10" PVC water lines at Wilkensen and at SR 507 to complete loops	2026

[1] *See Table 8.4 for project descriptions.*

- **2029 MDD with Fire Flow: without MPCs.** Fire flow demands were modeled using the system as it would be configured after completion of the 20-year CIP using 2029 MDD flow rates for the "without MPCs" scenario. This model run incorporated a reservoir level elevation of 470 for the two existing reservoirs (Public Works and Baker Hill) and the new reservoir in southeast Yelm in the vicinity of Wal-Mart (RES-2). In addition, the new reservoir, which will be located in the 630 pressure zone, was incorporated into the system by assuming the connection to the system provided a continuous pressure equivalent to an elevation of 477 feet downstream of the pressure-reducing valve. This model run demonstrated that all of the deficiencies identified for the existing system would be addressed after completion of the 6- and 20-year CIPs, as shown in Table 3-17.

3.3.5 Summary of System Deficiencies and Recommended Improvements

In 2008, water use in Yelm totaled 756 acre-feet, or 3,140 ERUs. The following sections summarize the capacity of the water system infrastructure compared to those demands. Improvements that are planned to address current capacity deficiencies are also summarized below. Details regarding the improvements, in the form of a CIP, are presented in Chapter 8.

3.3.5.1 Water Rights

Chapter 4 describes the water rights the City holds, water rights transfers that are currently being processed, and pending water rights applications to Ecology. The City's water rights portfolio total approximately 796.66 acre-feet. The total portfolio represents enough water to serve 3,308 ERUs based on an ERU value of 215 gpd/ERU.

A sequence of water rights approvals and transfers is described in Chapter 4 which will result in the City holding a portfolio of 3,949.25 acre-feet in 2030 (equivalent to 16,398 ERUs). Depending on how fast population increases in Yelm, the City's withdrawals will be limited by the available water rights until 2011 for both the "with MPCs" and "without MPCs" scenarios.

3.3.5.2 Sources

The existing sources in Yelm (Wells 1A and 2) provide enough capacity to serve 3,335 ERUs (see Table 3-4). Depending on how fast Yelm grows, the remaining source capacity could be exhausted in 2010. Completion of the Downtown Well improvements by 2011 will provide additional capacity of approximately 500 gpm, based on initial estimates, or the equivalent of 1,390 ERUs. A schedule is presented in Section 3.3.1.5 for the construction of new wells in the southwest Yelm wellfield for the "with MPCs" and "without MPCs" scenarios, beginning in 2012, that will result in adequate source capacity being maintained for the 6- and 20-year planning horizons, consistent with projected population and water demand growth.

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Table 3-17. Deficiencies of Significance 2029 MDD with Fire Flow without MPCs				
Node	Approximate Location	Deficit at 2015 Conditions	Primary Improvements to Address 2015 Deficit	Surplus or Deficit at 2029 Conditions
N-2	Grove Rd. & SR 507	-1,057	RES-2, T-4	1,968
N-11	Northern Pacific Rd.	-491	RES-2, T-4	-339
N-31	4th St. & Yelm Ave.	-942	D-4	3,343
N-41	Mill Pond School	-507	T-5	585
N-170	Creek St. & Creek Ln.	-482	RES-2, T-4	1,300
N-171	Creek St. & Creek Ln.	-412	RES-2, T-4	795
N-179	10400 Tranquility Ln.	-377	D-6	872
N-180	Algiers Ct. & Algiers Dr.	-862	D-5	1,090
N-182	Yelm View Ct. & Algiers Dr.	-702	D-5	1,125
N-234	Mountain View & SR 510	-531	D-7	795
N-236	1600 W Yelm Ave.	-786	D-7	795
N-304	Algiers Dr. east of Creek St.	-476	RES-2, T-4	175
N-311	16500 106th Ave. SE	-583	RES-2, T-4	995
N-312	16600 106th Ave. SE	-688	RES-2, T-4	821
N-313	16600 SR 507	-631	RES-2, T-4	1,420
N-316	Grove RD North of SR 507	-1,028	RES-2, T-4	1,008
N-432	Wal-Mart Area	-1,281	RES-2, T-4	1,631
N-434	Wal-Mart Area	-1,293	RES-2, T-4	1,370
N-435	Wal-Mart Area	-1,417	RES-2, T-4	200
N-438	Wal-Mart Area	-1,440	RES-2, T-4	51
N-439	Wal-Mart Area	-1,387	RES-2, T-4	439
N-440	Wal-Mart Area	-1,327	RES-2, T-4	3,179
N-471	Burnett Rd. & 91st Ave.	-966	D-7	-82
N-607	Burnett Rd. & Yelm Ave.	-896	D-7	128

3.3.5.3 Treatment Systems

Existing treatment systems for disinfection and corrosion control were sized for the existing sources and provide adequate capacity. New treatment facilities will be constructed as part of the implementation of new sources at the southwest Yelm wellfield.

3.3.5.4 Storage Facilities

The existing storage facilities provide 1 MG of storage, or enough to serve 3,651 ERUs in 2008 (see Table 3-6). The construction of new reservoirs as the southwest Yelm wellfield is developed, as well as a reservoir in southeast Yelm (Project RES-2), will provide additional capacity as water demands increase.

3.3.5.5 Transmission and Distribution System

Section 3.3.4 describes the hydraulic analysis of the existing distribution and transmission system and identifies deficiencies. A program of pipeline replacement projects has been developed which, when

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combined with the source and reservoir improvements, will address these deficiencies. Transmission projects also include mains that will connect the new wells and reservoirs to the distribution system.

3.3.5.6 Summary

Tables 3-18 and 3-19 summarize the water demands and available annual water rights, source, and reservoir capacities for current conditions and the 6- and 20-year planning horizons. Figure 3-15 presents the capacity that would be available for each year of the planning period for the "with MPCs" scenario; Figure 3-16 presents this information for the "without MPCs" scenario. These tables and figures show that the program of planned improvements will ensure that adequate capacity will be available to meet projected demands throughout the planning period for the "without MPCs" scenario.

Table 3-18. Water System Infrastructure Capacity (ERUs): "with MPCs" Scenario

		Available Capacity		
Year	ERUs Served[1]	Annual Water Rights[2]	Source[3]	Storage[4]
2008	3,140	3,308	3,335	3,651
2015	8,553	8,542	10,978	8,396
2029	16,103	16,103	14,590	14,205

[1] See Table 3-4.
[2] See Table 4-8 and the City's current Water Right Self Assessment Form in Chapter 4 for descriptions of water rights currently held and others being negotiated as of June 2010. Water rights expected to total 16,398 ERUs by 2030.
[3] See Table 3-4.
[4] See Table 3-6.

Table 3-19. Water System Infrastructure Capacity (ERUs): "without MPCs" Scenario

		Available Capacity		
Year	ERUs Served[1]	Annual Water Rights[2]	Source[3]	Storage[4]
2008	3,140	3,308	3,335	3,651
2015	4,479	6,242	6,809	6,004
2029	7,812	9,201	8,337	9,226

[1] See Table 3-5.
[2] See Table 4-7 and the City's current Water Right Self Assessment Form in Chapter 4 for descriptions of water rights currently held and others being negotiated as of March 2010. Water rights expected to total 16,398 ERUs by 2030.
[3] See Table 3-5.
[4] See Table 3-7.

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Figure 3-15
System Capacity in ERUs (with MPCs)

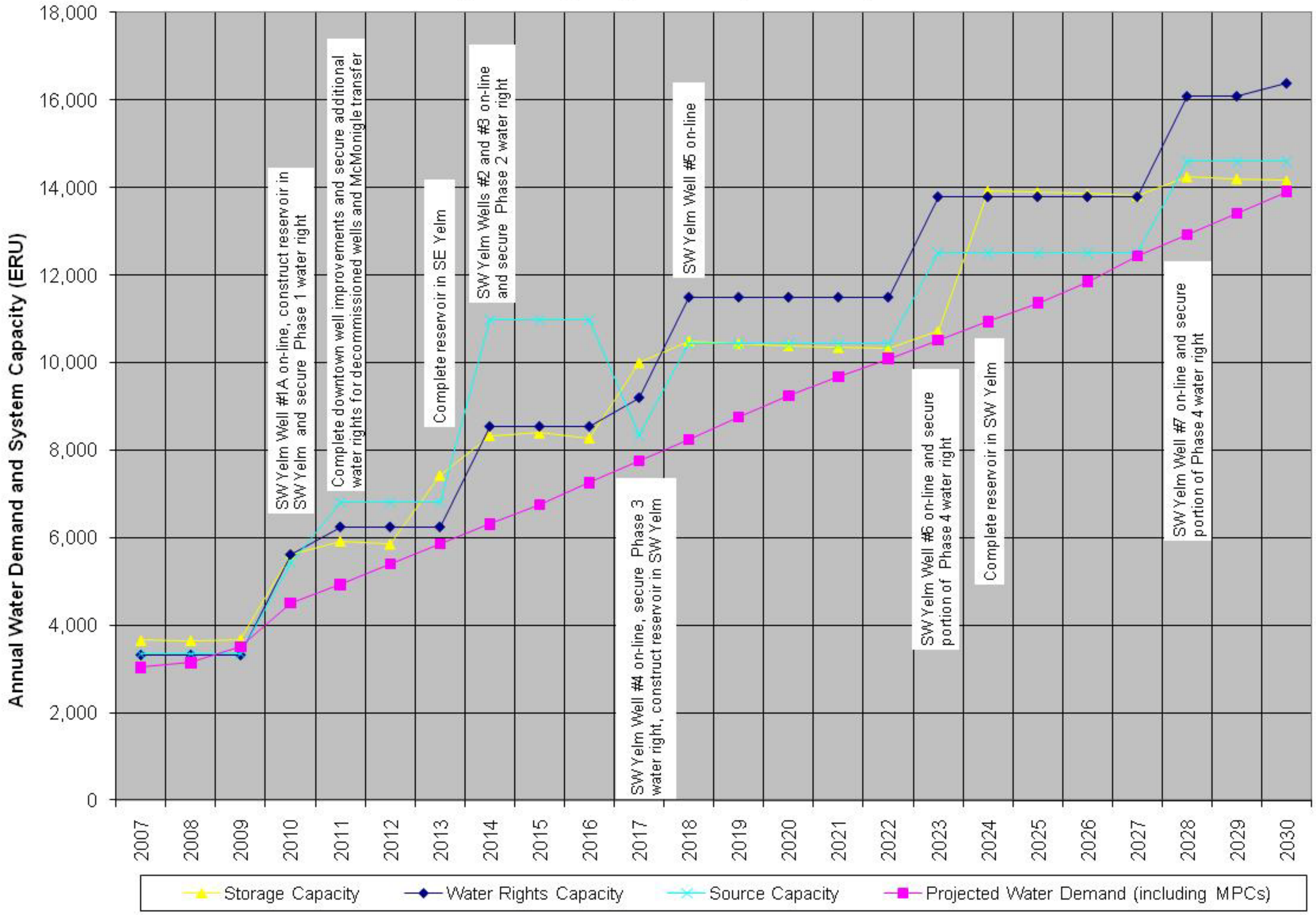

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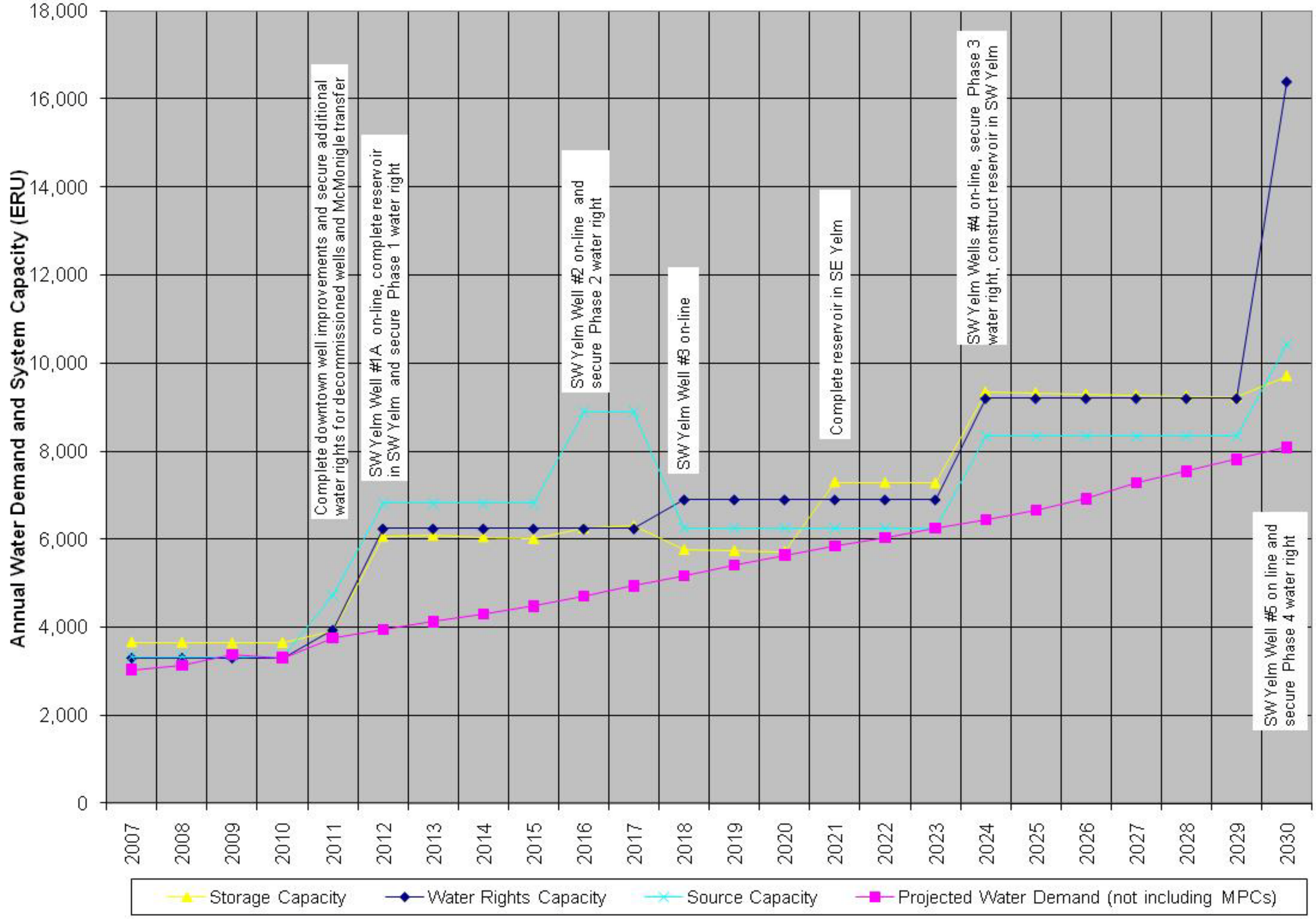
Figure 3-16
System Capacity in ERUs (without MPCs)



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