SECTION 4
WATER SYSTEM ANALYSIS

This section presents an analysis of the City of Grants Pass's (City's) water distribution system based on criteria outlined in **Section 3**. The water demand forecasts summarized in **Section 2** are used in conjunction with analysis criteria to assess water system characteristics including service pressures and zone boundaries, storage and pumping capacity and emergency fire flow availability. This section provides the basis for recommended distribution system improvements presented in **Section 5**.

Pressure Zone Analysis

Pressure zones are defined by ground topography. Their hydraulic grade lines (HGLs) are determined by overflow elevations of water storage facilities, discharge pressures of pump stations or outlet settings of pressure reducing facilities serving the zone. The City's existing distribution system is divided into five primary service levels (1, 2, 3, 4 and North Valley (NV)) defined by their HGLs. At each of these levels there are several hydraulically and geographically isolated pressure zones with similar HGLs. For the purposes of this analysis each hydraulically isolated pressure zone is considered independently regardless of service level or HGL. Existing and proposed future water service area boundaries and pressure zones are illustrated on the water system maps in **Appendix A**.

Existing Pressure Zones

The existing distribution system has both gravity storage and constant pressure zones. Zones currently served from finished water storage reservoirs include Zones 1, 2, 3, 4 and NV. Constant pressure zones are those which supply customers from booster pump stations without the benefit of storage. Constant pressure zones currently serve areas at higher elevations to the north and southeast of the city center including Zones 2HT (Hilltop), 2HK (Harbeck), 2MW (Meadow Wood low), 2NH (New Hope), 3MW (Meadow Wood high), 3P (Panoramic), 3S (Starlite) and 4LR (Laurel Ridge). Constant pressure zones are only recommended for areas with 200 Equivalent Residential Units (ERUs) or less, low water demand and limited potential for expansion or future looping. The existing system also includes two pressure reducing valve (PRV)-controlled subzones, 2A in the central city and 3B along Beacon Drive between Zones 2 and 4. Existing pressure zones are summarized in **Section 1**, **Table 1-2**.

The City's existing pressure zones provide adequate service pressures between 35 and 80 pounds per square inch (psi) to the majority of current water system customers. Some customers at slightly higher elevations on the perimeter of the distribution system, those near pressure zone boundaries or those in areas with limited existing water system piping may have pressures below 35 psi.

Proposed Future Pressure Zones

As the City's water service area grows into the urban growth boundary (UGB), the water system will need to provide adequate service pressure to more high-elevation customers at the perimeter of the existing distribution system. Where possible, the future service area growth will be supplied by extending piping from existing pressure zones. As existing constant pressure zones expand to include more than 200 ERUs, new storage reservoirs are recommended to supply customers by gravity. Proposed future pressure zone conversions from constant pressure to gravity service as well as new constant pressure zones are summarized in **Table 4-1**.

Future constant pressure zones are also proposed to serve isolated high elevation areas within the UGB and urban reserves as the water service area expands and development warrants. Some of the proposed constant pressure zones, such as 2SW (Southwest), 4GH (Granite Hill) and 4V (Vertical Dr), serve isolated high-elevation areas of less than five acres. In these cases, booster pumps on individual services may be a more feasible option to serve small groups of customers rather than creating new constant pressure zones including pumping facilities with adequate capacity to supply required fire flows.

Future Pressure Zone Boundary Changes

In order to adequately serve the UGB, significant expansion or changes are recommended for some of the City's existing pressure zone boundaries. Each of the following zone boundary adjustments is discussed in more detail in **Appendix C** including any alternative configurations which were considered:

Proposed Zone 2H

Proposed Zone 2H combines existing water mains in Zones 2HK (Harbeck) and 2HT (Hilltop) into a single zone. Zone 2H will be expanded through transfer of Zone 1 mains on Grandview Avenue to complete a Zone 2H loop for improved service pressures and fire flow availability in the area. This zone change would also allow the undersized Harbeck Pump Station to be abandoned. Implementing Zone 2H is dependent on construction of new mains through developable land where there is no existing public rights-of-way, thus this zone boundary change is anticipated to proceed only as develop warrants.

Spalding Industrial Area Zone 2 Expansion

New Zone 2 facilities are needed to provide adequate service pressure to future development in the Spalding Industrial area southeast of the intersection of the Redwood Highway (Hwy 199) and Interstate 5 (I-5). A new Zone 2 reservoir is proposed near Pearce Park to provide service pressure and fire storage. Existing Zone 1 mains on Foothill Boulevard north of Hwy 199, which receive minimal existing service pressure, would also be converted to the higher-HGL Zone 2. The converted Foothill Boulevard mains would loop the Spalding Industrial area with existing Zone 2 facilities north of NE A Street. The future Spalding Industrial area

cannot be adequately served from the existing Foothill Boulevard mains under either Zone 1 or Zone 2 service pressure, additional storage is required. This proposed zone expansion is anticipated to proceed as development in the Spalding Industrial area warrants.

Zone 3 and 4 service north of I-5

Recent expansion of the City's UGB included a large area north of I-5 between Granite Hill Road and existing Zone 4 customers in the Hillcrest neighborhood. Elevations in this area fall in the service range for existing Zones 3 and 4. Proposed Zone 3 properties in this area have an employment zoning designation which requires a large, 4,000 gallon per minute (gpm) fire flow. As presented in **Appendix C**, three alternatives, Options A, B and C were evaluated for future service to this area. Proposed facilities presented in the **Section 5** Capital Improvement Program (CIP) table reflect Option C. These facilities include:

- construction of an additional water main crossings under I-5 at NE Greenfield Drive and NW Scenic Drive
- new large diameter Zone 3 and 4 looped mains
- new Zone 4 pump station and storage facility on the City's Ausland Drive site to replace undersized existing Reservoir No. 13
- conversion of low elevation Zone 4 Hillcrest customers to Zone 3
- abandoning existing Hefley Pump Station and Beacon Drive PRV

Proposed Zone 4N

Recent expansion of the City's UGB included employment-zoned properties north of the current city limits along I-5 and Highland Avenue which are too high in elevation to be served from the existing North Valley Reservoir. A new constant pressure pump station and 16-inch diameter distribution main are needed to provide adequate service pressure and fire flow to potential customers in this area. This proposed zone expansion is anticipated to proceed as development warrants.

Table 4-1
Future Pressure Zone Summary

Zone ID	Description	Existing Zone Type	Future Zone Type	Zone Supplied From
1		Gravity storage	Gravity storage	-
1RR	River Road	-	PRV subzone	1
2		Gravity storage	Gravity storage	-
2A		PRV subzone	PRV subzone	2
2FD	Fruitdale	-	Constant pressure[1]	1
2H	Hilltop & Harbeck	Constant pressure	Constant pressure	1
2MW	Meadow Wood (low)	Constant pressure	Gravity storage	Existing = 1
2NH	New Hope	Constant pressure	Gravity storage	Existing = 1
2SW	Southwest	-	Constant pressure	1
3		Gravity storage	Gravity storage	-
3BG	Blue Gulch	-	PRV subzone	4LR
3MW	Meadow Wood (high)	Constant pressure	Constant pressure	1
3P	Panoramic	Constant pressure	Constant pressure	2MW
3S	Starlite	Constant pressure	PRV subzone[2]	Existing = 1 Future = 4LR
3SE	Southeast	-	Constant pressure	2MW
3WX	Williams Crossing	Constant pressure	Constant pressure	2NH
4		Gravity storage	Gravity storage	-
4GH	Granite Hill	-	Constant pressure	3
4LR	Laurel Ridge	Constant pressure	Gravity storage	Existing = 3
4N	North	-	Constant pressure	NV
4V	Vertical Drive	-	Constant pressure	4
NV	North Valley	Gravity storage	Gravity storage	-
RCC	Rogue Community College	-	See following discussion	-

Notes:

1. Zone 2FD would be initially served as a constant pressure zone. As development warrants, 2FD distribution piping will be merged with the future 2MW gravity storage zone and any 2FD pump station would be abandoned.
2. With the development of 4LR gravity storage, 3S may be converted to a PRV subzone and the Starlite Pump Station abandoned.

Rogue Community College (RCC)

As described in **Sections 1** and **2**, RCC is currently supplied through a private water distribution system with a dedicated groundwater source. For the purposes of this analysis, it is assumed that RCC may receive water service from the City within the 30-year planning horizon. However, there is currently no indication that RCC will pursue City water service in the foreseeable future.

The RCC campus property falls between approximately 1,005 and 1,130 feet elevation, straddling the service elevations for existing adjacent pressure Zone 1 and Zone 2. All current development on the RCC campus is below approximately 1,050 feet elevation. Estimated demands presented in **Section 2** included only the existing 30 acres of developed campus property. Previous planning efforts identified the RCC campus as Zone 2B. Based on discussions with City staff, previous planning work informally proposed two primary approaches to providing future water service to RCC:

1. Storage reservoirs which would supply the campus by gravity at approximately the same HGL as the existing on-campus reservoir which is part of the RCC private water system. This solution also requires a booster pump station to fill the proposed reservoir from existing nearby Zone 1 distribution piping.

2. A booster pump station near the college which could supply a future Zone 1 storage reservoir nearby as well as provide constant pressure service to the RCC campus, some of which is above the maximum Zone 1 service elevation of approximately 1,020 feet.

Option 1 – RCC Storage Reservoir

Existing development at the RCC campus which is below approximately 1,050 feet elevation, could be effectively served at an HGL of approximately 1,140 feet. RCC's existing private water system reservoirs are at a ground elevation of approximately 1,125 feet with an assumed overflow elevation of approximately 1,155 feet. Based on estimated demands for the existing 30 acre campus and assuming an institutional fire flow requirement of 4,000 gallons per minute (gpm), a potential reservoir should have an approximate capacity of 1.2 million gallons (MG). The City's *2001 Water Distribution System Master Plan* (*2001 WDSMP)* refers to the proposed RCC reservoir as Reservoir No. 12.

A new City booster pump station would also be required to fill a proposed RCC Reservoir from adjacent Zone 1 distribution piping. Based on estimated maximum day demand (MDD) for the existing 30 acre campus, a potential pump station supplying the proposed reservoir should have an approximate capacity of 90 gpm.

Future service to potential development at higher elevations on the RCC campus property would likely be served as a separate constant pressure zone supplied by a proposed booster pump station adjacent to a potential RCC storage reservoir. This potential RCC expansion is not evaluated as part of this WDSMP.

Option 2 – Constant Pressure Service

The RCC campus could be supplied as a constant pressure zone from a future RCC pump station at the intersection of Hubbard Lane and Canal Avenue. This approach may be advantageous if the City needs to construct additional Zone 1 storage facilities near the college. Based on previous planning work, a future Zone 1 storage reservoir this far from the City's Water Treatment Plant (WTP) would be expected to need additional booster pumping to overcome losses in the distribution piping and fill the reservoir. In this case a future RCC pump station would serve a dual purpose, filling the Zone 1 storage reservoir and providing constant pressure service to the college. Constant pressure service does present some challenges such as the college's 4,000 gpm required fire flow which the future pump station would need to provide with redundant pumps. A proposed RCC constant pressure station should be capable of providing peak hour demand (PHD) plus fire flow to the existing campus with an approximate firm capacity of 4,200 gpm.

At this time, improvements to provide water service to RCC are not recommended in this WDSMP. The need to plan for future service to RCC, and the most effective approach to provide service should be re-evaluated in future updates of this WDSMP.

Storage Analysis

Condition Assessment

Reservoir site visits were conducted to identify any major exterior issues and included a cursory inspection of on-site control buildings and valve vaults. No issues were identified at any of the reservoir sites. Recent inspection of the structural condition of Reservoir Nos. 4, 6 and 11 identified concerns regarding the condition of these facilities. It is recommended that the City complete a full structural evaluation of all three reservoirs in the next two years to determine the extent of repairs required to maintain these reservoirs in reliable service. The evaluation should include an analysis of each reservoir's expected performance in a seismic event.

Capacity

Storage facilities are provided for three purposes: operational storage, emergency or standby storage and fire suppression storage. As presented in **Section 3**, the total storage required is the sum of these three elements.

Storage reservoirs must have adequate capacity to meet demands within the zone being supplied by gravity as well as demands in all PRV subzones and all constant pressure zones pumping out of the gravity zone. For example, Zone 2 Reservoir Nos. 4 and 6 must have adequate capacity to meet demands in Zone 2 as well as PRV subzone 2A and Zone 3S which is supplied from Zone 2 through the Starlite Pump Station.

Fire storage is determined by the maximum fire flow requirement of the gravity zone and any PRV subzones. Constant pressure zones cannot be adequately supplied fire flow from a lower-elevation reservoir and must have adequate pumping capacity to meet fire flow requirements.

Existing Storage

Pressure zones 1, 2, 3, 4 and NV are currently supplied by gravity from finished water storage reservoirs. Under existing demand conditions, Zones 1 and 2 have adequate capacity to meet storage criteria. There are storage deficits in both Zone 3 and Zone 4. Existing storage requirements and current capacity in MG are summarized in **Table 4-2**.

Table 4-2
Existing Storage Analysis

Pressure Zone	Other Zones Served	Existing Reservoirs Supplying Zone	Required Storage Volume (MG)				Existing Storage (MG)	Storage Volume Deficit (MG)
			Operational	Standby	Fire Suppression	TOTAL		
1	2HK, 2HT, 2MW, 2NH, 3MW, 3P, 3WX	3, 5, 11	2.84	8.12	0.96	11.92	13.0	**0.0**
2	2A, 3S	4, 6	0.00	1.78	0.96	2.74	4.25	**0.0**
3	4LR	8	0.00	1.17	0.96	2.13	2.0	**0.2**
4	3B	13	0.00	0.12	0.18	0.30	0.08	**0.3**
NV	-	15	0.00	0.05	0.96	1.01	1.3	**0.0**

North Valley

The North Valley Reservoir No. 15 has significant surplus capacity under existing conditions. The reservoir is currently operated approximately one-quarter full due to slower than anticipated growth in North Valley and water quality concerns associated with slow reservoir turnover. At this lower operating level, the reservoir storage volume is approximately 0.3 MG. Reservoir No. 15 should be providing approximately 0.96 MG of fire storage in order to supply a 4,000 gpm industrial fire flow. It is recommended that the City operate the North Valley Reservoir No. 15 at least three-quarters full to provide adequate fire storage.

This operational change may not be practical due to water quality concerns associated with slow reservoir turnover. In that case the City may wish to assess the following recommended alternatives:

1. Increase pumping and transmission capacity from the North Valley Pump Station to Reservoir No. 15 such that the reservoir may be quickly refilled as storage is depleted in a fire emergency. It should be noted that larger North Valley transmission mains would be costly to construct and would likely have similar water quality concerns due to low demand under normal operating conditions

2. Work with the Grants Pass Public Safety / Fire Division and Rural/Metro Fire to determine current fire flow requirements for existing development in the North Valley Zone and operate Reservoir No. 15 at a level sufficient to provide fire storage for these existing customers. Actual fire flow requirements for existing structures may be lower than the 4,000 gpm industrial fire flow criteria due to automatic fire sprinkler systems and specific building construction materials, size and occupancy use.

Proposed Future Storage

As the City's water service area grows, water demand projections indicate that some existing constant pressure pumped zones will expand to include more than 200 ERUs. Storage reservoirs are recommended to supply customers by gravity in zones with more than 200 ERUs as described in **Section 3**. The future storage analysis presented in **Table 4-3** includes existing gravity zones as well as those existing constant pressure pumped zones which are anticipated to grow beyond 200 ERUs and are recommended for conversion to gravity zones. Proposed reservoirs are recommended to serve new gravity zones in the Meadow Wood, New Hope / Cathedral Hills and Laurel Ridge areas.

Table 4-3
Proposed Future Storage Analysis

Pressure Zone	Other Zones Served	Timeframe	Total ERUs	Required Storage Volume (MG)				Existing Effective Storage (MG)	Storage Volume Deficit (MG)
				Operational	Standby	Fire Suppression	TOTAL		
1	1RR, 2HK, 2HT, 2SW	**10-Year**	14,142	3.34	9.55	0.96	13.85	13.0	**0.9**
		20-Year	17,011	0.00[1]	11.49		12.45		**-**
		30-Year	22,272	0.00	15.05		16.01		**3.1**
2	2A, 3S (10-Year only)	**10-Year**	3,230	0.00	2.19	0.96	3.15	4.25	**-**
		20-Year	3,198	0.00	2.16		3.12		**-**
		30-Year	3,261	0.00	2.20		3.16		**-**
2MW	2FD, 3MW, 3P, 3SE	**10-Year**	282	0.00	0.19	0.18	0.37	0.0	**0.4**
		20-Year	971	0.00	0.65		0.83		**0.9**
		30-Year	1,531	0.00	1.04		1.22		**1.3**
2NH	3WX	**10-Year**	292	0.00	0.20	0.54	0.74	0.0	**0.8**
		20-Year	726	0.00	0.49		1.03		**1.1**
		30-Year	913	0.00	0.62		1.16		**1.2**
3	4GH, 4LR (10-Year only)	**10-Year**	2,112	0.00	1.43	0.96	2.39	2.0	**0.4**
		20-Year	2,341	0.00	1.59		2.55		**0.6**
		30-Year	2,590	0.00	1.75		2.71		**0.8**
4	3B, 4V	**10-Year**	217	0.00	0.15	0.18	0.33	0.08	**0.4**
		20-Year	435	0.00	0.29		0.47		**0.5**
		30-Year	528	0.00	0.36		0.54		**0.6**
4LR	3BG, 3S	**10-Year**	-	-	-	0.18	-	0.0	**-**
		20-Year	465	0.00	0.32		0.50		**0.5**
		30-Year	465	0.00	0.32		0.50		**0.5**
NV	4N	**10-Year**	2,236	0.12	1.56	0.96	2.64	1.3	**1.4**
		20-Year	2,609	0.16	1.83		2.95		**1.7**
		30-Year	2,671	0.17	3.01		3.01		**1.8**

Notes:

1. As described in Section 3, Zone 1 operational storage requirements are reduced beyond the initial 10-year planning horizon to reflect future WTP operations.

Zone 1

Zone 1 Reservoir Nos. 3, 5 and 11 have an approximate 0.9 MG storage deficit within the 10-year planning window. This 10-year Zone 1 storage deficit is due to large operational storage capacity requirements. As discussed in **Section 3**, the City's WTP is currently operated on a daily shift schedule rather than "call on-demand" based on reservoir water levels. Thus Zone 1 operational storage volume is calculated using conservative criteria through the 10-year planning window to account for demands which may occur while the WTP is not operating.

In the 20-year planning window, it is assumed that increased system-wide demands will require the City to begin operating the WTP on a 24-hour call on-demand basis or clearwell capacity will be provided for high service pump station operation while the WTP is idle. Zone 1 operational storage requirements at 20 years are calculated using the same criteria as all other City pressure zones which significantly reduces required storage capacity in Zone 1. As presented in **Table 4-3**, there is no storage deficit in Zone 1 reservoirs at the 20-year planning horizon. It is recommended that short-term Zone 1 storage requirements be re-evaluated as planning for future WTP replacement progresses.

In the long-term, it is recommended that the City plan for an additional Zone 1 storage reservoir with an approximate capacity of 3.1 MG. This facility would be needed to serve existing City residents who are currently supplied from private wells when and if they become City water customers as well as new development in the UGB and urban reserve areas. It is recommended that this long-term Zone 1 storage need be further evaluated as WTP capacity is expanded and continued in-fill development and growth occurs. The 20-year CIP prescribed in this WDSMP does not include construction of new Zone 1 storage.

Zone 2

Zone 2 Reservoir Nos. 4 and 6 have adequate storage through the 20-year and saturation development planning horizons. In order to provide adequate service pressure to the Spalding Industrial area and proposed Zone 2 service area expansion along Foothill Boulevard, new Zone 2 storage will be required as it is not practical to construct large diameter transmission mains from Reservoir No. 4 and south on Foothill Boulevard to the future industrial development. Proposed Reservoir No. 19 should have an approximate capacity of 1.2 MG to provide emergency storage and adequate volume to meet a 4,000 gpm industrial fire flow requirement.

Zone 3

Zone 3 Reservoir No. 8 has an approximately 0.2 MG storage deficit under existing conditions. This deficit is projected to increase with anticipated growth to approximately 0.8 MG at saturation development. It is recommended that the City plan for a second Zone 3 storage reservoir in the long term.

Zone 4

Zone 4 Reservoir No. 13 has an approximately 0.3 MG storage deficit under existing conditions. This deficit is projected to increase with anticipated growth to approximately 0.5 MG at saturation development. Due to the large existing capacity deficit, including inadequate fire suppression storage, and site accessibility limitations at the reservoir, it is recommended that the City plan to replace the existing 0.08 MG Reservoir No. 13 with a new approximately 0.6 MG reservoir within the next 5 years.

North Valley

The North Valley Reservoir No. 15 has excess capacity under existing demand conditions. As presented in **Table 4-3**, within the 10-year planning window a significant deficit of 1.4 MG develops based on projected future demands, growing to 1.8 MG at saturation development. These future demand projections, discussed in detail in **Section 2**, are heavily influenced by future development in Paradise Ranch. In 2005, the City established agreements with the Paradise Ranch Resort developer to supply domestic water demands, limited interruptible golf course irrigation and water for fire protection. Although it is recommended that the City continue long-range planning which considers these agreements with Paradise Ranch, future development timing in the proposed resort area is still largely unknown. It is recommended that necessary storage capacity to serve North Valley be re-evaluated as development occurs, and that the CIP presented in this WDSMP does not include the construction of additional North Valley storage in the 20-year planning horizon.

Meadow Wood

The Meadow Wood area in southeast Grants Pass is currently supplied constant pressure from the Meadow Wood Pump Station to Zones 2MW and 3MW. Based on future growth projections, a new reservoir is proposed within the 10-year planning horizon to replace constant pressure service to Zone 2MW with gravity service. The proposed Meadow Wood Reservoir No. 16 would provide suction supply to the Panoramic Pump Station (Zone 3P) and Zone 3MW pumps at the existing Meadow Wood Pump Station.

As development occurs, the proposed Reservoir No. 16 would also serve customers in the proposed Zone 2FD and provide suction supply to a proposed constant pressure pump station serving proposed Zone 3SE. Proposed Reservoir No. 16 should have an approximate capacity of 1.3 MG to meet projected saturation development demands as presented in **Table 4-3**.

New Hope / Cathedral Hills

The New Hope / Cathedral Hills area along the Williams Highway in south Grants Pass is currently served by constant pressure pumping from the New Hope Pump Station. This area is designated as Zone 2NH. Based on future growth projections, a new reservoir is proposed within the 10-year planning horizon to replace constant pressure service with gravity service. In addition to serving existing customers and anticipated growth in Zone 2NH, this proposed

Reservoir No. 17 would provide suction supply to the small Williams Crossing Pump Station (Zone 3WX). Proposed Reservoir No. 17 should have an approximate capacity of 1.2 MG to meet projected saturation development demands as presented in **Table 4-3**.

Laurel Ridge

The Laurel Ridge area along NW Starlite Place in northwest Grants Pass is currently supplied constant pressure from the Laurel Ridge Pump Station to Zone 4LR. Based on future growth projections, a new reservoir is proposed within the 20-year planning horizon to replace constant pressure service with gravity service. In addition to serving customers in Zone 4LR, the proposed Reservoir No. 14 would ultimately supply future development in the Blue Gulch area south of Laurel Ridge (future Zone 3BG) and existing customers in Zone 3S.

Zone 3BG is proposed as a PRV-controlled sub-zone served from proposed Laurel Ridge Reservoir No. 14. Zone 3S is currently supplied constant pressure from the Starlite Pump Station and through the existing Starlite PRV. Following construction of proposed Reservoir No. 14, it is recommended that the Starlite Pump Station be abandoned and Zone 3S be served through the Starlite PRV. Proposed Reservoir No. 14 should have an approximate capacity of 0.5 MG to meet projected saturation development demands as presented in **Table 4-3**.

Pumping Capacity Analysis

Pumping capacity requirements are estimated based on available storage, the number and size of pumps serving the zone and the zone's maximum fire flow requirement. Recommendations are based on firm capacity which is defined as a pump station's capacity with the largest pump out of service.

In pressure zones supplied by gravity, operational and fire storage provided by reservoirs make it unnecessary to plan for fire flow or peak hour capacity from pump stations assuming adequate storage is available. Pump stations supplying gravity zones must have sufficient firm capacity to meet the maximum day demand for all customers in the zone and any higher level zones supplied from the primary zone.

Constant pressure pump stations supply a pressure zone without the benefit of storage. These stations are only recommended for areas with 200 ERUs or less and low water demand with limited potential for future looping with adjacent pressure zones. Pump stations supplying constant pressure service must have firm pumping capacity to meet peak hour demands while simultaneously supplying the largest fire flow demand in the zone**.** The pumping capacity analysis is summarized in **Table 4-4**.

Table 4-4
Pumping Capacity Analysis

Zone	Existing Pump Stations	Existing Firm Capacity (gpm)	Current				10-Year				20-Year				30-Year (Saturation)			
			Other Zones Served	Required Capacity		Needed	Other Zones Served	Required Capacity		Needed	Other Zones Served	Required Capacity		Needed	Other Zones Served	Required Capacity		Needed
				Type	gpm	gpm		Type	gpm	gpm		Type	gpm	gpm		Type	gpm	gpm
1	WTP High Service Pumps	16,600	2, 2HK, 2HT, 2MW, 2NH, 3MW	MDD	6,535	-	2, 2HK, 2HT, 2MW, 2NH	MDD	7,993	-	2, 2HK, 2HT, 2MW, 2NH, 2SW	MDD	9,826	-	1RR, 2, 2HK, 2HT, 2MW, 2NH, 2SW	MDD	12,583	-
2	Lawnridge, Madrone	3,790	2A, 3, 3S	MDD	2,014	-	2A, 3, 3S	MDD	2,472	-	2A, 3	MDD	2,597	-	2A, 3	MDD	2,736	-
2FD	-	0										PHD + FF	1,549	1,549		Served by gravity from 2MW		
2HK	Harbeck	168		PHD + FF	1,524	1,356		PHD + FF	1,524	1,356		PHD + FF	1,524	1,356		PHD + FF	1,549	1,381
2HT	Hilltop	1,676		PHD + FF	1,524	-		PHD + FF	1,524	-		PHD + FF	1,549	-		PHD + FF	1,549	-
2MW	Meadow Wood (low)	150	3P	PHD + FF	1,667	1517	3MW, 3P	MDD	119	-	2FD, 3MW, 3P, 3SE	MDD	556	406	2FD, 3MW, 3P, 3SE	MDD	722	572
2NH	New Hope	700	3WX	PHD + FF	3,177	2477	3WX	MDD	132	-	3WX	MDD	336	-	3WX	MDD	528	-
2SW	-	0										PHD + FF	1,514	1,514		PHD + FF	1,514	1,514
3	Champion	2,400	4LR, NV	MDD	778	-	4LR, NV	MDD	951	-	4GH, 4LR, NV	MDD	1,306	-	4GH, 4LR, NV	MDD	1,465	-
3MW	Meadow Wood (high)	500		PHD + FF	1,501	1,001		PHD + FF	1,502	1,002		PHD + FF	1,606	1,106		PHD + FF	1,606	1,106
3P	Panoramic	1,220		PHD + FF	1,512	292		PHD + FF	1,521	301		PHD + FF	1,521	301		PHD + FF	1,521	301
3S	Starlite	618		PHD + FF	1,512	894		PHD + FF	1,521	903								
3SE	-	0										PHD + FF	1,505	1,505		PHD + FF	1,681	1,681
3WX	Williams Crossing	70		PHD	8	-		PHD	14	-		PHD	14	-		PHD	14	-
4	Hefley	958		MDD	83	-		MDD	104	-		MDD	187	-		MDD	236	-
4GH	-	0										PHD + FF	4,014	4,014		PHD + FF	4,014	4,014
4LR	Laurel Ridge	700		PHD + FF	1,559	859		PHD + FF	1,569	869	3BG, 3S	MDD	222	-	3BG, 3S	MDD	222	-
4N	-	0										PHD + FF	4,069	4,069		PHD + FF	4,069	4,069
4V	-	0										PHD + FF	1,521	1,521		PHD + FF	1,521	1,521
NV	North Valley	570		MDD	35	-		MDD	1083	513	4N	MDD	1271	701	4N	MDD	1306	736

Notes:

1. 2HK pumping capacity deficit is planned to be addressed through the future integration of Zones 2HK and 2HT. Hilltop Pump Station capacity is adequate to supply the combined Zone 2H.

Existing Pump Stations

Existing pump stations serving gravity Zones 1, 2, 3 and 4 have adequate firm pumping capacity to supply MDD to zone reservoirs under existing and projected future demand conditions through saturation development.

North Valley Pump Station (Zone NV)

As with the storage capacity analysis, the existing Zone NV North Valley Pump Station has adequate pumping capacity under existing conditions but develops a significant pumping deficit within the 10-year planning horizon based on projected demand growth in the North Valley area. This projected demand growth is heavily influenced by future development in Paradise Ranch. Although it is recommended that the City continue long-range planning which considers 2005 agreements with the Paradise Ranch developer to provide water service, future development timing in the proposed resort area is still largely unknown. Thus, it is recommended that necessary pumping capacity to supply the North Valley Reservoir No. 15 and Zone NV customers be re-evaluated as development occurs.

Existing Constant Pressure Pump Stations

The Williams Crossing Pump Station has adequate capacity to meet projected demands for Zone 3WX through saturation development. It is assumed that fire flow is provided to the six customers in Zone 3WX from the adjacent Zone 2NH distribution system.

Existing constant pressure pump stations Meadow Wood low level (Zone 2 MW), New Hope and Laurel Ridge are proposed for conversion to gravity zones, with pumps supplying a storage reservoir, within the 20-year planning horizon. Each of these stations and pressure zones are discussed in more detail under the ***Proposed Future Pump Stations*** below.

Meadow Wood high level (Zone 3MW), Panoramic and Starlite Pump Stations all have capacity deficits under existing conditions. It is recommended that the Meadow Wood high level pumps and Panoramic Pump Stations be upgraded to provide adequate fire flow at firm capacity. As discussed under the ***Proposed Future Pump Stations*** heading below, the Starlite Pump Station is anticipated to be abandoned following construction of the proposed Laurel Ridge Reservoir No. 14. In the interim, supplemental fire flow is provided to the Starlite Zone from the Laurel Ridge PRV.

<u>Hilltop and Harbeck (Zones 2HT and 2HK)</u>

The existing constant pressure Hilltop Pump Station has adequate firm capacity to meet projected Zone 2HT peak hour demands and provide adequate residential fire flow capacity through saturation development. Neighboring Zone 2HK, supplied constant pressure from the existing Harbeck Pump Station, has insufficient firm capacity to supply residential fire flow. As development occurs, distribution piping may be extended to connect Zones 2HT and 2HK to form a single proposed Zone 2H. With these two zones hydraulically connected

through adequately sized distribution piping, the Hilltop Pump Station could supply adequate firm capacity and the undersized Harbeck Pump Station could be abandoned. Further discussion of proposed Zone 2H is presented in Appendix C. It is recommended that capacity upgrades to the Harbeck Pump Station to meet residential fire flow requirements be re-evaluated as development occurs. For the purpose of the CIP presented in this WDSMP, it is assumed that the piping necessary to connect the two pressure zones will be constructed and that Harbeck Pump Station can be abandoned.

Proposed Future Pump Stations

Meadow Wood low level (Zone 2MW)

The Meadow Wood area is currently served by constant pressure pumping. Under existing conditions, the Meadow Wood Pump Station low level pumps (Zone 2MW) require additional firm capacity to provide current PHD and fire flow to Zone 2MW and PHD to Panoramic Loop (Zone 3P) customers. Within 10 years, Zone 2MW is anticipated to grow beyond the 200 ERU maximum recommended for constant pressure zones. As described earlier in this section, a proposed storage reservoir is recommended for construction within the 10-year planning horizon to replace constant pressure service with gravity service. When Zone 2MW is transitioned to gravity service, fire flow and operational (peak hour) capacity will be provided from proposed Reservoir No. 16 and will no longer be required from the Meadow Wood Pump Station low level pumps.

Under projected future demand conditions the Meadow Wood Pump Station low level pumps have adequate firm capacity to supply MDD through the 10-year planning window. It is recommended that the pump station's low level capacity be expanded within the 20-year planning horizon to meet projected MDD at saturation development in existing Zones 2MW, 3MW and 3P as well as proposed future Zones 2FD and 3SE. This additional capacity may be provided instead from a proposed Fruitdale Pump Station which would initially supply proposed Zone 2FD by constant pressure as development warrants. For the purpose of the CIP presented in this WDSMP, expansion of the Meadow Wood low level pumping capacity is not included and should be re-evaluated based on the timing and configuration of development in Zones 2FD and 3SE.

New Hope / Cathedral Hills (Zone 2NH)

The New Hope area is currently served by constant pressure pumping. Under existing conditions, the New Hope Pump Station requires additional firm capacity to provide current PHD and fire flow to New Hope and Williams Crossing customers. Within 10 years, the New Hope area is anticipated to grow beyond the 200 ERU maximum recommended for constant pressure zones based on demand projections presented in **Section 2**. As described earlier in this section, a proposed storage reservoir is recommended for construction within the 10-year planning horizon to replace constant pressure service with gravity service. When Zone 2NH is transitioned to gravity service, fire flow and operational (peak hour) capacity will be provided from proposed Reservoir No. 17 and will no longer be required from the

New Hope Pump Station. Under projected future demand conditions the New Hope Pump Station has adequate firm capacity to supply MDD through saturation development. If it is determined that the timing of Reservoir No. 17 construction is delayed beyond the 10-year planning horizon, a redundant high capacity pump should be added to the pump station in order to provide adequate firm pumping capacity.

Ausland Pump Station (Zone 4)

Zone 4 is currently served by the Hefley Pump Station and Reservoir No. 13. As described under the ***Proposed Future Pressure Zones*** and the **Storage Analysis** headings, in order to address the storage deficiency in Zone 4 and provide for expansion of Zone 4 inside the UGB north of I-5, new Zone 4 storage and pumping is recommended within the next 5 years. The new Ausland Pump Station would allow for the abandonment of the Hefley Pump Station.

Laurel Ridge (Zone 4LR)

Laurel Ridge is currently served by constant pressure pumping. Under existing and projected 10-year demand conditions, the Laurel Ridge Pump Station requires additional firm capacity to provide PHD and fire flow to Laurel Ridge customers. In the short term it is recommended that the Laurel Ridge Pump Station be expanded to include a redundant high capacity pump capable of supplying 1,500 gpm in the event of a fire emergency.

Within 20 years, the Laurel Ridge area is anticipated to grow beyond the 200 ERU maximum recommended for constant pressure zones based on demand projections. As described earlier in this section, a proposed storage reservoir is recommended for construction within the 20-year planning horizon to replace constant pressure service with gravity service. When Zone 4LR is transitioned to gravity service, fire flow and operational (peak hour) capacity will be provided from proposed Reservoir No. 14 and will no longer be required from the Laurel Ridge Pump Station. Under projected 20-year and saturation development demand conditions the Laurel Ridge Pump Station has adequate firm capacity.

Proposed Future Constant Pressure Pump Stations

New constant pressure pump stations are proposed to provide PHD and fire flow to small, high elevation areas within the City's UGB and urban reserves as development warrants. Based on service area boundaries and projected demands developed in **Section 2**, Zones 2FD, 2SW, 3SE, 4GH, 4N and 4V have the potential for development within the 20-year planning horizon. The recommended firm capacity of these proposed pump stations is largely determined by the required fire flow for the proposed pressure zone. Due to proposed employment and institutional zoning in pressure Zones 4N and 4GH, these stations should be capable of providing over 4,000 gpm at firm capacity. For the purpose of the CIP presented in this WDSMP, these future pump stations, which will be driven by development, are assumed to be 100% developer funded and are not included in the CIP.

Back-Up Power

At least two independent power sources are recommended for the City's pump stations. It is recommended that pump stations supplying gravity storage reservoirs include, at a minimum, manual transfer switches and connections for a portable back-up generator. The emergency storage volume in each reservoir will provide short term water service reliability in case of a power outage at the pump station. Back-up power is particularly critical for stations providing constant pressure service. On-site standby power generators with automatic transfer switches are recommended for all constant pressure pump stations serving zones without the benefit of gravity storage.

On-site back-up power generators are installed at the existing WTP high level pumps and all constant pressure pumping stations, except Williams Crossing and Starlite. Both of the zones served by these stations will continue to be supplied with water in the event of a loss of power.

The City is in the process of installing a manual transfer switch and generator plug at Lawnridge, Madrone, Champion, Hefley and North Valley pump stations. The City has acquired a trailer mounted diesel generator to allow operation of at least one pump at each of these stations.

Pump Station Condition Assessment

In December 2015, MSA conducted site visits with City staff, and documented the condition of existing pump stations. Field visit notes and photos for each pump station facility are presented in **Appendix D**. All 13 pump stations boosting water to higher level pressure zones in the distribution system were visited and assessment of the condition of the facility was made. The assessment focused on the physical structure housing the mechanical and electrical systems, pumping systems, standby power availability, status and flow metering.

Each of these components was given a Condition rating ranging from 1 (very good) to 5 (very poor) and a Criticality rating ranging from 1 (not critical) to 4 (critical, pump station could not operate upon failure). Issues with each of the components were documented, and then the Condition and Criticality ratings were used to prioritize improvements to address identified issues. An additional rating, Serviceability, was identified as further criteria that the City could use to manage and prioritize the investment in these individual components at each station in the future. Where data was available to provide an assessment of Serviceability, the rating was included. City staff will input additional Serviceability ratings in the future as equipment is maintained and data can be gathered. Major issues noted at each pump station, based on a poor Condition rating and a high Criticality rating, include:

- **Madrone Pump Station** – structural review recommended to assess building settlement

- **Champion Pump Station** – isolation valves and control valves need replacement – Pumps 1 and 2
- **Lawnridge Pump Station**
    - structural review recommended for building
    - replace failing rubber bellows
    - install discharge isolation valving
- **New Hope Pump Station** – repair or replace inoperable exhaust fans
- **Multiple Stations** – repair or replace existing inoperable flow meters at six pump stations

Distribution Capacity and Hydraulic Performance

Hydraulic Model

A steady-state hydraulic network analysis model was used to evaluate the performance of the City's existing distribution system and identify proposed piping improvements based on hydraulic performance criteria, such as system pressure and flow velocity, described in **Section 3**. The purpose of the model is to determine pressure and flow relationships throughout the distribution system for average and peak water demands under existing and projected future conditions. Modeled pipes are shown as "links" between "nodes" which represent pipeline junctions or pipe size changes. Diameter, length and head loss coefficients are specified for each pipe and an approximate ground elevation is specified for each node.

The hydraulic model was developed prior to this WDSMP using the InfoWater modeling software platform and geographic information system (GIS) base mapping. Building on the facilities identified in the prior model and updated facility and operations data provided by the City, the model was then calibrated using fire hydrant flow test data and analysis scenarios were created to evaluate existing and projected 20-year demands.

For distribution system modeling, the City's WTP High Service Pump Station is assumed to be off. Distribution storage reservoirs are modeled at their approximate operational level, based on historical level data from the City's SCADA system and input from City staff. This is approximately 75 percent full for reservoirs serving Zones 1, 2 and 3 (Res. Nos. 3, 4, 5, 6, 8, 11). The Zone 4 Reservoir No. 13 is undersized such that it is constantly either filling or emptying; it is modeled as 90 percent full for this steady-state analysis. The North Valley Reservoir No. 15 is operated approximately 25 percent full due to low demand and water quality concerns.

Modeled Water Demands

Existing and projected future demands are summarized in **Section 2**, **Tables 2-2** and **2-6**. Within the existing water service area, demands are assigned to the model based on current customer billing address and billed water consumption. Future demands in water service

expansion areas are assigned uniformly over each proposed pressure zone area illustrated on the water system maps in **Appendix A**.

Model Calibration

Model calibration typically involves adjusting the model parameters such that pressure and flow results from the model more closely reflect those measured at the City's fire hydrants. This calibration process tests the accuracy of model pipeline friction factors, demand distribution, valve status, network configuration, and facility parameters such as tank elevations, PRV settings and pump controls and curves. The required level of model accuracy can vary according to the intended use of the model, the type and size of water system, the available data, and the way the system is controlled and operated. Pressure and flow measurements are recorded for the City's fire hydrants through a process called fire flow testing.

Fire Flow Testing

Fire flow testing consists of recording static pressure at a fire hydrant and then "stressing" the system by flowing an adjacent hydrant. While the adjacent hydrant is flowing, residual pressure is measured at the first hydrant to determine the pressure drop that occurs when the system is "stressed". Boundary condition data, such as reservoir levels and pump on/off status, must also be known to accurately model the system conditions during the time of the flow test. For this WDSMP, hydrant flow tests were conducted on May 13th and 14th, 2015. The recorded time of each fire hydrant flow test was used to collect boundary condition information from the City's supervisory control and data acquisition (SCADA) system.

Steady-State Calibration Results

For any water system, a portion of the data describing the distribution system will be missing or inaccurate and assumptions will be required. This does not necessarily mean the accuracy of the hydraulic model will be compromised. Depending on the accuracy and completeness of the available information, some pressure zones may achieve a higher degree of calibration than others. Models that do not meet the highest degree of calibration can still be useful for planning purposes.

Many of the City's smaller pressure zones are served through constant pressure pump stations. For the majority of these stations, accurate pump discharge flow measurements are not available. Some stations do not have flow meters, others are not functioning properly or they may be sized incorrectly to capture the range of flows at the station. The absence of accurate flow data for constant pressure zones makes it difficult to accurately model these facilities. Flows were approximated based on the assigned demands in the model, City-provided pump curves and discharge pressures measured at each station.

No flow tests were conducted in the PRV-controlled Zone 3B or in the constant pressure Harbeck (2HK), Hilltop (2HT) or Williams Crossing (3WX) zones. These zones serve a

small number of customers with little or no potential for future expansion; thus, the absence of flow testing data in these zones is not expected to impact the overall accuracy of the hydraulic model. No flow tests were conducted in the Meadow Wood high (3MW) zone due to insufficient existing hydrants in this largely undeveloped area. The calibration's confidence level was evaluated based on the difference between modeled and field-measured criteria summarized in **Table 4-5**.

Table 4-5
Calibration Confidence

Confidence Level	Static Pressure Difference	Residual Fire Flow Pressure Difference
High	±5 psi	≤10 psi
Medium	± 5-10 psi	10-20 psi
Low	>10 psi	>20 psi

Each existing pressure zone's overall confidence level was determined by the number of low-, medium- and high-confidence results, as summarized in **Table 4-6**. Overall system calibration confidence is considered moderate to low.

Table 4-6
Calibration Confidence Results

Pressure Zone	Overall Confidence
1	Medium
2	High
2A	Low
2HK	No Data
2HT	No Data
2NH	Low
2MW	Low
3	Medium
3B	No Data
3MW	No Data
3P	High
3S	Low
3WX	No Data
4	High
4LR	Medium
NV	Low

Fire Flow Analysis

Fire flow scenarios test the distribution system's ability to provide required fire flows at a given location while simultaneously supplying MDD and maintaining a minimum residual service pressure of 20 psi at all services. Required fire flows are assigned based on the zoning surrounding each node as summarized in **Section 3**, **Table 3-1**.

Some areas within the City's existing distribution system are served through 2-inch diameter mains which are not capable of supplying recommended fire flows. These areas generally do not have existing fire hydrants and hydrants on nearby, larger-diameter water mains are not spaced to meet Oregon Fire Code requirements. Other than these 2-inch mains, the City has invested in large diameter loops through developing commercial areas and smaller projects to complete additional looping for fire flow in residential areas. As a result, relatively few fire flow deficiencies were identified under existing and projected future MDD conditions.

Peak Hour Demand Analysis

Distribution system pressures were evaluated under peak hour demand conditions to confirm identified piping improvements. Peak hour demands were estimated as 1.7 times the maximum day demand. No additional pressure deficiencies were identified under these conditions.

Distribution Main Condition Assessment

Interviews were conducted with City staff to characterize the condition of the distribution system piping and identify any areas of concern. In order to provide for the continued reliable operation of the distribution system, renewal and replacement of distribution system piping must be planned for. With the exception of specific locations where significant corrosion and failure of mains are occurring, specifically north of Midland and west of 6th Street, the service life of pipelines have exceeded 60+ years. For the purposes of planning an annual budget for continued main replacement, it is recommended that the City consider a 100-year service life for mains. In order to maintain reliable operation, without significant unexpected main breaks and leaks, capital maintenance budgeting for the distribution system should be based on complete replacement every 100 years. While some mains may perform satisfactorily for a longer duration, others can be expected to fail in a shorter time frame, due primarily to environmental conditions.

Corrosion Issues

Based on discussions with City staff, there have been a number of main breaks affecting 10-inch diameter cast iron mains in Zones 2 and 3 along NW Midland Avenue, Morgan Lane and Vine Street. Previous work by the City indicates corrosive soils reacting with the pipe materials may be one cause of these issues. Severe corrosion recently led the City to replace a large section of stormwater piping in this area. Current development in this area is commercial and light industrial. The old Grants Pass Airport operated on a site between NW

Vine Street and Morgan Lane from at least the early 1940s through approximately 1960. Due to recent main breaks, evidence of corrosive soils and the industrial history of the area, it is recommended that the City evaluate possible causes of main breaks including soil conditions and pipe materials prior to proceeding with recommended CIP water main replacement projects described in **Section 5**.

Pressure Reducing Valve Stations

Four PRV stations in the City's water system were assessed as part of pump condition site visits in December 2015. Two of these stations - the 9th and Savage PRV and the Manzanita PRV – have significant issues, including:

- No vault drain (standing water was observed in both vaults)
- Unsecured square hatch
- No smaller diameter bypass valve

It is recommended that the City plan for the replacement of these two PRV stations.

Distribution System Water Quality

The City of Grants Pass meets all current drinking water regulations. The 2014 *Water Treatment Plant Facility Plan Update* presented a comprehensive review of current and future water quality compliance issues relating to the City's source and treatment facilities. This analysis focuses on microbial contaminants (Total Coliform Rule), lead and copper (Lead and Copper Rule) and disinfection by-products (Stage 2 Disinfectants and Disinfection Byproducts Rule) which may be exasperated or originate in the distribution system.

Total Coliform Rule Compliance

The City is currently meeting all applicable requirements for the Total Coliform Rule. It is important to maintain active circulation of water throughout the distribution system, in both pipes and reservoirs in order to retain a chlorine residual. The absence of chlorine residual and accumulation of sediments contribute to bacterial growth, which in turn can result in failure to comply with this rule.

The City has experienced challenges maintaining a detectable chlorine residual throughout the distribution system while also managing the presence of disinfection by-products, due primarily to high water age in the distribution system. High water age in the Grants Pass system is generally caused by the need to pump water through multiple pressure zones and storage reservoirs, to reach the highest elevation zones. Future improvements to the water treatment process which are planned for inclusion in the future replacement of the City's WTP will help to reduce the concentration of disinfection by-products and the chlorine demand of the finished water delivered to the distribution system. The City has taken further action and continues to improve methods to reduce water age, maintain adequate chlorine

residuals and decrease distribution system chlorine demand, including:

1. Assessing implementation of an annual unidirectional flushing program (UDF) to reduce in-system chlorine demand. As part of this WDSMP project, a UDF pilot study will evaluate flushing program needs. The implementation of such a program requires up-front capital investment in development of the flushing plan and purchase of necessary equipment. On-going operational costs include budgeting for the staff required to perform the flushing operations on a routine basis.

2. Booster chlorination facilities have been installed at Lawnridge, Madrone and Champion Pump Stations to improve chlorine residual where high water age exists in these upper pressure zones. Recently the City has also improved automation of booster chlorination facilities at Lawnridge to allow for both flow pacing and chlorine residual monitoring feedback to accurately dose additional chlorine.

These steps have improved the City's ability to reliably maintain a detectable chlorine residual throughout the distribution system and have resulted in better management of disinfection by-products. At this time no further actions, beyond evaluation of a UDF program, are recommended to support continued compliance with the Revised Total Coliform Rule.

Lead and Copper Rule Compliance

The Grants Pass WTP has historically produced non-corrosive water, keeping the City in compliance with the Lead and Copper Rule since it was enacted in the early 1990s. There appears to be no concerns with future compliance with the Lead and Copper Rule.

Stage 2 Disinfectants and Disinfection Byproducts Rule (D/DBPR) Compliance

Currently, the City conducts quarterly sampling for DBP at the following four sample sites, all of which are currently in compliance:

- Merlin Landfill
- 1452 Forestview Drive
- New Hope Pump Station
- 1047 Starlite

The DBP levels at some of these sites have occasionally approached the maximum contaminant level (MCL). The City is proactively managing this issue through operational changes to minimize water age, and no further action is needed at this time.

Distribution System Hydropower Feasibility

Municipal drinking water systems present multiple opportunities for recovery of potential energy through the generation of hydroelectric power (hydropower). At any location where

water is transmitted by gravity flow to a lower elevation location, potential energy exists in the system that is typically, and intentionally, lost through the use of a control valve (consuming the energy) or discharge to an un-pressurized state (releasing the energy), such as a distribution system reservoir. At locations where this potential energy exists, the energy may be recovered through the installation of hydropower generation facilities – a turbine and a generator. The quantity of electrical power that may be generated from this potential energy depends on two primary factors, the flow rate of water and the available energy (the hydraulic head, or pressure).

Potential Hydropower Site Evaluation

In a municipal drinking water system, there are three primary opportunities for hydropower generation:

1. Water source
2. Transmission from treatment to the distribution system
3. Regulated connections between pressure zones

Water Source

Where a water system's source of supply is a gravity diversion (intake) located at a higher elevation than the WTP, the potential energy associated with the elevation difference is typically released in one of the initial steps in the water treatment process, in an un-pressurized basin (such as an initial sedimentation basin). Hydropower generation facilities may be installed to convert this excess energy to electrical power before it is released.

For the City of Grants Pass, the diversion of water at the Rogue River intake is pumped up from the river to the WTP, therefore there is no excess potential energy available for hydropower generation.

Transmission from the WTP to the Distribution System

In some drinking water systems, the WTP is located at an elevation higher than the distribution system, resulting in gravity transmission of water from the WTP to distribution system water storage reservoirs and customers. In this case, the excess potential energy is released at the reservoirs or consumed through a PRV, to prevent high pressure in the distribution mains from damaging distribution system components or customer fixtures. Hydropower generation facilities may be installed to convert this excess energy to electrical power before it is consumed or released.

In Grants Pass, the supply from the WTP to Zone 1, the lowest elevation pressure zone in the water system, is pumped up from the WTP. There is no excess potential energy available for hydropower generation at this location.

Regulated Pressure Zone Connections

Throughout a distribution system, there are typically a number of locations where a connection exists between a higher and lower elevation pressure zone. At these locations where water flows from the higher elevation zone to the lower elevation zone, a PRV is installed to consume the excess potential energy and prevent high pressure in the distribution mains from damaging distribution system components or customer fixtures. Hydropower generation facilities may be installed to convert this excess energy to electrical power before it is consumed.

For the City, there are four locations where this condition exists and there may be potential for hydropower generation:

1. NW Starlite Place PRV (Zone 4LR to 3S)
2. NE Beacon Drive PRV (Zone 4 to 3B)
3. Manzanita PRV (Zone 2 to 2A)
4. 9th & Savage PRV (Zone 2 to 2A)

These four regulated pressure zone connections are each analyzed in the following paragraphs, including an initial assessment of other factors which may remove them from further consideration and an estimate of the annual hydropower generation capability.

<u>NW Starlite Place PRV</u>

This PRV station, installed in NW Starlite Place, connects two existing constant pressure zones, Zone 4LR (Laurel Ridge) and 3S (Starlite). The purpose of this regulated connection between zones is to provide redundant supply to each zone in the event that either of their respective pump stations are out of service. As such, flow through the PRV is intermittent which precludes the implementation of hydropower generation at this location.

<u>NE Beacon Drive PRV</u>

The PRV station, installed adjacent to the NE Beacon Drive right-of-way, connects Zone 4 to a small Zone 3B which serves approximately 7 existing residential services, with a future total of 13 residential services anticipated. The annual volume of water supplied through this PRV connection is approximately 0.82 MG and the available hydraulic head is approximately 150 feet. Annual hydropower generation potential at this location is approximately 560 kilowatt hours (kWh), assuming an overall system efficiency of 70 percent. At an assumed average value of $0.08 per kWh, the annual revenue from a hydropower generation facility at this location is approximately $45. As such, hydropower generation is not economically feasible at this location.

Manzanita PRV

This PRV station, located in a buried utility vault in the southwest corner of the intersection of NW Manzanita Avenue and NW Hawthorne Avenue, connects Zone 2 to Zone 2A. This is one of two locations where Zone 2A receives regulated supply from Zone 2. The other location is at 9th and Savage. The annual volume of water supplied through the two PRV connections is approximately 80 MG and the available hydraulic head is approximately 90 feet. Annual total hydropower generation potential between the two PRV locations is approximately 32,000 kWh. The annual revenue from hydropower generation facilities utilizing the total potential energy of supply to Zone 2A is approximately $2,563.20. Given the low revenue potential and need to construct and operate facilities at both sites, hydropower generation is not economically feasible at either location.

9th & Savage PRV

This PRV station, located in a buried utility vault in the sidewalk on the northwest corner of the intersection of NE 9th Street and NE Savage Street, is the other location where water is supplied from Zone 2 to Zone 2A. As described above, hydropower generation is not feasible for the regulated supply between the two pressure zones.

Hydropower Feasibility Conclusions

Based on a review of the City's water system hydraulics and the assessment presented above, there are limited opportunities for implementation of hydropower generation. Three regulated connections between pressure zones in the distribution system provide the hydraulic and physical feasibility to generate hydropower but the conditions at these locations are not economically viable, primarily due to the low average rate of water supply through these PRVs resulting in electricity production that does not support the construction or operational costs of maintaining the facility and equipment.

Summary

This section presented an analysis of the City of Grants Pass's water distribution system based on projected future water demands presented in **Section 2** and performance criteria outlined in **Section 3**. This water system assessment includes service pressures and zone boundaries, storage and pumping capacity, facility condition and emergency fire flow availability. This section provides the basis for recommended distribution system improvements presented in **Section 5** Capital Improvement Program.